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## 37th European Conference on Visual Perception Belgrade, Serbia 24 – 28 August 2014

### Abstracts

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<b>Sunday</b>		Talks: Visual Search	63
Invited Talk: Perception Lecture	1	Talks: Motion	65
<b>Monday</b>		Talks: Colour	67
Symposium: A celebration of the life and scientific work of Ian Howard	2	Talks: Biological Motion	69
Symposium: Advances in studying the perception of surface properties	4	Posters: Face Perception II	71
Talks: Attention	6	Posters: Illusions II	77
Talks: Art and Vision	9	Posters: Brain Mechanisms II	79
Talks: Eye Movements	11	Posters: Attention II	82
Talks: Lightness	13	Posters: Perception and Action II	84
Posters: Face Perception I	15	Posters: Eye Movements II	86
Posters: Illusions I	20	Posters: Colour and Illumination II	88
Posters: Brain Mechanisms I	22	Posters: Clinical II	90
Posters: Attention I	25	Posters: Multisensory Processing II	91
Posters: Perception and Action I	27	Posters: Sensory Development and Aging II	93
Posters: Eye Movements I	30	Posters: Visual Search	94
Posters: Colour and Illumination I	32	Posters: Visual Memory	98
Posters: Clinical I	33	Posters: Biological Motion	102
Posters: Multisensory Processing I	35	Posters: Applications	105
Posters: Sensory Development and Aging I	37	Posters: Object Recognition and Categorization	107
Posters: Motion	39	Posters: Spatial Vision	109
Posters: Grouping Principles	43	Posters: Rivalry	111
Posters: Depth, 3D, Stereo	47	<b>Wednesday</b>	
Posters: Aftereffects	50	Invited Talk: Rank Prize Lecture	113
Posters: Surface, Texture and Material Perception	53	Symposium: Amodal completion: Michotte's legacy and new directions fifty years after 'Les compléments amodaux'	113
Posters: Perceptual Learning	54	Symposium: Measuring visual awareness - approaches, applications, recommendations	116
Posters: Scene Perception	56	Talks: Multisensory Processing	118
<b>Tuesday</b>		Talks: Learning	120
Symposium: Putting Vision into Context: a fresh look at contextual modulation	58	Talks: Face Perception	122
Symposium: Motion processing in typical and atypical development: symposium in memory of John Wattam-Bell	60	Talks: Development	124
		Posters: Face Perception III	126

---

Posters: Illusions III	131
Posters: Brain Mechanisms III	134
Posters: Attention III	137
Posters: Perception and Action III	140
Posters: Eye Movements III	142
Posters: Colour and Illumination III	145
Posters: Clinical III	147
Posters: Multisensory Processing III	149
Posters: Sensory Development and Aging III	151
Posters: Visual Cognition	152
Posters: Art and Vision	157
Posters: Computational Neuroscience	160
Posters: Lightness and Brightness	163
Posters: New Methods	165
Posters: Binocular Vision	167

#### **Thursday**

Talks: Perceptual Mechanisms	169
Talks: Clinical	171
Talks: Perception and Action	173
Talks: Grouping Principles	175

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1983 Lucca (I)

1984 Cambridge (GB)

1985 Peñíscola (E)

1986 Bad Nauheim (D)

1987 Varna (BG)

1988 Bristol (GB)

1989 Zichron Yaakov (IL)

1990 Paris (F)

1991 Vilnius (LT)

1992 Pisa (I)

1993 Edinburgh (GB)

1994 Eindhoven (NL)

1995 Tübingen (D)

1996 Strasbourg (F)

1997 Helsinki (FI)

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1999 Trieste (I)

2000 Groningen (NL)

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2007 Arezzo (I)

2008 Utrecht (NL)

2009 Regensburg (D)

2010 Lausanne (CH)

2011 Toulouse (F)

2012 Alghero (I)

2013 Bremen (D)



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## ECVP 2014 Abstracts

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### SUNDAY

#### INVITED TALK: PERCEPTION LECTURE

◆ **Theoretical approaches to lightness and perception**

A L Gilchrist (Psychology Department, Newark Campus, Rutgers University, USA;  
e-mail: alan@psychology.rutgers.edu)

Theories of lightness, like theories of perception in general, can be categorized as high-level, low-level and mid-level. However I will argue that in practice there are only two categories: one-stage mid-level theories, and two-stage low-high theories. Low-level theories usually include a high-level component and high-level theories include a low-level component, the distinction being mainly one of emphasis. Two stage theories are the modern incarnation of the persistent sensation/perception dichotomy according to which an early experience of raw sensations, faithful to the proximal stimulus, is followed by a process of cognitive interpretation, typically based on past experience. Like phlogiston or the ether, raw sensations seem like they must exist, but there is no clear evidence for them. Proximal stimulus matches are post-perceptual, not read off an early sensory stage. Visual angle matches are achieved by a cognitive process of flattening the visual world. Likewise, brightness (luminance) matches depend on a cognitive process of flattening the illumination. Brightness is not the input to lightness; brightness is slower than lightness. Evidence for an early (< 200 msec) mosaic stage is shaky. As for cognitive influences on perception, the many claims tend to fall apart upon close inspection of the evidence. Much of the evidence for the current revival of the new look is probably better explained by (1) a natural desire of (some) subjects to please the experimenter, and (2) the ease of intuiting an experimental hypothesis. High level theories of lightness are overkill. The visual system doesn't need to know the amount of illumination, merely which surfaces share the same illumination. This leaves mid-level theories derived from the gestalt school. Here the debate seems to revolve around layer models and framework models. Layer models fit our visual experience of a pattern of illumination projected onto a pattern of reflectance, while framework models provide a better account of illusions and failures of constancy. Evidence for and against these approaches will be reviewed.

Monday

**MONDAY****SYMPOSIUM: A CELEBRATION OF THE LIFE AND SCIENTIFIC WORK OF IAN HOWARD**◆ **A celebration of the life and scientific work of Ian Howard**

B J Rogers<sup>1</sup>, R Allison<sup>2</sup>, S Palmisano<sup>3</sup> (<sup>1</sup>Department of Experimental Psychology, University of Oxford, UK; <sup>2</sup>Department of Electrical Engineering and Computer Science, York University, Canada; <sup>3</sup>School of Psychology, University of Wollongong, Australia;  
e-mail: brian.rogers@psy.ox.ac.uk)

Ian Porteus Howard (1927-2013) had a remarkable academic career spanning over 60 years that started with his appointment at the University of Durham in 1952. He is probably best known for his outstanding books – “Human Spatial Orientation” (1966) (with Brian Templeton), through “Human Visual Orientation” (1982), “Binocular Vision and Stereopsis” (1995), the 2 volumes of “Seeing in Depth” (2002) and finally the 3 volumes of “Perceiving in Depth” (2012). Ian was also a talented experimentalist and the creator and builder of many novel pieces of experimental equipment including his rotating sphere and rotating room. Over the six decades he worked on a wide variety of research topics together with many graduate students, post-docs and researchers from Canada, USA, UK, Japan and Australia.

◆ **Howard in Depth**

B J Rogers (Department of Experimental Psychology, University of Oxford, UK;  
e-mail: brian.rogers@psy.ox.ac.uk)

Ian’s interests in 2-D spatial vision are very evident from the titles of his first two books - "Human Spatial Orientation" (1966 with Brian Templeton) and "Human Visual Orientation" (1982). In the early '90's, Ian's interest in torsional eye movements and my own interest in binocular stereopsis brought us together to carry out a series of experiments on the role of horizontal and vertical shear transformations of binocular disparity in driving cyclovergent eye movements. This in turn led us to organise the 1993 York Conference on "Binocular stereopsis and optic flow" as well as Ian's decision to write a third book on "Binocular Vision and Stereopsis" which he asked me to co-author. Writing the book was one of the most difficult challenges I have ever faced, not least because while Ian would write 1000+ words almost every day, I had to try and catch up in manic bursts between teaching and other commitments. Ian's objective was to provide a complete and comprehensive review of all the work that had been done in the field up to that time; a philosophy that also characterized the subsequent two volumes of "Seeing in Depth" (2002) and the final three volumes of "Perceiving in Depth" (2012).

◆ **Howard's wisdom: From OKN to Troxler Fading**

E G González (Vision Science Research, Toronto Western Hospital, Canada;  
e-mail: esther.gonzalez@utoronto.ca)

During my time as a postdoctoral fellow in Ian's lab we explored the hypothesis that, in humans, the coupling of stereopsis and OKN allows people to stabilize the images of objects within the plane of fixation while ignoring competing motion signals from objects at other distances. After that, I spent a number of years characterizing the visual system of people who have lost an eye early in life. Along with other researchers, I had obtained evidence of plasticity and recruitment of the resources of the enucleated eye by the remaining eye, but some of the data did not make sense and I was convinced that patching one eye in binocularly normal controls was not equivalent to true monocular viewing. I had the idea that patching one eye created a form of binocular rivalry and consulted Ian about testing it with Troxler fading. I was surprised to hear that, in 1959, he had done some research with enucleated people and encouraged me to proceed. When I did the research, I found that peripheral fading with binocular viewing takes longer than with monocular—that is, patched—viewing while the time to fading of enucleated people is as long as the binocular time. I will discuss these results and Ian's help in all this.

◆ **Howard in Motion**

S Palmisano (School of Psychology, University of Wollongong, Australia;  
e-mail: stephenp@uow.edu.au)

In the late 1980s, and throughout the 1990s, Ian Howard's Human Perception Lab (at York University, Canada) was one of the most productive and dynamic centres studying self-motion perception in the world. Masao Ohmi, Bob Cheung, Jack Landolt, Thomas Heckmann, Laura Telford, Eric Groen, Robert

Monday

Allison and myself (to name just a few) all worked on self-motion perception in Ian's lab. The appeal of working on self-motion with Ian was obvious. On a given day, you could be accelerated through a hall of mirrors, ride inside a rotating sphere or drum, be tumbled head-over-heels in the tumbling room, or even experience self-motion in microgravity during parabolic flight. Much of Ian's research during this period investigated visually induced illusions of self-motion, known asvection. With his collaborators, Ian showed thatvection: (a) was dominated by the motion of the perceived background; (b) could be enhanced by the presence of a stationary foreground; (c) was similar for both central and peripheral motion stimulations; (d) could produce convincing perceptions of head-over-heels self-rotation. His seminal papers challenged focal-ambient and peripheral dominance theories of self-motion perception, and continue to shape modern research into visual-vestibular interactions.

[ $\Psi$ -P3 (The Centre for Psychophysics, Psychophysiology and Psychopharmacology) and NASA Cooperative Agreement NCC 9-58.]

◆ **Howard's inclinations**

N Wade (School of Psychology, University of Dundee, UK; e-mail: n.j.wade@dundee.ac.uk)

Orientation was the bedrock of Ian Howard's analysis of perception. It provided the focal points for his first books, on "Human Spatial Orientation" and "Human Visual Orientation", and it informed his analyses of "Binocular Vision". In the course of my doctoral research (on visual-vestibular interaction) Ian was kind enough to supply a preprint of the chapter on the Aubert and Müller phenomena from his first book. One of its many outstanding features was the description of early German literature, due largely to the admirable assistance of his wife, Toni. After first meeting Ian in the early 1970s, we have shared interests in the historical foundations of research on visual orientation and binocular vision as well as experimental studies in these areas. There was a similar mutual fascination with the interplay between art and visual science and Ian used some of my 'perceptual portraits' in pamphlets for his research group as well as the cover illustration for "Human Visual Orientation".

◆ **Howard's slant**

H Kaneko (Department of Information Processing, Tokyo Institute of Technology, Japan;  
e-mail: kaneko@ip.titech.ac.jp)

In a series of studies, we investigated the effect of vertical disparity on the perception of surface slant (Howard and Kaneko 1994, Kaneko and Howard 1996, 1997a, 1997b). We used random-dot stereograms with various types of shear and size disparities presented on a large mirror stereoscope. The results showed that perceived slant (inclination) about a horizontal axis depends on the difference between horizontal- and vertical-shear disparities. In the similar way, perceived slant about a vertical axis depends on the difference between horizontal- and vertical-size disparities. In both cases, horizontal disparity was detected locally and vertical disparity was extracted over a relatively large area. The visual system may use the difference between horizontal- and vertical-shear disparities to protect against the effect of torsional misalignment of both eyes and the difference between horizontal- and vertical-size disparities to compensate for the effect of eccentric viewing of the surface. In other words, the vertical disparities extracted over a large area provide the reference for measuring horizontal disparity and contribute to the high sensitivity and accuracy of disparity processing for space perception.

◆ **Howard's Devices**

R Allison (Department of Electrical Engineering and Computer Science, York University, Canada;  
e-mail: allison@cse.yorku.ca)

Ian Howard loved optomechanical or electromechanical solutions for experimental stimuli and apparatus, an approach that is rare nowadays. Sometimes the device was the stimulus itself, as with the tumbling room, and in others the electromechanical system moved conventional stimuli, as in the dichoptiscope. This approach often allowed for precision, realism and fidelity not possible with computer-generated displays although it required skill at mechanical design and construction. Having collaborated with Ian on building several devices, I will review Ian's approach to the design of such apparatus, in particular highlighting some notable devices used to study binocular vision. I will also discuss what we can learn from Ian's approach in the light of new rapid-prototyping and manufacturing technologies for producing precise and easily constructed mechanical devices.

[NSERC (Canada)]

Monday

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◆ **Howard's way**

S Anstis (Department of Psychology, University of California, San Diego, USA;  
e-mail: sanstis@ucsd.edu)

I shall discuss Ian Howard's remarkable personal qualities, based upon our 40-year friendship. I also worked with Ian on depth and movement. Ian, Brian Rogers and I worked on an analog of Craik-O'Brien-Cornsweet edges in the depth domain. In the luminance domain, a sharp light-dark edge is superimposed on a blurred dark-light edge, and the sharp edge predominates perceptually. In the depth domain, we superimposed a sharp near-far edge on a far-near spatial gradient, and again found that the sharp edge predominated, giving a depth illusion. Ian and I, together with Spillmann & Kurtenbach, also investigated a random-dot field that alternated with its own photographic negative. Eye movements across this odd stimulus generated reverse phi, whose positive feedback made the eye movements self-sustaining. Jean Lorenceau has used this stimulus to help some paralyzed people learn to trace out letters of the alphabet with their eye movements, opening the door to a world of communication. Somehow, everything that Ian touched turned to gold.

**SYMPOSIUM: ADVANCES IN STUDYING THE PERCEPTION OF SURFACE PROPERTIES**

◆ **Advances in studying the perception of surface properties**

A Radonjić<sup>1</sup>, M Maertens<sup>2</sup> (<sup>1</sup>Department of Psychology, University of Pennsylvania, USA;  
<sup>2</sup>Modeling of Cognitive Processes, Berlin Institute of Technology, Germany;  
e-mail: radonjic@sas.upenn.edu)

Identifying surface properties accurately is important because it helps us to recognize objects and learn about their current state; this in turn guides our actions. Imagine choosing which strawberry to pick without information about its color! Although the perception of surface lightness, color and material all relate to the same broader question — how the visual system extracts information about physical properties of an object's surface from the pattern of light that reaches the eyes — they are often treated as separate fields of inquiry. We argue that success in solving the broader question requires considering these issues within a unified framework. Understanding the perception of surface properties is challenging because information about invariant properties of a surface becomes entangled with information about variable viewing conditions in the photoreceptor response. How vision resolves this ambiguity in the signal to recover a relatively stable representation of the physical properties of objects is one of the central problems in vision science, and common underlying principles are likely to govern the solution across different domains. This symposium aims to initiate discussion on current theoretical perspectives and research directions in color, lightness and material perception, and to identify the main challenges facing the field going forward.

◆ **Perception of infield-surround stimuli under controlled illumination conditions**

N Umbach, J Heller (Department of Psychology, University of Tuebingen, Germany;  
e-mail: nora.umbach@uni-tuebingen.de)

The perception of lightness has traditionally been studied with infield-surround stimuli (e.g., Wallach, 1948) and associated with concepts like the ratio principle and discounting the background (Walraven, 1976). Although it has been shown that the ratio principle (infields are matched when infield-surround ratio is identical) often fails, it is still commonly stated that it holds for a wide range of different illuminations. In the experimental literature, concepts like surround, background, and illumination are often not clearly defined and distinguished. In order to disentangle these concepts, we presented infield-surround stimuli in an illuminated room. In this setting, luminance of the surround cannot be interpreted as illumination by the perceptual system. We performed an experiment using decrements, presenting infields in five different surrounds under constant illumination conditions. Subjects first performed same-different judgments, followed by an asymmetric matching task. For these stimuli and both tasks, subjects performed luminance matching as opposed to ratio matching which would have been expected for decrements. These results show that it is important to clearly distinguish between the concepts surround, background, and illumination when trying to understand general concepts underlying lightness perception.

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◆ **The role of contrast in lightness perception using natural stimuli**

M Maertens (Modeling of Cognitive Processes, Berlin Institute of Technology, Germany;  
e-mail: marianne.maertens@tu-berlin.de)

The human visual system perceives the lightness of surfaces accurately despite substantial variations in illumination. While it is clear that the lightness of image regions is influenced by its surroundings, the exact mechanism for this contextual modulation is not yet understood. Different mechanisms have been proposed ranging from local mechanisms that respond to the physical contrast between an object and its background to mechanisms that involve the object's geometry and the depth and illumination structure in a scene. Using variegated checkerboard stimuli that contained photometric and geometric cues to illumination and to the presence of transparent media, we showed that observers' lightness matches in different viewing contexts were best predicted by a combination of a contrast computation between target and surround checks and a normalization of these contrast values according to differences in illumination. Here, we systematically manipulated the contrast between target and surround checks so as to realize more extreme contrast values within a viewing context. We argue that variations in observers' lightness matches for surface reflectances within one viewing condition (Type II constancy failures) can be explained by the application of the same contrast-based computation that is beneficial for extracting surface lightness in different viewing contexts.

[Supported by an Emmy-Noether research grant of the German Research Foundation (DFG MA5127/1-1).]

◆ **Lightness constancy via Bayesian anchoring**

R F Murray<sup>1,2</sup>, M Kim<sup>1,2,3</sup> (<sup>1</sup>Department of Psychology, York University, Canada; <sup>2</sup>Centre for Vision Research, York University, Canada; <sup>3</sup>Department of Psychology, New York University, USA; e-mail: rfm@yorku.ca)

Lightness constancy is the remarkable ability of human observers to perceive surface reflectance accurately despite variations in illumination and context. Two successful approaches to understanding lightness perception that have developed along independent paths are anchoring theory and Bayesian theories. Anchoring theory is a set of rules that predict lightness percepts under a wide range of conditions (Gilchrist, 2006). Some of these rules are counterintuitive, e.g., a rule that large surfaces tend to look lighter than small surfaces. Bayesian theories are formulated as probabilistic assumptions about lights and objects, and they model percepts as rational inferences from sensory data (e.g., Adelson, 2000). Here we reconcile these two seemingly divergent approaches by showing that many rules of anchoring theory follow from simple probabilistic assumptions about lighting and reflectance. We describe a simple Bayesian model that makes maximum a posteriori interpretations of luminance images, and we show that this model predicts many of the phenomena described by anchoring theory, e.g., anchoring to white, scale normalization, and articulation effects. Thus anchoring theory can be naturally formulated in a Bayesian framework, and this approach shows that many seemingly idiosyncratic properties of human lightness perception are actually rational consequences of simple assumptions about lighting and reflectance.

[Supported by Natural Sciences and Engineering Research Council of Canada and Canada Foundation for Innovation.]

◆ **Studying color constancy using natural tasks**

A Radonjić, D H Brainard (Department of Psychology, University of Pennsylvania, USA;  
e-mail: radonjic@sas.upenn.edu)

In everyday life we use color to identify and choose objects. However, color constancy has rarely been studied using tasks that require subjects to identify or choose. We have developed a selection-based paradigm for studying constancy that captures how color is used in real-life. On each trial in our experiments, the observer is asked to choose which of the two test objects, presented under a test illumination, appears closer in color to a target object, presented under a standard illumination. The tests are chosen from a predetermined set of color samples which vary over a fixed range — typically from the tristimulus match to the reflectance match for the target. Across trials, the target is presented with all pairwise combinations of tests. From observers' choices we can infer a selection-based match for the target under the test illumination, using a variant of the analysis that underlies maximum likelihood difference scaling. We use this selection-based match to quantify constancy. The color selection paradigm enables us to study constancy using a fairly natural task. To date we have employed the method to



Monday

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investigate the role of stimulus complexity on color constancy, as well as the nature of instructional effects in constancy experiments.

[Supported by NIH RO1 EY10016 to DHB]

◆ **The role of memory in surface color perception**

M Olkkonen<sup>1</sup>, T Saarela<sup>1</sup>, S Allred<sup>2</sup> (<sup>1</sup>Department of Psychology, University of Pennsylvania, USA; <sup>2</sup>Department of Psychology, Rutgers – The State University of New Jersey, USA; e-mail: mariaol@sas.upenn.edu)

Real-world color perception often involves memory. Despite this, the role of memory has often been overlooked in the color appearance literature. We investigated the effect of memory on color estimates in typical center-surround displays. First, we measured the effect of (1) memory, (2) color context, and (3) both memory and context on color matches. Results: (1) Delayed color matches were noisy and biased toward the average color of the whole stimulus set. (2) Manipulating the context elicited the classical surround color induction effect. (3) Memory and context effects were subadditive: Surround color induction was substantially weakened in delayed color matches. Subadditivity of memory and context effects does not follow from existing color appearance models. However, the subadditivity is accounted for by a Bayesian model of reflectance estimation: it arises if observers, while estimating surface reflectance, give more weight to prior expectations when sensory noise is high. To further investigate this idea, we next measured the effect of different levels of sensory noise on the bias toward average stimulus color. As predicted, increased noise led to larger biases. In summary: Memory makes color processing noisier, and perceptual biases arise as observers give more weight to expectations about stimulus color.

[Supported by NSF BCS 0954749 to SRA]

◆ **Effects of surface reflectance on 3D shape estimation in dynamic scenes**

K Doerschner<sup>1,2</sup>, D Dovencioğlu<sup>1,2</sup>, O Ben-Shahar<sup>3</sup>, M Wijntjes<sup>4</sup> (<sup>1</sup>Department of Psychology, Bilkent University, Turkey; <sup>2</sup>National Magnetic Resonance Research Center, Bilkent University, Turkey; <sup>3</sup>Computer Science Department, Ben-Gurion University, Israel; <sup>4</sup>Faculty of Industrial Design Engineering, Delft University of Technology, Netherlands; e-mail: katja@bilkent.edu.tr)

The interaction of observers with the physical world requires our visual system to estimate 3D geometry and material properties of objects from various visual cues. Image motion is a particularly powerful cue to 3D structure, as has been demonstrated and investigated in many experiments using classical shape from motion stimuli. However, these studies commonly assume - implicitly or explicitly - a diffusely reflecting surface. While optic flow in these cases is indeed directly linked to the object motion, its behavior when the surface is specular, is related to the 3D curvature of the underlying shape (Koenderink & van Doorn, 1980). While this specular flow may facilitate a complete reconstruction of the 3D shape in the theoretical sense (Adato et al. 2010, 2011), its different nature may also bias the perceptual estimation of 3D shape from motion. In this talk we present results of two studies that investigate the effects of surface reflectance on shape estimation tasks for moving and static objects. We discuss our findings in light of the special challenges that measuring perceived object qualities in dynamic scenes pose.

[Supported by a Marie Curie IRG (239494), a Marie Curie ITN (316746), and a Tuba GEBIP fellowship.]

## TALKS: ATTENTION

◆ **Visual attention filters for hue and saturation**

G Sperling, P Sun, C E Wright, C Chubb (Department of Cognitive Sciences, University of California, Irvine, USA; e-mail: sperling@uci.edu)

An attention filter is a top-down instruction-initiated brain process in feature-based attention that allows selected visual information to pass but attenuates unselected information. Here we demonstrate a paradigm that enables one to quickly and precisely measure such human perceptual filters as accurately as one might measure photographic color filters. The principle involves centroid judgments. Subjects use a mouse to position a pointer at the centroid—the center of gravity—of a briefly displayed cloud of dots. They receive precise feedback. Trained subjects judge the centroid of 2,4,8, or 16 dots almost as accurately as the position of single dot. In attention experiments, a subset of dots in a large dot cloud is distinguished by some characteristic, such as a different color, and subjects judge the centroid of only the distinguished subset, e.g., dots of a particular color. The analysis computes the precise contribution to the judged centroid of every color of dot, i.e., the attention filter for that particular color and thereby

the selectivity of attention for that feature in that context. Measured attention filters for selecting dots of one color from a mixture of isoluminant colors are remarkably precise (>10:1 selectivity), attention filters for saturation much less so.

[Supported by USA National Science Foundation Award BCS-0843897]

◆ **Crowding limits multiple object tracking**

B Sayim, L de-Wit, J Wagemans (Department of Psychology, University of Leuven, Belgium;  
e-mail: bilge.sayim@ppw.kuleuven.be)

In dynamic, cluttered environments, humans often track several moving objects. It has been proposed that tracking is limited by the number of objects, their speed, or spacing. Here, we investigated the role of crowding – the inability to discriminate peripheral targets when surrounded by distracters – in multiple object tracking (MOT). Twenty observers tracked targets among distracters in a standard MOT paradigm. Each object was surrounded by a virtual ellipse that could not be entered by the other objects. In accordance with the size of crowding zones, these virtual ellipses contracted/expanded when the objects moved towards/away from fixation. We compared two types of ellipses, one was oriented with the main axis towards fixation (corresponding to the shape of the crowding zone) and the other one orthogonal to this axis. When the virtual ellipses prevented objects entering the crowding zones of other objects, MOT performance was better than when the virtual ellipses were rotated by 90 degrees, even though the minimal spacing between objects was the same in both conditions. These results show that crowding plays a major role in MOT, and that not spacing per se, but crowding-specific spatial relations determine MOT.

◆ **Top-down control of rapid attentional allocation to multiple objects**

A Grubert, M Eimer (Department of Psychological Sciences, Birkbeck College, University of London, London; e-mail: a.grubert@bbk.ac.uk)

Visual search for known target objects is controlled by representations of target-defining features. These attentional templates can guide spatial attention rapidly and efficiently to single targets among irrelevant distractors in the visual field. In the real world, we are often confronted with multiple task-relevant objects that arrive in rapid succession. How fast can attention be allocated to newly arriving events when it is already focused at the location of another target? And how rapidly can a top-down task set be switched off once a target item is found and the task set loses its relevance? Two visual search experiments are presented, which measured behavioural and electrophysiological markers of top-down guided attentional selection of two successively presented objects with target features. Results demonstrated that attention can be allocated efficiently to two objects at different locations that appear within 100 milliseconds of each other. When only the first object was task-relevant, attentional selection of the second object was strongly suppressed, indicating that attentional guidance processes are subject to rapid strategic control, and not simply an automatic consequence of the sustained activation of attentional templates. Results demonstrate the dynamic nature and flexibility of attentional selectivity in time and space.

◆ **Stimulus-driven capture of attention by subliminal onsets**

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We used a cueing procedure to test whether subliminal luminance-contrast cues capture human attention in a stimulus-driven way. On the basis of known top-down contingencies of attentional capture, we tested whether for attention capture by a contrast cue, the cue had to match the top-down set of searched-for target features, or whether the cue captured attention in a stimulus-driven way, regardless of its match to the top-down set. To test these hypotheses, participants searched for targets of a fix known contrast polarity (e.g., white) or of a fix known equiluminant color (e.g., red). In this situation, a non-predictive subliminal contrast cue captured attention, regardless of whether the cue was of the same contrast polarity as the target (e.g., white) or of a different contrast polarity than the target (e.g., black). This result was found for a target detection task, a target discrimination task, and if a saccade was made to the target. Also, the contrast cue captured attention even if a color-defined, luminance-equated non-singleton target was used. In summary, the results clearly support the conclusion that contrast cues capture human attention in a stimulus-driven way.

Monday

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◆ **Occipital TMS at phosphene threshold captures attention**

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Bright stimuli attract attention even when task-irrelevant, suggesting that attentional selection is driven principally by physical stimulus properties. However, the role of stimulus intensity in capture has become unclear, given recent demonstrations of capture even by stimuli so faint that they are not consciously perceived. Such unseen capture has been hypothesized to rely on feedforward subcortical processes, although it has proved experimentally difficult to evaluate the strength of this reliance and dissociate this from potential cortical sources. Here, we bypass the feedforward subcortical inputs, by directly stimulating occipital visual cortex using transcranial magnetic stimulation at the threshold for producing a flash-like phosphene percept. We found that phosphenes, when used as attentional cues, improved observers' ability to indicate which side of a Landolt-square target had a gap suggesting that phosphenes capture attention. Additionally, capture was stronger for seen cues than unseen cues, even though these were physically identical. Taken together, we show that subcortical feedforward processes are unnecessary for attentional capture and that not only physical stimulus properties but also variations in the state of the nervous system determine attentional capture.

[Supported by Deutsche Forschungsgemeinschaft RA 2191/1-1 to Dragan Rangelov]

◆ **Attention improves visual performance in amblyopic macaque monkeys**

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Amblyopia is a loss of acuity in one eye following abnormal visual experience in early life. Recent research suggests that amblyopes may also have deficient attention mechanisms. We investigated covert endogenous attention in non-human primate amblyopes and visually normal controls. We tested the effect of spatial cueing on subjects' ability to discriminate the direction of motion a vertical grating patch (target) appearing among an isoeccentric circular array of evenly-spaced, differently oriented, drifting grating patches. Performance was assessed at varying levels of contrast for each eye of each subject, with fixation control. We compared performance under valid cue and neutral cue conditions. We evaluated contrast gain (threshold shift) and response gain (change in maximum accuracy) for each cue condition. The results showed that (1) attention improved accuracy and decreased reaction times for all eyes tested; (2) the effect of the valid cue was greater for amblyopic than for non-amblyopic or control eyes; (3) for amblyopic eyes, attention improved performance consistent with a change in both response gain and contrast gain, whereas the predominant effect for non-amblyopic eyes was an increase contrast gain. The results indicate that covert endogenous attention is functional in amblyopes and, if deployed, can improve amblyopic vision.

[Supported by NIH R01s EY05864 to LK and EY016200 to MC]

◆ **Exogenous spatial attention in amblyopic adults is intact**

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Amblyopia is a developmental disorder characterized by a deficit in visual acuity, contrast sensitivity and position acuity in one eye following abnormal binocular experience during childhood. We explored whether exogenous (transient) attention improves orientation discrimination in amblyopes with the amblyopic or fellow eye and whether it differentially affects processing at locations across the visual field. 15 amblyopic (9-strabismic, 6-anisometric) and 15 control (age- and gender-matched) adults were tested monocularly on a 2-AFC orientation discrimination task. Four tilted Gabor patches appeared briefly along the vertical and horizontal meridians. To manipulate attention, participants were presented with either a valid-cue or a neutral-cue (one or four peripheral precues). Participants reported the orientation of the Gabor indicated by a response cue. Performance was significantly higher and faster for the valid- than the neutral-cue condition for both groups. The magnitude of the attentional benefit did not differ between the two groups or the two eyes in each group. Moreover, both groups exhibited canonical performance fields—better performance along the horizontal than vertical meridian and at the lower than upper vertical meridian—and similar effects of attention at all locations. These results illustrate that exogenous attention remains functionally intact in amblyopic adults.

[Supported by NIH R01 EY016200 to MC]

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**TALKS: ART AND VISION**
**◆ Illusory blue from gray medieval mural paintings: color naming, color categorization and Stroop effect**

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Colorimetric analysis of samples medieval paintings showed that whereas restorers considered them as blue, they had flat reflectance spectra and central ('gray') chromaticity coordinates. This study investigated the influence of simultaneous contrast and semantic knowledge on this medieval color illusion in three experiments. First, samples were mainly named blue when they were shown in their pictorial context on a color-calibrated computer screen. Munsell-color-matching showed a high deviation toward exaggerated bluish responses whereas color naming or color matching of other yellow or red painting details were consistent with the chromatic measures. Moreover, blue naming increased in the real viewing condition for observers visiting a medieval castle, suggesting that the illuminance condition or individual semantic knowledge (e.g. virgin mantle is blue) plays a role. Finally, significant benefit in RT were found in an adapted Stroop-experiment using these spectral coordinates for ink, insofar as the color word "blue" rather than "gray" was used. The Stroop effect was modulated by the background opposing color of the screen used to mimic the simultaneous contrast found in the paintings. Taken together, these results demonstrate that these greys are perceived as blue due to both chromatic and semantic contexts, and have implications with regard to medieval color theory.

[PEPs 2013 grant]

**◆ Do people dislike angles or do they like curvature?**

M Bertamini, L Palumbo (Psychological Sciences, University of Liverpool, United Kingdom; e-mail: m.bertamini@liv.ac.uk)

Curved shapes are preferred to angular shapes. This may be a byproduct of a dislike for angles (threat) or curves may be beautiful in themselves. We confirmed the basic effect using polygons with and without smoothing by a cubic spline (Exp 1). In Exp. 2 we used background scenes so that stimuli appeared within or outside peripersonal space. We hypothesized that dislike for threat would be particularly relevant in peripersonal space but could not confirm this. In Exp 3 we presented contours through apertures, so that in one condition we could have straight lines. Curved lines (parabola) were preferred to angular stimuli but also to straight lines without corners, suggesting that a dislike for angles was not a key factor. Finally Exp 4 adapted the manikin task with the same stimuli as Exp 1 to test a possible avoidance response for angular shapes. RTs for approaching vs. avoiding angular shapes did not differ. By contrast participants were slower and made more errors when moving the manikin away from curved shapes than for moving it towards, suggesting an approach reaction to curvature. Taken together the evidence does not support a dislike for angularity, but rather curvature is per se visually pleasant.

**◆ Analyzing artworks by means of vision sciences: the case of two Mona Lisas generating a stereogram**

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Connecting the domains of art and perceptual sciences can create interesting new perspectives on the perception, reception and appreciation of artworks. Here we show how applying knowledge and methods from vision sciences further illuminates the art historical meaning and relevance of Leonardo da Vinci's well-investigated masterpiece "La Gioconda". We examined two versions of the portrait, the famous version exhibited in the Louvre museum/Paris and a less known sister version owned by the Prado museum/Madrid, that have probably been painted next to each other in Leonardo's studio (Carbon & Hesslinger, 2013). On the basis of participants' estimations of the respective artist-model constellations we were able to reconstruct the original studio setting. We further compared the two versions by means of bidimensional regression analysis, which revealed an intriguing quality of this image pair: taken together, the Louvre and the Prado versions of the Mona Lisa might represent the world's first stereoscopic image. We present visual material, statistical analyses and reconstructions of the original setting supporting this hypothesis.

Monday

◆ **Stream along the aesthetic mind. The dynamics of elaborating artistic movies**

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Aesthetic appreciation is a dynamic process, for instance the appeal of innovative design is modulated by the degree of elaboration (Carbon & Leder, 2005), liking increases after a perceptual insight into suddenly emerging Gestalt (“Aesthetic-Aha”-effect, Muth & Carbon, 2013) and interestingness is linked to “disorientation”, surprise and expectation of processing success (Berlyne, 1971; Silvia, 2008). Dynamics of appreciation are particularly relevant to the perception of indeterminate artworks which challenge recognition but offer insights into Gestalt. We conducted studies on temporal and semantic dynamics during the elaboration of film material with characteristic changes in terms of determinacy. Via a lever participants evaluated the film continuously on two dimensions blockwise. Outcomes reveal dynamic relationships between an artwork’s semantics and its aesthetic impact: Peaks in evaluated determinacy and surprise were defined as perceptual insights; (i) we found that a typical insight occurred during an increase in complexity. Whereas (ii) liking increased immediately after such an insight, (iii) interestingness rose already shortly before and correlated with surprisingness and complexity. We suggest that the stream of processes during the elaboration of indeterminate art reflects the dynamic interaction between observer and artwork and is crucial to an understanding of the unfolding of meaning and aesthetic experience.

◆ **Neural substrates of the local-to-global shift in mosaic images**

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It was hypothesised that the pleasure mediating understanding of deceptive properties of ambiguous images can account for much of their positive appreciation. Our previous study (Stevanov et al, 2012) showed distinct patterns of brain activity in the occipito-temporal lobe that correlates with the occurrence of perceptual flips in ambiguous paintings of Ocampo, Arcimboldo, Del-Prete and Utagawa. These images have distinct local and global interpretations experienced as two-or-more equally likely interchangeable percepts. To substantiate the brain response to perceptual flips from that associated with the shift from local to global percept, we constructed global images of objects comprised of less conspicuous local images. Stimuli were slowly demagnified starting from local details and ending with the global view. Subjects pressed a button when they recognised the global figure indicating the moment when the local-to-global shift occurred. Stronger brain activity was found in object selective regions than in late stages of the ventral visual pathway. Different patterns of brain activity in occipito-temporal regions obtained in two studies suggest qualitatively different contributions of perceptual flips and local-to-global changes in visual-affective processing of ambiguous images.

[This work was supported by Japan Society for Promotion of Science Grant-in-Aid for Scientific Research (A) (22243044) awarded to Akiyoshi Kitaoka and by JSPS Grant-in-Aid for Scientific Research No. 25.13011 awarded to Hiroshi Ashida and Jasmina Stevanov]

◆ **Aesthetic and neural responses to synthetic images varying in their amplitude spectrum**

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A key property of natural scenes is their characteristic 1/f amplitude spectrum. Recently, consideration of natural scene statistics has motivated theoretical and computational approaches to a diverse array of perceptual tasks and functions: from contrast coding and contour completion to aesthetic appreciation. We investigated the response profile of early visual areas to synthetic images varying in the slope of their amplitude spectra in two viewing conditions: (1) explicit aesthetic rating and (2) passive exposure while performing an unrelated and demanding visual search task around fixation. In both conditions, the images were equated in RMS contrast and displayed at either low (10%) or high (30%) contrast levels. Participants (n = 12) underwent fMRI scanning at 3T whilst viewing these images. Across both tasks and contrast levels, in each visual area analysed (V1 to V4) BOLD responses were 1.5 to 2.5 times higher for images with a 1/f amplitude spectrum compared to steeper and shallower slopes. During the aesthetic condition only, the putamen and mOFC were also found to be active. Together, our results

show that early visual areas are optimally tuned toward processing images with natural scene statistics, suggesting a potential contribution to their aesthetic appeal.  
[Australian Research Council DP120103659 ]

## TALKS: EYE MOVEMENTS

### ◆ A direct comparison of perceptual and oculomotor contrast sensitivity

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Microsaccades (tiny, rapid eye movements) are inhibited for a few hundred milliseconds after the onset of a stimulus, a reflex possibly triggered through direct projections from the retina to the superior colliculus. We compared the contrast sensitivity of this oculomotor response to perceptual contrast sensitivity. The oculomotor system may be more sensitive because its function is to quickly optimize the input for a more complete perceptual analysis in visual cortex. We asked observers to detect a Gabor patch that appeared at fixation for 1 ms in a random half of trials. We used eight different contrast levels (adjusted for each observer) to estimate perceptual contrast thresholds, and to measure how microsaccadic inhibition changed as a function of stimulus contrast. In a signal detection analysis, treating each microsaccade as a report of stimulus absence, we translated microsaccade rates into units of  $d'$ , a direct measure of the oculomotor system's sensitivity. Oculomotor sensitivity increased with contrast, with stronger and faster microsaccadic inhibition for higher contrasts. However, we observed no significant inhibition for contrasts below the perceptual threshold. Therefore, under optimal conditions (foveal stimulation, full attention, no spatial or temporal uncertainty), the perceptual system has the same sensitivity as the oculomotor system.

[Supported by the Emmy Noether Programme (grant RO 3579/2-1) of the German Research Foundation (DFG).]

### ◆ The "where" and the "when" of overt attention in natural scenes: fixation probability predicts fixation duration

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The allocation of overt attention to a given location in a natural scene is characterized by two variables: the probability of the location to be fixated and the fixation's duration. While both measures have been used widely, surprisingly little is known about their relation. Using a large corpus of fixation data of 72 participants, 135 colour images and 3 distinct tasks, we first demonstrate that fixation probability ("empirical salience") computed on a subset of participants predicts fixation duration in a disjoint subset performing a different task. Linear-mixed-effect modelling shows that this relation cannot be explained away by joint dependencies on low-level features (e.g., luminance, contrast, edge density) nor by spatial biases. In a second step, we demonstrate that fixation probability obtained on these corpus data still predicts fixation durations for novel experimental data, even if stimuli are deprived of colour, globally reduced in luminance or contrast, or locally equalized in either luminance or contrast. Only if object content is removed, while keeping second-order statistics intact, the relation between fixation probability and duration falters. In sum, our data show a robust dependence of fixation duration on fixation probability, which does not depend on low-level image features, but on high-level scene content.

### ◆ Eye movements do not follow perceived location in visual crowding

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The relationship of eye movements and crowding is currently widely studied. Inaccurate source localization is one explanation contributing to crowding. In this study, we investigate whether an erroneously perceived position of objects due to crowding also affects saccadic landing position. Participants were asked to judge the position of two gabor patches (target and reference) that appeared on both sides of the fixation and to make a saccade to the target (defined as the one that was physically closest to fixation). Either the target or the reference was surrounded by four flanking Gabors (with either the same orientation or an orientation that differed by 45 degrees). Localization errors were determined relative to the perceived location of isolated targets. In crowded conditions, observers made larger perceptual localization errors than in the isolated conditions. During such errors, the reference was thus (mistakenly) perceived as being closer to fixation than the target. Nevertheless, our results show that

Monday

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even though this was the case, observer's eyes still landed correctly on the reference position (physically farther away than the target). We conclude that even though crowding influenced the observers' perceived location of objects, this did not influence the landing positions of their eyes.

◆ **The role of temporal integration windows in visual stability**

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Perception of objects and events requires integration of visual information over multiple timescales. Within a physiologically plausible range, three main temporal windows (TW) can be distinguished. At the shortest range, thresholds of perceived simultaneity are consistently estimated at 40 ms. TWs of 100 ms have been found in various paradigms such as backward masking: stimuli presented within such a TW are integrated into a single percept. In addition, various visual phenomena, such as apparent motion, the attentional blink, and inhibition of return operate on timescales of around 200-300 ms. Beyond this TW, two stimuli tend not to be viewed as part of a single object or event. Here we show that these TWs are affected differently by saccades. Brief TWs (< 100 ms) are disrupted peri-saccadically and are "reset" shortly after the beginning of each new fixation. In contrast, TWs of around 200 ms continue across saccades, underlying perception of events such as apparent motion in allocentric coordinates. Overall, this pattern of results suggest that a hierarchy of temporal integration windows plays an important role in visual stability and that many studies reporting spatial remapping can be re-interpreted in terms of time. [This research was supported by European Research Council Starting Grant "Construction of Perceptual Space-time" (ERC grant agreement no. 313658).]

◆ **Putting the "social" into social attention**

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Social stimuli have a tendency to both attract and direct attention. The literature on social attention has however, emerged largely from laboratory-based paradigms lacking in social context. This study examined the role of social context in modulating gaze behaviour of participants when they viewed people participating in a social interaction. A video of two actors in a waiting room was played to three groups of participants. In two social conditions, participants were told that the video was a live webcam feed from another room. The "socially-engaged" group believed they would subsequently be completing a task with the actors. The "non-engaged" group believed the actors would complete the task without them. In the final non-social, "free-viewing" condition, participants were told that the video was pre-recorded. Results demonstrated that social context significantly influenced viewing behaviour. Participants in the social conditions followed the gaze direction of the actors significantly less than those in the free-viewing condition. Furthermore, attention to the heads of the actors was significantly greater in the free-viewing condition relative to the social conditions. These results suggest that by underestimating the impact of ecological validity in social attention studies, researchers may risk drawing inaccurate conclusions about social behaviour in the "real-world".

◆ **Flexible frames of reference for multiplex viewing**

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Eye-guidance in scene viewing continues to inform theories of visual perception, however the proliferation of display screens in our daily built environment creates particularly unnatural formats of scene presentation, quite unlike our evolved natural environment. Using a picture-viewing paradigm we recorded eye gaze location with a sampling frequency of 1000Hz for observers as they viewed a range of photographic scenes. Scenes were presented either in contiguous or separated format, with a small bezel introduced to render the same scene but in four separate quadrants. Scenes could also appear scrambled into four quadrants, again either in abutting or separated format. The data reveal behavioural biases introduced by converting a single static display into quadrants of similar or different scenes. Viewers of scrambled scenes no longer exhibit the characteristic central fixation bias, even though the overall scene content is identical. Visual inspection becomes increasingly anchored around the four sub-scenes across the viewing time of the recording epoch. The data are compared with response latency data for

change detection in multiplex arrays and eye-movement data from CCTV observation to demonstrate the dynamic adjustment of frames of reference for viewing displays to suit the task and viewed content. [This research was conducted as part of the PhD thesis of Matthew J. Stainer, funded by the University of Dundee. Preparatory work leading to this research was enabled thanks to funding from British Academy project grant and Scottish Institute for Policing Research to Ken Scott-Brown. ]

## TALKS: LIGHTNESS

### ◆ **The role of grouping in the reverse contrast illusion**

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The Reverse Contrast illusion (Economou, Annan, Gilchrist, 1998) demonstrates an effect opposite to SLC. A gray bar surrounded by a black background and flanked by white bars, looks darker than an equiluminant gray bar resting on a white background and flanked by black bars. Grouping seems to mediate the direction and magnitude of the effect. When grouping between the bars and their flanks is strongest, reversed effects are observed. When grouping is weakened, the lightness difference between the targets tends to revert to a contrast direction. In order to more carefully test the contribution of grouping to the illusion we created a version in which the backgrounds were homogeneous, so that the baseline effect of the bars would be maximized. We parametrically varied the strength of several grouping factors: proximity, good continuation, common orientation, bar-width similarity, shape similarity, common fate and articulation. Observers adjusted the luminance of a patch on the screen to match the lightness of the target. Our results confirm that grouping manipulations affect the size of the illusion. We propose that this method could be used to measure the coherence of perceptual groups although issues concerning the graded nature of grouping still need to be addressed.

### ◆ **Simultaneous lightness contrast under different illuminations**

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We investigated lightness perception under different illuminations with observers adapted to the ambient light. Four simultaneous lightness contrast paper displays were sequentially presented in random order; one display was the classic textbook illusion (1), the other three were contrast displays with four squares per background arranged in such a way to form a cross with a central gap around the target. The crosses for the three modified contrast displays were characterized as follows: white cross on black background and black cross on white background (2); dark grey cross on black background and light grey cross on white background (3); crosses with luminance ramps (4). Participants were randomly assigned to one of three illumination conditions – scotopic, normal, and Gelb, which yielded for the identical targets the following luminance: 0.82, 6.81, and 560 cd/m<sup>2</sup> – and were asked to find for each target the corresponding “color” on a 16-step achromatic Munsell scale inserted inside a box whose illumination was unaffected by stimulus illumination. A main effect of illumination on lightness matching was found ( $p < 0.0001$ ), with targets appearing lighter as stimulus luminance is increased, regardless the type of configuration. Results are discussed with reference to existing theories in lightness perception.

### ◆ **Partial integration versus local/global anchoring: A test**

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If a spotlight covers half of a large rectangular piece of black paper, a middle gray square placed within the spotlight appears lighter than a white square located outside the spotlight (Gilchrist et al, 1999). This is consistent with anchoring theory, but inconsistent with the intrinsic-image theory claim that the relative reflectance of the two squares can be computed by integrating only the reflectance edges that intervene between the two (excluding the illumination edge). However, a partial integration model (Ross & Pessoa 2000; Gilchrist, 1988) could predict those results because the illumination edge would be partially classified as a reflectance edge and partially as an illumination edge. To test this possibility we repeated the test but added two additional dark gray squares, one in each region of illumination. Partial integration predicts that both squares in the spotlight, the middle gray and the dark gray, will lighten by the same proportion. The anchoring model predicts that the dark gray square will lighten more than the middle gray square, a phenomenon called gamut compression. Fifteen observers made Munsell matches



Monday

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for the four squares. The dark gray square lightened about twice as much as the middle gray square, consistent with the anchoring prediction.

[NSF: BCS-1230793; NIH: R25 60825-06 ]

◆ **Computational cortical theory of lightness constancy under varying illumination**

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In natural vision, achromatic surface color appearance (lightness) is remarkably invariant under changes in illumination (lightness constancy). The neural mechanisms underlying constancy critically involve cortical processes, including incompletely understood luminance 'ratio taking' computations in area V4 (Zeki & Marini, 1998). Edge integration theory (Rudd, 2013) proposes that the brain computes lightness by first encoding logarithms of luminance ratios at edges, then spatially integrating these ratios at a subsequent cortical stage. Prior to integration, edge ratios are perceptually weighted based on their classification as either surface reflectance, or illumination, edges. Rudd (2010) showed that observers tend to exclude ambiguous edges from edge integration when instructed to interpret these edges as illumination, rather than reflectance, edges. Here I show that lightness percepts in images containing real illumination cues (e.g. Adelson's checker-shadow) can also be explained if only reflectance edges are perceptually integrated, thus supporting the goal of representing surface reflectance independently of illumination. The exclusion of illumination edges from edge integration cannot be a strictly automatic process because it is sometimes influenced by instructions. I propose a cortical theory of lightness computation involving feedforward mechanisms in areas V1  $\Rightarrow$  V2  $\Rightarrow$  V4, and top-down feedback to V1, to explain the instruction effects.

◆ **Perceived lightness over space and time**

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Lightness of a surface depends on a particular luminance sampled through fixations (Toscani et al., 2013). However this information changes when the surface moves across a light field and so do lightness matches (Zdravkovic, 2008). We studied luminance integration over time and space in a lightness task. A virtual pendulum was presented in a scene with a clearly visible decreasing illumination (from left to right). Observers had to fixate a spot on a dark or light region of the pendulum for the whole duration of each trial. The pendulum either moved back and forth across the whole scene starting from a lighter or a darker position or was kept motionless in these two regions of interest. The observers performed matching task using virtual scale with twenty gray shades presented on the bottom of the same screen. In accordance with previous eye tracking and behavioural data, observers produced lighter matches when the pendulum was in the lighter side of the scene ( $p < .02$ ). Also when it moved from lighter to darker region the matches were lighter than when moving in the other direction ( $p < .05$ ), suggesting a particular importance of the first impression. Finally, lighter fixated region yielded to brighter matches ( $p < .0001$ ).

◆ **Attached vs. cast shadows: Same or different?**

A D Logvinenko (Department of psychology, Glasgow Caledonian University, United Kingdom; e-mail: a.logvinenko@gcu.ac.uk)

When in shadow the achromatic colours appear different than in highlight. This was confirmed by Logvinenko & Maloney (2006) who using multidimensional scaling (MDS) showed the two-dimensionality of achromatic colours. As they used only cast shadows, a question arises: is it also the case for attached shadows? Recently Madigan & Brainard (2014) argued in favour of the negative answer. Though, they failed to confirm the two-dimensionality for cast shadows either. To resolve this issue, an experiment was conducted in which 4 observers rated five times the dissimilarity between 8 achromatic Munsell chips presented in highlight and in shadows of both types. Specifically, the chips were presented in four conditions: in front in highlight; at slant in highlight; in front in shadow; and at slant in shadow. MDS analysis of the obtained dissimilarities revealed the two-dimensionality of achromatic colours for both types of shadow. Furthermore, the dimension induced by the cast shadow was found to be different from that induced by the attached shadow. This confirms an observation well-known to artists that attached and cast shadows are experienced as different phenomenological dimensions.

**POSTERS: FACE PERCEPTION I**◆ **Are faces lost in the crowd holistically?**

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Crowding is the disruptive effect of clutter on object recognition. Most models characterise crowding as a singular process, affecting features ranging from colour to motion. However, recent studies challenge this by demonstrating that crowding also occurs ‘holistically’ between faces (Louie, Bressler & Whitney, 2007). We first replicate this effect: with an identity-matching task on an upright target face (processed ‘holistically’), crowding is strong with upright flanker faces and weaker with inverted flankers (processed ‘featurally’). We find no such tuning for inverted target faces- both flanker orientations are equally disruptive. Although this has been taken as evidence that crowding is tuned for the holistic similarity between faces, we propose that the poor performance with inverted faces (a marker of holistic processing) may have obscured a low-level selectivity for feature orientation. To investigate this we adapted an eye-judgement task requiring detection of horizontal eye-shifts, known to be immune to inversion effects (Goffaux & Rossion, 2007). In this case, crowding is orientation-tuned for both upright and inverted target faces: performance is poor with matched target-flanker orientations and improves when they differ. Our results suggest that crowding is selective for the low-level similarity between face features, regardless of their role in ‘holistic’ identity processes.

[Supported by the Medical Research Council.]

◆ **Emotional faces and attentional blink: Happy face but not angry face holds attention**

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Attentional blink refers to a deficit in identifying the second of two targets embedded in a series of distractor stimuli presented in rapid succession. It has been assumed that the allocation of attention to first target (T1) should result in fewer processing resources available to identify second target (T2) when presented within about 500ms after T1. Thus if T1 holds more attention, the larger attentional blink should be observed. In this research, we examined the degree of attentional blink by adopting angry, happy, and neutral faces as T1, and animal faces as T2. Distractor stimuli were neutral upside-down faces. Note that we used toothy and non-toothy happy and angry faces: Toothiness of emotional faces was a between-subjects factor. Results showed that, irrespective of teeth exposure, attentional blink was larger when T1 was happy face than when T1 was angry face or neutral face. Correct identification rates of T1 did not differ significantly among three emotional faces when non-toothy faces were used, whereas neutral faces were identified more correctly than happy and angry faces when toothy emotional faces were used. Taken together, these results suggested, contrary to previous findings, that happy faces held more attention than angry faces.

◆ **Happy is complex and neutral is bright: Statistical image properties of face photographs showing different emotions**

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Emotional stimuli, especially faces, elicit various behavioral and neurophysiological responses, even after brief exposure. To shed more light onto the mechanisms of emotion perception, we analyzed statistical image properties of face photographs. We used images from four face databases depicting a total of 299 individuals who showed either four, six, seven or eight different types of emotions, respectively. The type of emotion had an effect on all analyzed image parameters: mean luminance, overall Fourier power, the slope of the radially averaged Fourier power spectrum, as well as measures that were calculated using the pyramid histogram of oriented gradients (PHOG; self-similarity, complexity and anisotropy). Of these, the slope of the Fourier power spectrum, i.e. the relation of power and spatial frequencies, was of particular interest. For example, this slope was steeper in images of happy faces than in neutral ones, i.e. they contained relatively high power in the low frequency range. PHOG complexity was higher in happy and fearful faces than in disgusted, neutral, sad and contemptuous faces. Our results suggest that information on emotions might be carried by image properties processed at low levels of the visual system. Consequently, such properties should be monitored in neurophysiological experiments.

Monday

◆ **Transcranial electric stimulation and cognitive training improves face perception**

- 4 R J Bennetts<sup>1</sup>, T Penton<sup>2</sup>, C Kohl<sup>2</sup>, M J Banissy<sup>2</sup>, S Bate<sup>1</sup> (<sup>1</sup>Psychology Research Centre, Bournemouth University, United Kingdom; <sup>2</sup>Department of Psychology, Goldsmiths, University of London, United Kingdom; e-mail: rbennetts@bournemouth.ac.uk)

Recently, there has been much interest in the effectiveness of cognitive training programmes across a variety of cognitive and perceptual domains. Some evidence suggests that combining training programmes with noninvasive brain stimulation techniques such as transcranial random noise stimulation (tRNS) can enhance training gains, but to date this has only been examined in numerosity and arithmetic tasks. In this study, we examined whether tRNS modulated the effects of a face recognition training programme. Participants completed a face discrimination training task for an hour per day over five days. Each day, training was preceded by twenty minutes of active high frequency tRNS or sham stimulation, targeted at the posterior temporal cortices or the inferior frontal gyri (IFG). Participants who received active stimulation to the posterior temporal cortices showed significant improvement on a facial identity discrimination task (the Cambridge Face Perception Test) after training, whereas those receiving sham or IFG stimulation showed no performance change. There was no evidence of an effect of stimulation on a face memory task (the Cambridge Face Memory Test). These results suggest that tRNS can enhance the effectiveness of cognitive training programmes, but further work is needed to establish whether perceptual gains can be generalised to face memory.

◆ **Perception of attractiveness and health by faces**

- 5 E A Nikitina (Laboratory of Developmental Psychology, Institute of Psychology, Russian Academy of Sciences, Russian Federation; e-mail: nalenka@yandex.ru)

Discussion of the problem of faces' attractiveness from the evolutionary perspective commonly suggests that the most attractive persons are the healthiest ones. However, the results of the psychological studies are contradictory. From one hand, symmetry (Rhodes et al., 2001; 2007), averageness (Langlois, 1990), sexual dimorphism (Komori et al., 2009) and skin coloration (Stephen et al., 2009) of faces contribute to both health and attractiveness perception. From the other hand, some experiments (Kalick et al., 1998) demonstrate that real health indicators of persons with the most attractive faces do not exceed significantly such indicators of the least attractive persons. The participants assessed gender, attractiveness and health by the set of 28 photos of newborns faces. The group of experts estimated symmetry and skin coloration of stimuli faces. Sexual dimorphism was determined as the percentage of correct answers of the whole group of participants about each baby gender. Health indicators of newborns (Apgar scores, height, weight of every child, mother's age, mother's health, complications of pregnancy and delivery, etc.) were taken from medical documentation. The analysis did not show any consistent correlations between attractiveness of faces and any health indicators. However, perceived health significantly correlates with attractiveness.

◆ **Orientation tuning is sharper when processing upright than inverted faces.**

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Inversion disrupts the visual mechanisms specifically engaged when processing faces. Recent evidence indicates that it impairs the encoding of horizontally-oriented cues of the facial image. However, it is unclear whether this horizontal encoding impairment is due to inversion broadening the orientation tuning curve, or shifting its peak location (i.e., preferred orientation). Alternatively it may merely shift the tuning curve downward and/or reduce its peak amplitude. We addressed these questions by systematically characterizing the effect of inversion in the orientation domain. Face images were filtered using 20°-wide Gaussian filters centered on vertical to horizontal range in steps of 22.5°. Participants discriminated face image pairs at upright and inverted planar orientation, in the different filtering conditions. We fitted the discrimination sensitivity as a function of orientation content separately for upright and inverted conditions using wrapped Gaussian functions. Besides that inversion shifted the orientation tuning curve downward and decreased its peak amplitude, we found that it broadened its bandwidth compared to upright planar orientation. In contrast, peak location was comparable for upright and inverted faces. Our results suggest that inversion decreases the overall quality and sharpness of orientation-selective face encoding but preserves its preferred orientation.

◆ **Why extensive training reduces the face inversion effect ?**

7 R Laguesse, G Van Belle, L Marichal, B Rossion (Psychology, UCLouvain, Belgium;  
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Inversion impairs face recognition, an effect that is thought to reflect a disruption of the ability to simultaneously perceive all features of an inverted face and integrate them into a single global representation (“holistic perception”). According to recent evidence, the face inversion effect can be reduced following extensive training with a new set of inverted faces (Laguesse et al., 2012). In this study, we used the same training procedure and attempted to understand the nature of this effect by looking at 8 participants’ behaviour in a gaze contingency task (Van Belle et al, 2010) allowing us to manipulate holistic processing with the amount of facial features simultaneously perceived on inverted faces. We replicated the reduction of the face inversion effect after training in a 4 alternatives forced choice matching task on a set of new faces. However, the relative advantage at processing inverted faces with a central mask than a central window in gaze contingency did not increase substantially, and did not provide supporting evidence that the untrained inverted faces were perceived more holistically following expertise training. Additionally, the inversion effect was dramatically reduced for learned faces in all conditions, suggesting that they were learned using a feature-based learning strategy.

◆ **Why is this specific image of Madonna the most prototypical one? Predicting prototypicality on basis of inspection frequency and familiarity**

8 T M Schneider<sup>1,2</sup>, C C Carbon<sup>1,3</sup> (<sup>1</sup>Department of General Psychology and Methodology, University of Bamberg, Germany; <sup>2</sup>Department of Psychology, Johannes Gutenberg-University, Mainz, Germany; <sup>3</sup>Bamberg Graduate School of Affective and Cognitive Sciences, University of Bamberg, Germany; e-mail: Tobias.Schneider@uni-bamberg.de)

Face research mainly concentrates on the perception of faces and how we can recognize faces. A topic, which is hardly addressed, is how facial prototypes are generated and on which experiences they are established. We tested a simple representation model based on the factors: frequency (how often specific visual exemplars of a face have been inspected so far) and how familiar the regarding exemplars are to the observer. Accordingly, participants were asked to rate the estimated frequency and familiarity of facial presentations of 10 famous persons across a period of 30 years (10 pictures for each celebrity = 100 stimuli total). To investigate the prototypicality of the shown presentations, the participants ranked the typicality of each picture for each celebrity. The estimated frequency and familiarity significantly and positively predicted 88% of the variance of the rankings, indicating that prototypes are generated on frequency-weighted familiarity of single exemplars. Interestingly, further analyses revealed that the age of the exemplars had no predictive power for prototypicality. We discuss different variables contributing to facial prototypes and how they are established and adapted, i.e updated, with regard to our results.

◆ **Geometric distortions of faces and their detection in natural scenes**

9 K Pongakkasira (Psychology, University of Kent, England; e-mail: kaewmart17@gmail.com)

Geometric distortions of faces and their detection in natural scenes Kaewmart Pongakkasira & Markus Bindemann School of Psychology, University of Kent, Canterbury, UK It has been suggested that human face detection might be driven by oval, face-shaped templates. This study examined this possibility directly by measuring the detection of distorted faces in natural scenes. To manipulate face shape, the faces were presented in their original dimensions or were selectively stretched in a horizontal or vertical plane while the other dimension remained constant. In three experiments, face detection was impaired for horizontally and vertically stretched faces compared to their unstretched counterparts. This effect was present in response times, accuracy, and in eye movements, and cannot be attributed to differences in face size per se or differences in the surface area of stretched and unstretched faces. These findings support the notion of oval templates for face detection.

◆ **Contrast chimeras reveal the importance of the eyes for early face processing**

10 K Fisher, J Towler, M Eimer (Brain and Behaviour Lab, Birkbeck, University of London, UK;  
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Reversing the contrast polarity of a face is known to disrupt face-selective processing and impair face recognition compared to faces in normal contrast. Here we used contrast chimeras and the face-sensitive N170 component of event-related brain potential (ERP) to investigate the importance of ordinal contrast relationships in the eye region and in the rest of the face for early face processing. Contrast chimeras were constructed by preserving the eyes in normal contrast while negating the rest of the face (positive eyes chimera), and by negating the eye region while preserving the rest of the face in normal contrast

Monday

(negative eyes chimera). As expected, full contrast inverted faces triggered delayed and enhanced N170 components as compared to normal contrast faces, confirming a disruption of contrast-sensitive face-selective processing. Additionally, positive eye chimeras triggered N170 components that were indistinguishable from those elicited by normal contrast faces. Importantly, negative eye chimeras were shown to delay and enhance N170 components as compared to normal contrast faces, and were statistically indistinguishable from full contrast inverted faces. Together, these results demonstrate that ordinal contrast relationships in the eye region but not in other facial regions are crucial for early perceptual face representations.

◆ **Face familiarity as a modulating but not a necessary factor for specific Thatcherization effects?**

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Thompson (1980) was the first psychologist who revealed Margaret Thatcher as an illusion, at least when considering her face: when he locally inverted the mouth and eyes areas and then inverted the whole facial context, this grotesque manipulation gets unnoticed. Besides Mrs Thatcher, the illusion works strongly and consistently across other faces, among them famous as well as unfamiliar faces. However, none study before tested Thatcherization for famous and unfamiliar faces in one single study together. Results from such a study (N=23, with 16 famous plus 16 unfamiliar faces) showed significantly higher accuracy (combined with longer RTs) for famous compared to unfamous faces, but only if original and thatcherized faces were inverted. Furthermore, participants used significantly more fixations in assessing grotesqueness in thatcherized famous compared to thatcherized unfamiliar faces. Behavioral results showed that inversion instead of Thatcherization causes most variance between perceptions of famous versus unfamiliar faces. Regarding eye movements, Thatcherization seems to be more irritating to the observer in famous faces than in unfamiliar faces revealed by the need for more fixations until participants could decide.

◆ **A trade-off between the representativeness of a morphed average face and the number of individual faces used in morphing**

12 S Mukaida<sup>1</sup>, T Kato<sup>2</sup> (<sup>1</sup>Faculty of Information Media, Hokkaido Information University, Japan; <sup>2</sup>Faculty of Informatics, Kansai University, Japan; e-mail: mukaida@do-johodai.ac.jp)

Average faces are structurally simple and visually straightforward representations of the facial characteristics of given populations of faces and are widely used in face processing research. This study addresses the question of how many faces should be used in morphing so the morphed average face may be seen as a reasonable representation of its population. For each of four groups of Japanese faces defined by gender (female and male) and age (30's and 40's), we constructed average faces of 12, 18, 24, 30, 36, 42, 48, 54, and 60 faces. We then paired the average faces of different age groups that were constructed using the same number of faces. One group of participants rated whether the paired faces looked the same individual and another their apparent age difference. As the number of individual faces in morphing increased (up to 30 for male and 48 for female faces), the perceived similarity of the average faces increased at the expense of their perceived age difference. For both female and male faces, a balanced point seems to be 24 faces where average faces of different age groups are likely to be seen as photographs of the same individual taken years apart.

[This study was supported by a grant to the first author from the Grant-in-Aid for Scientific Research(C) [23500263].]

◆ **The role of the face in detecting human presence in natural scenes**

13 M Endo (Law and Letters, University of the Ryukyus, Japan; e-mail: endom@ll.u-ryukyu.ac.jp)

The objectives of this study are to examine what role face cues play in detecting human presence in various natural backgrounds. Thirty-two undergraduates were asked to identify as quickly as they could, any human presence in random pictures of natural scenes, some of which contained only one individual while others contained no one. In brightly lit scenes, a human head/face seen from the front was detected significantly faster than when seen in profile or from the back. However, the advantages of the frontal view were not as evident when the picture contained the upper torso of a human body or even the whole body. In dark scenes, where only the contours were identifiable, profiles were detected significantly faster than frontal views when the picture contained only the head. However, a human presence in frontal view was detected significantly faster than human forms in profile view when the picture contained the

whole body. These findings suggest saliency of the face as the visual cue for human detection at short distances, and the involvement of other cues, such as human body forms at middle or long distances.

◆ **Facial paralysis grading: are achromatic images sufficient?**

<sup>14</sup> T Wang, L Qi, J Dong, S Zhang, S Wang (Department of Computer Science and Technology, Ocean University of China, China; e-mail: qilin@ouc.edu.cn)

Remote diagnosis of facial paralysis is gaining popularity due to the fast development of computer networking and multimedia techniques. Patients' facial movements are usually captured in the form of chromatic images and videos, which increased the workload of data storage and transmission. We wonder whether the chromatic and continuous motional information are critical in the diagnosis. We investigated 10 professional doctors' grading on 30 facial paralysis patients. These patients performed 5 facial movements (raise eyebrows, close eyes, screw-up nose, plump cheeks and open mouth) and these were recorded as achromatic images, chromatic images and chromatic videos. Each doctor viewed all these samples in a controlled random order that different visual data types of the same patient were shown in an interval of ten days. The experiment result shows that the facial movement, as expected, significantly affects the assessment for 25 patients (83.3%); while the type of the visual data is insignificant in affecting paralysis grading assessment for 28 patients (93.3%). The result suggests that for remote facial paralysis diagnosis, performing different facial movements is important, whereas the chromatic and continuous motional information are non-critical. For example, achromatic images can be adopted when the data storage and transmission are highly considered.

[This work was supported by grants from National Natural Science Foundation of China (Project No.61271405) and the Ph.D.Program Foundation of Ministry of Education of China (20120132110018).]

◆ **A new Mooney test**

<sup>15</sup> R J Verhallen, J D Mollon (Department of Psychology, University of Cambridge, United Kingdom; e-mail: rjv31@cam.ac.uk)

The Mooney Face Test (Mooney, 1957) is widely used in neuropsychology and vision science. It was originally designed for administration by personal interview. We have developed a new, online, three-alternative forced-choice (3AFC) version. We photographed 158 Caucasian volunteers and manually selected two photographs per volunteer as stimuli (316 in total). Application of a Gaussian blur, and a subsequent thresholding procedure, created two-tone Mooney images. Creating convincing distractor images presented the greatest challenge: by means of six automated transformations of the original stimulus image (various combinations of image morphing, rotation, and polarity inversion), we created six potential distractors, from which we manually selected two. On a 3AFC trial, the chance of a correct guess is 1/3; so to further reduce the level of chance performance, participants were required not simply to identify the image containing the face, but to click on one of the eyes of the face. A large online cohort (n=333) shows a wide distribution of performance and a significant sex difference favouring males ( $\rho=0.25$ ,  $p<0.0001$ ). Our extended, online version could be valuable in further investigating individual differences, and in elucidating the exact nature of what is measured by the Mooney test.

◆ **Featural and configural face processing probed with simultaneous and serial presentation**

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Configural face processing refers to perceiving the relational feature configuration (the first-order relations) and their spatial relations (the second-order relations). Scrambling features impairs configural processing, however we argue that simultaneous visibility of features can still initiate configural processing even with disrupted feature interrelations. Therefore, we devised a method for serial presentation of features assuming it will impair any kind of configural processing: (1) rapid serial presentation and (2) serial presentation interleaved with 2s blanks. Observers determined the number of trial repetitions. The highest recognition rate was achieved with the first-order congruent features presented simultaneously or within interleaved serial presentation. We suggest that interleaved serial presentation of the features allows enough time to initiate configural processing as participants are trying to retrieve a mental representation of the familiar face and compare each presented feature against it. With rapid serial presentation, recognition rate dropped dramatically, trial repetitions increased significantly and reaction time was substantially longer as a result of failure to initiate configural processing. Therefore, rapid serial presentation is the only mode that triggers pure featural processing.

Monday

Our results support the findings of previous studies accounting featural processing for prolonged reaction time.

## POSTERS: ILLUSIONS I

### ◆ A new type of the color-dependent Fraser-Wilcox illusion

17 A Kitaoka (Department of Psychology, Ritsumeikan University, Japan; e-mail: akitaoka@lt.ritsumei.ac.jp)

Fraser and Wilcox (1979) presented a motion illusion in a stationary image and Kitaoka and Ashida (2003) devised a new pattern to enhance the illusion. "Rotating snakes" is one of the applied works. Although the Fraser-Wilcox illusion chiefly depends on luminance, its color-dependent variant was proposed by Kitaoka (2010). The color-dependent Fraser-Wilcox illusion is produced with a combination of four elemental parts: long-wavelength part, short-wavelength part, dark part, and bright part. Kitaoka and Yanaka (2013) reported that the direction of illusory motion is reversed under a dim or dark illumination, suggesting a critical role of rods. The present study reports a new type of the color-dependent Fraser-Wilcox illusion, which is obtained when low-pass filtering is applied to an image of the color-dependent Fraser-Wilcox illusion. The main feature is that the illusion is fully observed in the central vision as well as the peripheral vision. Possible mechanisms are discussed.

### ◆ Edge constrained filling-in

18 J Geier<sup>1</sup>, M Hudák<sup>2</sup> (<sup>1</sup>Scientific group, Stereo Vision Ltd, Budapest; <sup>2</sup>Department of General Psychology, Pázmány Péter Catholic University, Hungary; e-mail: mariann@stereovision.hu)

Van Lier et al (2009) found that 'an afterimage colors may spread to previously uncolored areas, triggered and constrained by contours presented after the colored image' (p. R323) on the basis of the contour-driven afterimage of a coloured stimulus. We varied this phenomenon to investigate whether it is indeed the contours fitted to the edges of the adapting stimulus that cause the effect. We found that (i) the afterimage of the entire 8-pointed star stimulus is seen even when no test contour is present; (ii) the 4-pointed test contour star need not fit the edges, and the effect is restricted to the area of the adapting stimulus and not the one enclosed by the contours; (iii) to elicit the same effect triggered by van Lier et al's four-pointed star test contour, it is sufficient to use the contour segments that fit to the inner grey area of the adapting stimulus. We conclude that it is not the contours that trigger the colour of the afterimage, but the 4-pointed star test contour of one colour obstruct the spreading of the other colour.

### ◆ Illusory rotation of superimposed elements in terms of the Pinna illusion and apparent motion

19 M Ichikawa<sup>1</sup>, Y Masakura<sup>2</sup> (<sup>1</sup>Department of Psychology, Chiba University, Japan; <sup>2</sup>School of Computer Science, Tokyo University of Technology, Japan; e-mail: ichikawa@L.chiba-u.ac.jp)

When viewing the concentric circles, which consist of oblique components, the observers see an illusory rotation of the circles by expanding and contracting the circles (Pinna illusion: Pinna & Brelstaff, 2000, Vision Research). If several elements, such as dots, were superimposed on the circles, they will see the illusory rotation not only for the circles, but also for those superimposed elements (Ichikawa, Masakura & Munechika, 2006, Perception). We examined how the amount of dots (ranging from 0 to 40) affects the illusory rotation of the dots when the rotation of the circles was generated by the Pinna illusion (Pinna illusion condition), or by apparent motion (apparent motion condition). In the Pinna illusion condition, the direction of apparent rotation for the dots was always the same with that of the inner circle, and that rotation increased with the increment of dots. However, in the apparent motion condition, the direction of apparent rotation of the dots was frequently opposite to that of the inner circle, and the rotation of the dots decreased with the increment of dots. These results suggest that the basis of illusory rotation for the superimposed elements varies with the type of motion illusory, which generates the motion signal.

[This study is supported by JSPS Grant-in-Aid for Scientific Research (B) (#25285197) to ML.]

### ◆ The slalom illusion in the context of illusory lines

20 T N Gheorghes, J Reidy, A Soranzo (Psychology, Sociology and Politics, Sheffield Hallam University, United Kingdom; e-mail: t.gheorghes@shu.ac.uk)

In the slalom illusion, the straight trajectory of a dot crossing a pattern of tilted lines is perceived as being sinusoidal (Cesaro & Agostini, 1988). The perceived trajectory of the moving dot bends to enter

the line perpendicularly, generating a local distortion at each line trajectory intersection. The magnitude of the illusion is known to be affected by the angle of intersection, the velocity of the moving dot and the distance between the inducing lines. In the present research, we investigate whether the slalom illusion persists when replacing the inducing lines with Kanizsa illusory ones, and the impact of this on the magnitude of the illusion. Lee & Nguyen (2001) showed that V1 and V2 neurons respond to illusory contours, which would suggest that the illusion should persist in the presence of illusory lines. However, the authors found that the response to illusory lines in V1 is weaker and delayed when compared to V2. Given V1 neurons' implication in processing motion, it is expected that if the slalom illusion persists in the illusory condition, its magnitude would be negatively affected. Results are discussed in the context of early perceptual processing and global integration.

◆ **The slalom illusion in the context of partially invisible trajectory**

21 A Soranzo, T N Gheorghes, J Reidy (Psychology, Sheffield Hallam University, UK;  
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The slalom illusion is the condition whereby the straight trajectory of a dot crossing a pattern of tilted lines is perceived as being sinusoidal (Cesaro and Agostini, 1998). The authors suggested that this illusion might be due to a local distortion of the moving dot when traversing each tilted line: When the dot approaches the lines, its trajectory is distorted toward the normalization, that is, the dot bends to enter the line perpendicularly (Swanson, 1984). Furthermore, there might be a perceptual tendency of the moving dot to continue along this virtual trajectory. However, as the physical trajectory of the dot is straight, the final perceived trajectory is a compromise between the virtual and the physical trajectory. In the present experiment, we test this hypothesis by manipulating the area between the tilted lines. The area between the lines was either a) the same colour as the dot, to make the dot trajectory partially invisible; or (b) empty, leaving the dot's full trajectory visible. Results show that the illusion magnitude increases when the dot trajectory is partially invisible, supporting the hypothesis that the illusion results from a compromise between the physical and the virtual trajectory.

◆ **Considerations on retinal visual reset and some visual illusions**

22 M Idesawa (UEC Museum of Communications, UEC Tokyo: The University of  
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Some function similar to chopping amplifier in physical system must be provided in retina to solve inherent problem such as drifting. One possible mechanism might be a periodical visual reset; in which zero levels of retinal signal were renewed or refreshed periodically. The feedback delay and the spatial averaging features in retina might have some relations. Continuous wagon wheel illusion (James S. P. Macdonald et al., 2014 *Atten Percept Psychophys*, 76 64–72) might be the most typical periodical phenomena in human vision. Many attempts have been made to prove this feature, however, no concrete evidences were found. The author has examined the rate of periodical reset by detecting the speed giving the stationary fringe perception in the specially designed moving gratings; then found that the rate was varied with the environmental illumination level (50lx: 20Hz, 500lx: 25Hz, 1000lx: 30Hz, ...). Based on the features of visual reset and spatial filtering in retina, the author proposed the potential model for explaining anomalous motion illusions in still figures (Idesawa, 2010 *Optical Review* 17 557–561) and in swinging figures (Idesawa, 2011 *Perception* 41 ECVF Abstract Supplement 91). With the idea of retinal visual reset, consistent explanations for these illusions would be possible.

◆ **Illusion and illusoriness in perceptual and cognitive development**

23 K Deiana, B Pinna (Department of Humanities and Social Sciences, University of Sassari, Italy;  
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Within modern vision science, the visual illusions reveal two issues that challenge scientists. The first issue is related to the mismatch/disagreement between the geometrical/physical domain and the phenomenal one. The necessary condition for the perception of a phenomenon as an illusion, is the perception of this mismatch. The second issue follows from the first one and is related to at least two different visual levels emerging from each illusion: the perception of the illusion and the perception of the illusoriness. While the illusion is necessarily related to the presence and the perception of a mismatch between physical and phenomenal domains, the illusoriness is a perceptual attribute that is not necessarily related to the presence of a mismatch, but it can be perceived by itself and it is usually related to a sense of strangeness, singularity, quirk and oddity. Aim of this work is to study the perception of illusion vs. illusoriness. Differently from what recent neuroscience has stated we demonstrated, through some new phenomena here reported and studied in the entire life span development, that not all the



Monday

illusions show the illusoriness and vice versa. Furthermore, not all the effects showing the illusoriness attribute are really illusions.

## POSTERS: BRAIN MECHANISMS I

### ◆ **Unilateral art-training effect in left insular cortex: Drawing/music commonalities?**

24 L T Likova, S Nicholas (Smith-Kettlewell Eye Research Institute, USA; e-mail: lora@ski.org)

Striking unilateral activation has recently been discovered in left insular cortex (LIC) for listening to melodies previously rehearsed on a musical instrument. The underlying mechanisms are not yet known. Does this deep post-training asymmetry reflect a form of higher order, art-related cognition? Or a lateralized motor learning re-activation? We addressed this puzzle in a multimodal drawing-training paradigm. Methods: Using fMRI before and after training sighted and blindfolded participants to draw, we compared their brain activity under visual (or respectively, tactile) conditions in i) passive image viewing (or touching), ii) active reproduction by drawing from memory, iii) copying while images are present, and iv) non-image drawing (scribbling) as a motor control. Results/Conclusions: Pre-training, an LIC region was engaged during image viewing and copying. Post-training, however, the passive viewing activation was significantly reduced while both drawing tasks - drawing-from-memory and copying - activated LIC highly significantly; the motor-control condition did not activate LIC either pre- or post-training, excluding the motor re-activation hypothesis. Furthermore, LIC was not activated in any condition under blindfolding, implying restriction to the visual modality only. These results will be interpreted in a novel framework including presence-of-self, agency and embodied cognition in art, rather than simple re-activation of hand-representation.

[NSF and NEI grants to L.T.Likova]

### ◆ **A unified system-level model of visual attention and object substitution masking (OSM)**

25 F Beuth, F H Hamker (Artificial Intelligence, Chemnitz University of Technology, Germany; e-mail: beuth@cs.tu-chemnitz.de)

The phenomena of visual attention (Hamker, 2005, Cerebral Cortex) and object substitution masking (OSM; DiLollo & Enns, 2000) are supposed to rely on different processes. However, Pöder (2012) already suggested that attentional gating is sufficient and reentrant hypothesis testing is not required to explain OSM. However, present computational models have not been demonstrated to account for both phenomena at the same time. Based on a previous model of the frontal eye field (FEF) and the ventral stream (Zirnsak et al., 2011) we are developing a novel neuro-computational model that allows to simulate OSM and common visual attention experiments, like biased competition and visual search. In biased competition and in OSM setups, multiple stimuli or the target and the mask compete for a visual representation by means of inhibitory connections. This competition mechanism accounts for the mask duration dependency in OSM. OSM also requires a high number of distractors (set size effect) like in visual search paradigm. Our model explains this observation by spatial attention and spatially recurrent processing between FEF and V4. We conclude that OSM can be accounted by well-known attentional mechanisms within a unified model.

### ◆ **Integrating brain-stimulation and eye-tracking to investigate the dissociation between object and spatial visual processing**

26 O Blazhenkova, A Pasqualotto (Psychology, Sabanci University, Turkey; e-mail: olesya@sabanciuniv.edu)

The current study aims to integrate brain-stimulation and eye-tracking technologies to explore the specific roles of the main cortical areas involved in object (appearance in terms of shape and colour) and spatial (location and spatial relations) visual processing. This research examines short- and long-term effects of brain stimulation of the primary visual cortex, dorsal and ventral pathways during object and spatial visual processing, in terms of both performance and strategies. Moreover, it explores the modulating role of individual differences in object and spatial visual processing on the effects of brain stimulation. Specifically, four groups of participants received transcranial random noise stimulation (tRNS) on either V1, IT, PP, or “placebo” stimulation. During the stimulation, participants were administered a visual-object task and a visual-spatial task. The effects of brain stimulation on performance were estimated both in terms of accuracy and response time. To assess the long-term effects of the stimulation, participants were administered the same tasks after seven days. During both testing sessions, eye-tracking data was recorded and analysed in terms of fixations duration, frequency, and image exploration patterns. We

expected to find double dissociation between object and spatial processing, and to shed light on the contribution of the specific brain areas.

◆ **Co-registration of EEG and eye movements in vision research**

27 A R Nikolaev<sup>1</sup>, C Nakatani<sup>1</sup>, P Jurica<sup>2</sup>, G Plomp<sup>3</sup>, C van Leeuwen<sup>1</sup> (<sup>1</sup>Laboratory for Perceptual Dynamics, KU Leuven - University of Leuven, Belgium; <sup>2</sup>Laboratory for Advanced Brain Signal Processing, RIKEN Brain Science Institute, Japan; <sup>3</sup>Functional Brain Mapping Laboratory, Université de Genève, Switzerland; e-mail: Andrey.Nikolaev@ppw.kuleuven.be)

Co-registration of EEG and eye movements provides a natural way of segmenting into episodes ongoing brain activity related to perceptual processes. Co-registration is more than a simple addition of two techniques: it requires significant modifications of the experimental design and data processing, as well as a number of specific operations, in order to control the artifactual interaction of oculomotor and visual systems. In our presentation we will demonstrate the advantages of simultaneous recording and analysis of brain activity and eye movements. We will give two examples of the saccade-wise segmentation of EEG activity during free viewing of natural scenes: 1) for predicting failures in memory encoding; 2) for distinguishing memory encoding and saccade guidance processes. The first example indicates that in a change-detection task, dissociation between the direction of eye movements and attention leads to change blindness. The second example shows that the amplitude of the activity preceding short "scrutinizing" saccades is larger for correct change detection than for detection failure, suggesting that successful encoding requires local scanning of task-relevant scene regions. In addition, we will demonstrate dependence of the presaccadic EEG activity on saccade sizes, which during free viewing represent different scanning strategies.

[ARN, CN and CvL were supported by an Odysseus grant from the Flemish Science Organization (Fonds Wetenschappelijk Onderzoek, FWO).]

◆ **Visual decision-making and action implementation: Evidence in favour of race-like models with inhibition**

28 C Tandonnet (Faculté de Psychologie FPSE, Université de Genève, Switzerland; e-mail: christophe.tandonnet@unige.ch)

Models of visual decision-making differ by how evidence for the different alternatives is accumulated (i.e., independently vs. with interaction) and what the evidence reflects (i.e., only perceptual processing vs. involves also action selection). Measures of action implementation may be useful to assess the principles of decision making. Indeed, these measures can dissociate at least the models assuming that evidence accumulation involves action selection, a common assumption in models of saccadic decision-making. In previous studies, motor activity was assessed in visual choice tasks with manual responses. Transcranial magnetic stimulation and electro-encephalographic data are consistent with initial facilitation of both responses followed by inhibition of the non-selected response. For the race-like models assuming that evidence accumulation involves action selection, this pattern is compatible with inhibitory interaction between evidence accumulation for the different alternatives but not with independent accumulation. The models assuming that accumulation of evidence reflects only perceptual processing (race-like and diffusion-like models) cannot account for this pattern, unless further assumptions are added. Thus, interaction between alternatives through inhibition may reflect a basic mechanism of visual decision-making. The generalization of this principle to decisions involving saccadic eye movements are discussed.

[The author is supported by a grant from the Swiss National Foundation (100014-149600).]

◆ **Face symmetry perception in LOC: A study with fMR adaptation**

29 D Gokcay, F Yildirim, G Yildirim (Cognitive Science, Medical Informatics, METU, Informatics Institute, Turkey; e-mail: dgokcay@metu.edu.tr)

The role of lateral occipital cortex (LOC) in shape perception has been widely accepted (Grill-Spector, Malach, 2001), while its role in symmetry perception has also been demonstrated (Tyler et al., 2005). We investigated the neuroanatomical substrates of facial symmetry perception using fMR adaptation paradigm, hypothesizing strong participation of LOC. A custom database of face pictures, standardized for brightness, texture, pose and expression is generated. Furthermore, a symmetric version of each picture is produced through a warping scheme. In 3T Siemens-Trio scanner, subjects (n=11) evaluated whether the picture on display is the same as the previous one, while a block design paradigm is used. Two different blocks are utilized: 1. Adaptation block containing original pictures with same identity, 2. Adaptation-release block containing alternating original and symmetric pictures with same identity.

Monday

Results indicate that LOC participates in facial symmetry discrimination, because in both left and right hemispheres, LOC demonstrated significant adaptation release with a signal increase of 0.3%. Spatial extent of the activations was more prominent over the right hemisphere, and a sub-area of LOC, LO2, (Larson, Heeger, 2006), responded more extensively to the symmetry manipulation. We conclude that, in LOC, neuron populations that specialize in processing the symmetry attribute of faces exist.

◆ **Factors determining the balance between evidence integration and probabilistic sampling**  
30 **in perceptual decision-making**

J H Christensen<sup>1,2</sup>, M Lengyel<sup>3</sup>, J Fiser<sup>1</sup> (<sup>1</sup>Department of Cognitive Science, Central European University, Hungary; <sup>2</sup>Center for Visual Cognition, University of Copenhagen, Denmark; <sup>3</sup>Computational and Biological Learning Lab, Department of Engineering, University of Cambridge, United Kingdom; e-mail: jabba@c@gmail.com)

We have reported that contrary to theories of Evidence Integration (EI), time in visual perceptual decision-making is needed not only for accumulating external sensory evidence, but also for collecting samples from static internally represented distributions as it is predicted by the theory of Probabilistic Sampling (PS) (Cosyne 2013; VSS 2013). However, the precise relationship between EI and PS in the general case of dynamic stimuli is still unknown. We used an estimation-based variant of the classical random dot motion task, where in each trial, participants reported their best estimates of stimulus direction and their subjective uncertainty about it. Across trials, we varied the strength of the sensory evidence and the trial time, and across experiments, we varied the trial sequence volatility (intermixed versus blocked coherence levels). We found a marked decrease in error-uncertainty correlation within the first 300-500ms of the trial, indicating EI, followed by a significant increase throughout the trial, indicating PS. Importantly, the transition between these segments shifted as a function of signal coherence and volatility. Consequently, EI and PS during decision making work in parallel, with EI taking the lead early but PS dominating the later part of the probabilistic process.

◆ **Parietal transcranial random noise stimulation improves long-term visual acquisition of**  
31 **foreign vocabulary**

A Pasqualotto<sup>1,2,3</sup>, B Kobanbay<sup>1</sup>, M J Proulx<sup>2,3</sup> (<sup>1</sup>Faculty of Arts and Social Sciences, Sabanci University, Turkey; <sup>2</sup>Department of Psychology, University of Bath, UK ; <sup>3</sup>School of Biological and Chemical Sciences, Queen Mary University of London, UK ; e-mail: achille@sabanciuniv.edu)

The acquisition of a foreign language is a complex task and previous research investigated which learning method could yield the best results in terms of long-term acquisition. In particular, past studies stressed the importance of the testing phase for memory consolidation. There is evidence that a fronto-parietal circuitry is involved in language processing and comprehension, but it is still unknown which specific portion is crucial for foreign vocabulary acquisition, and this has never been directly assessed by using transcranial random noise stimulation, or tRNS. This type of neural stimulation enhances activity in the underlying cortex. In our study we tested the acquisition of visually presented Swahili vocabulary while three groups of participants were stimulated by tRNS over frontal or parietal lobes, plus a placebo condition. Vocabulary acquisition was tested both immediately and after seven days. We found that parietal, but not frontal, stimulation significantly improved the memory performance compared to the placebo condition both immediately and in the long-term. These results suggest that the parietal cortex is more directly involved in the consolidation of memory for foreign vocabulary than would have been previously expected.

[This work was supported by a Marie Curie IEF (grant number: PIEF-GA-2010-274163) and a grant from the EPSRC (EP/J017205/1).]

◆ **A theory for stimulus integration and bistable perception**

32 R Cao<sup>1,2</sup>, M Maurizio<sup>2</sup>, B Jochen<sup>1</sup>, A Pastukhov<sup>1</sup> (<sup>1</sup>Center for Behavioral Brain Sciences, Otto von Guericke University Magdeburg, Germany; <sup>2</sup>Complex Systems, Istituto Superiore di Sanita, Italy; e-mail: rcao.neurophys@gmail.com)

Multistable phenomena expose a 'self-organized' instability of perceptual representations, ensuring that all tenable interpretations are explored (Friston, Breakspear, Deco, 2012; Pastukhov et al., 2013). Based on an earlier model of competing stochastic integration (Gigante et al., 2009; Braun & Mattia, 2010) we model multistability with four ensembles of discrete neural nodes, such as bistable cell assemblies (Mattia et al., 2013). Importantly, all nodes undergo independent internal stochastic dynamics, modulated by input. Exploiting our improved analytic treatment of discrete stochastic integration (Cao et al.,

2014, ECVP), we constrain the model fully from experimental observations (mean and variance of dominance times, for different relative and absolute input strengths). In the resulting architecture, two lower-level ensembles stochastically integrate competing evidence, while two higher-level ensembles contest dominance in an all-or-nothing manner. The dominant higher-level ensemble suppresses its lower-level counterpart, ensuring instability. The ensuing collective dynamics accounts for the input dependence of dominance times (Levelt's propositions) and, for the first time, also for the variance and skewness of dominance distributions, maintaining their characteristic, Gamma-like shape. Gratifyingly, our observation-driven architecture rediscovers many aspects of current large-scale models of cortical function ('predictive coding', 'global workspace model', 'human Turing machine' (Hohwy et al., 2008; Dehaene & Changeux, 2011; Zylberberg et al., 2011)).

## POSTERS: ATTENTION I

### ◆ Influences of visual attention on chromatic and achromatic channels: effects of stimulus size and eccentricity

33 K Kuwamura<sup>1</sup>, M Sato<sup>1</sup>, K Uchikawa<sup>2</sup> (<sup>1</sup>Graduate School of Environmental Engineering, University of Kitakyushu, Japan; <sup>2</sup>Department of Information Processing, Tokyo Institute of Technology, Japan; e-mail: k\_kei7108@yahoo.co.jp)

We examined magnitudes of attentional influences on chromatic and achromatic channels in the visual system using a dual-task paradigm. Chromatic and/or achromatic discrimination tasks were performed simultaneously in central and in peripheral visual field. In the central task, stimuli were of twenty dots randomly distributed within a 5-deg circular region. The observer's task was to discriminate a higher contrast dot from other distracters. In the peripheral task, we measured contrast thresholds of a peripheral stimulus in the dual- and single-task. Two sizes of the peripheral stimulus were tested. The small test stimuli of eight circles of 1.2-deg in diameter were presented with eccentricity of 4-deg. The large test stimuli of two rectangles of 9.5-deg width and 16-deg height were presented with eccentricity of 11-deg. The observer's task was to discriminate a stimulus with higher contrast. Threshold elevation obtained in the dual-task was significantly large when the central and peripheral tasks were combinations of chromatic and achromatic discriminations for the small test stimuli, whereas threshold elevation did not depend on such combinations for the large test stimuli. These results suggest that it is difficult to pay visual attention simultaneously both to chromatic and to achromatic stimuli in a small visual field.

### ◆ Individual differences in the ANTI-V paradigm

34 R Gorjup<sup>1,2</sup>, P Bernardis<sup>2</sup>, M Grassi<sup>2</sup>, W Gerbino<sup>2</sup> (<sup>1</sup>Faculty of Education, University of Primorska, Slovenia; <sup>2</sup>Department of Life Sciences, University of Trieste, Italy; e-mail: radogorjup@hotmail.com)

To compare direct and indirect indices of attention we used the ANTI-V paradigm (Roca et al., 2011), which includes a primary task (providing independent measures of phasic alertness, orienting, and executive control) and a secondary task (providing direct measures of vigilance). Fifty-four students participated in the experiment. Accuracy in the primary task was at ceiling, while the pattern of response speeds displayed the expected effects related to phasic alertness, orienting, and executive control. An unexpected correlation between phasic alertness and executive control speed scores was also obtained. As regards the secondary task, both accuracy and speed scores were obtained, allowing us to discover a moderate speed-accuracy trade-off between the two tasks: higher accuracy in the secondary go/no go task was associated with the slowing down of speed in the primary yes/no task. Averaging over various conditions of the primary task (i.e., independent of alerting tone presence, cue validity, and flanker congruency) a strong correlation was obtained between response speeds in primary and secondary tasks. However, CFQ scores (a self-report individual measure of everyday failures of attention) did not correlate with overall speed, but with specific aspects of performance related to phasic alertness and vigilance.

[Supported by EcoAutobus-Industria 2015 (P.I. Walter Gerbino)]

### ◆ Attending to multiple locations for action is neither automatic nor universal

35 S J Sandoval Similä, R D McIntosh (Human Cognitive Neuroscience, University of Edinburgh, UK; e-mail: s.j.sandoval-simila@sms.ed.ac.uk)

Visual attention has been found to be allocated to the target of manual movements (Deubel, Schneider, & Paprotta, 1998), and two-step movements have been reported to recruit attention to both target locations in parallel (Baldauf, Wolf, & Deubel, 2006). We addressed a related question of whether the starting

## Monday

point of the movement is also attended, when the responding hand is not known in advance. We found some evidence of attentional enhancement at the target location, in line with previous findings, but not for enhanced attention to the hand start point. In order to assess whether this was a specific lack of attention to the start position, or a more general limitation in splitting of attention between two locations for action, we attempted to replicate prior findings showing enhanced attention to multiple target locations during two-step movements. Our results indicate that the splitting of attention in multi-step pointing is not automatic or universal, and may require considerable practice at the task to emerge at all. Our results highlight the importance of both individual differences and practice in the coupling of attention and action.

◆ **Does action disrupt the ability to track multiple objects?**

36 H J Guest<sup>1</sup>, T S Horowitz<sup>2</sup>, I M Thornton<sup>3</sup> (<sup>1</sup>Department of Psychology, University of Malta, Malta; <sup>2</sup>National Cancer Institute, National Institutes of Health, USA; <sup>3</sup>Department of Cognitive Science, University of Malta, Malta; e-mail: ian.thornton@um.edu.mt)

Recently, we measured the ability to control multiple objects using an iPad task, inspired by mobile app games such as Flight Controller and Harbor Master (Thornton, Bühlhoff, Horowitz, Rynning & Lee, 2014). In this interactive Multiple Object Tracking (iMOT) task, the goal was to avoid objects colliding, rather than tracking for identity as in standard MOT. However, in one dual-task experiment participants simultaneously controlled objects and tracked them as in standard MOT. We predicted the need to focus attention to act would significantly impair tracking for identity. In fact, dual-task MOT performance actually improved slightly relative to baseline. Here, we report a new experiment to further explore the impact of action on MOT performance. In all trials the primary task was to track 4 targets among a set of 8 objects. Several times during each trial, one object, selected at random, briefly changed color. In the baseline MOT trials, these changes were ignored. During active trials, each changed object had to be quickly touched. Changed objects were either from the tracking set or were selected from all 8 objects. Consistent with our previous study, we found that the need to act did not substantially impair tracking under either touch condition.

◆ **Factors affecting gaze position lag in multiple object tracking**

37 J Lukavsky (Institute of Psychology, Academy of Sciences, Czech Republic; e-mail: lukavsky@praha.psu.cas.cz)

Previously, it has been shown the gaze position during Multiple Object Tracking is systematically lagging behind the scene content by approx. 100 ms (Lukavský, 2013). We ran additional experiments to investigate how the cognitive workload and predictability of objects' movements affect the lag time. In Experiment 1 we manipulated the number of tracked objects (2 or 4). In Experiments 2a and 2b we manipulated the predictability of movements on the screen by adjusting the parameters of von Mises distribution from which the objects' directions were sampled. Similarly to the previous study, the lag was evaluated by comparing eye movements from trials presented in forward and backward direction. All experiments confirmed the presence of gaze position lag of 100 ms when tracking 4 targets with speed 5 deg/s. We found a significant increase of lag in less predictable movements (by +33 ms). The observed changes in gaze position lag for lower cognitive workload (-14 ms) or more predictable movements (-19 ms) were not significant.

[The work on this project was supported by Czech Science Foundation (GA13-23940S)]

◆ **Break on through to the other side: Bottom-up capture of attention despite of a wandering mind**

38 C Huber-Huber, U Ansorge (Department of Basic Psychological Research and Research Methods, University of Vienna, Austria; e-mail: christoph.huber-huber@univie.ac.at)

Research showed that during mind wandering attention is decoupled from the environment and directed towards internally generated thoughts, suggesting that it could be more difficult to keep attention directed towards stimuli presented in the environment during mind-wandering episodes. So far, this has been shown for the capture of attention by abrupt onsets and for goal-directed forms of attention employed to find a target during visual search. In the present study, we went one step further and investigated whether attentional decoupling would affect bottom-up attentional capture by a colour-singleton distractor. In our task, participants searched for a shape-defined target while response times and errors were measured. An irrelevant colour-singleton distractor was presented on half of the trials. To check for mind-wandering, every few trials participants reported their state of attention on a 9-point Likert scale. We found that reports of mind-wandering are linked to errors and slower responses during visual search. Crucially,

however the irrelevant colour-singleton distractor captured attention regardless of the mind-wandering state. The additive effects of mind-wandering and bottom-up attentional capture suggest that some mechanisms of attention to the external environment are spared during mind-wandering. Results are discussed in light of existing theories of mind-wandering and attentional capture.

◆ **Modulation of microsaccadic rate by temporal expectancy and motor preparation**

<sup>39</sup> M Valsecchi, K R Gegenfurtner (Allgemeine Psychologie Abteilung, Justus-Liebig Universität Giessen, Germany; e-mail: matteo.valsecchi@psychol.uni-giessen.de)

The rate of microsaccade occurrence during fixation can be influenced by concomitant cognitive tasks and it has been suggested that the rate of microsaccades might decrease as the predicted onset of a task-relevant stimulus approaches. In the present study we investigate how temporal expectancy and motor preparation influence microsaccade rate. Twelve observers performed a masked letter discrimination task (2AFC, exposure time titrated to achieve 75% correct). A signal at the beginning of each trial instructed the observer to respond as quickly as possible or to hold the response until mask offset. In a given block of trials the asynchrony between the initial signal and the target was either 1500 or 3000 ms. The microsaccade rate in the time interval between 1300 and 1500 ms after signal onset was significantly lower (0.56 vs. 0.88 microsaccades/s) when the observers expected the target stimulus to appear immediately afterwards (1500 ms asynchrony), as compared to when they expected it to appear later in time (3000 ms asynchrony), independent of whether an immediate response was required. We conclude that microsaccade rate reflects temporal attention rather than motor preparation and could potentially be used to probe expectancy buildup when an overt response cannot be collected.

◆ **Object recognition: covert and overt attention to distinguishing features**

<sup>40</sup> O Baruch, R Kimchi, M Goldsmith (Psychology, University of Haifa, Israel; e-mail: oritb@research.haifa.ac.il)

It was previously demonstrated that in the course of object recognition attention is directed to distinguishing features—those that are diagnostic of object identity (Baruch, Kimchi & Goldsmith, 2012). Here we examined whether this deployment of attention is covert or overt. Observers performed a recognition task with artificial fish such that fish identity had to be determined by two features. Differences in allocation of attention to distinguishing and non-distinguishing features were examined using both eye-tracking and a visual probe detection paradigm. We found that in most trials, throughout the trial, eye gaze remained at the center of the object and that probe detection was superior for probes presented at the location of the distinguishing features. These results indicate that object recognition can be achieved by the deployment of covert attention to distinguishing features. When eye movements were observed, fixations were found more often next to distinguishing than to non-distinguishing features, further confirming the role of attention (covert or overt) to distinguishing features in the object recognition process.

## POSTERS: PERCEPTION AND ACTION I

◆ **The effect of object size and shape on the use of motion in depth cues in a visually-guided grasping task**

<sup>41</sup> P A Duke<sup>1</sup>, S K Rushton<sup>2</sup> (<sup>1</sup>Psychology, University of Leicester, UK; <sup>2</sup>Psychology, Cardiff University, UK; e-mail: pad11@le.ac.uk)

Information about an object's motion in depth is available from changing image size ('looming') and changing binocular disparities (absolute and relative). We examined how looming and changing binocular cues contribute to timing of visually-guided grasping. Observers placed one hand on a monitor and made a grasping movement to intercept approaching objects (ellipsoids or spheres) as they reached the hand. Looming and changing-disparity cues were independently manipulated to introduce cue-conflicts. We estimated the relative contribution of changing-disparity vs looming and a constant depth error. Observers relied mostly on changing-disparity in all conditions. Horizontal and vertical size affected the relative use of changing-disparity vs looming. Reducing the horizontal size reduced the use of changing-disparity, but only for objects of small vertical size. Constant depth errors were found with all objects, increasing with decreasing object size. Results suggest that when judging when to grasp approaching objects of the sizes tested, the contribution of changing-disparity is greater than looming (0.75:0.25) and is fairly constant. This would be expected from geometry since target size was always smaller than interocular separation. However, for the smallest objects, the reduced contribution of

## Monday

changing-disparity and large constant errors may reflect low confidence in disparity and weaker signals for convergence.

◆ **Another failure to explain why people look at their index finger when grasping**

42 D Voudouris, J B J Smeets, E Brenner (Faculty of Human Movement Sciences, Research Institute MOVE, VU University Amsterdam, The Netherlands; e-mail: d.voudouris@vu.nl)

We use visual information to guide our grasping movements. When grasping an object with a precision grip, our thumb and index finger reach two different positions more or less simultaneously. Studies examining eye movements in grasping have shown that people tend to look towards their index finger's grasping point. We have found that this tendency is evident even when the thumb has to manoeuvre around the object, when an obstacle is placed close to the thumb's grasping point, or when the thumb makes contact with the object before the index finger. Could it be that people fixate their index finger's grasping point because this digit is more commonly used in everyday actions? To examine this, we asked right-handed participants to grasp a block, placed in one of three different orientations, with their thumb and little finger. Participants systematically looked at their little finger's grasping point. In a second experiment participants grasped the block with the index fingers of both hands. They did not systematically look at their right index finger. We conclude that the reason people fixate their index finger is not because it is the most commonly used digit.

◆ **The control of functional grasp is dissociated from object use: evidence from left-handers**

43 S P Bidula<sup>1</sup>, L Przybylski<sup>1</sup>, M Pawlak<sup>1,2</sup>, G Kroliczak<sup>1</sup> (<sup>1</sup>Action and Cognition Laboratory, Institute of Psychology, Adam Mickiewicz University in Poznan, Poland; <sup>2</sup>Department of Neurology and Cerebrovascular Disorders, Poznan University of Medical Sciences, Poland; e-mail: sb@amu.edu.pl)

Right-handers demonstrate a partial dissociation of areas involved in the control of functional grasp and tool use. We tested whether or not a similar effect could be also observed in left-handed individuals. Sixteen participants were tested using fMRI during planning and execution of a functionally-appropriate pantomimed grasp of a tool (vs. non-tool), and simulated use of a tool (vs. a control manual task). The stimuli were high-resolution images (shown at three angles: 0, 135, and 225 degrees) in their foreshortened perspectives (emulating 3D viewing). As in right-handers, a 2 (hand: right, left) by 2 (task: grasp, use) repeated-measure ANOVA revealed two main effects, and no interaction. The hand effect pointed only to respective sensorimotor cortices. The areas involved more in the control of grasp vs. use were located primarily in the superior divisions of the parieto-frontal networks. The inverse contrast showed that in addition to the involvement of the ventral precuneus, dorsomedial prefrontal, and anterior divisions of the superior and middle temporal cortices, there was a significantly greater modulation in the left angular gyrus during tool use actions. The observed pattern of activity indicates that the control of these two higher-order manual tasks is also partially dissociated in left-handers.

[This research was funded by National Science Center grant Maestro 2011/02/A/HS6/00174.]

◆ **Hitting targets moving in simple harmonic motion**

44 C de la Malla<sup>1,2</sup>, J López-Moliner<sup>1,2</sup> (<sup>1</sup>Vision and Control of Action group, Departament de Psicologia Bàsica, Universitat de Barcelona, Catalunya; <sup>2</sup>Institute for Brain, Cognition and Behaviour (IR3C), Universitat de Barcelona, Catalunya; e-mail: j.lopezmoliner@ub.edu)

Hitting a moving target requires that we do not miss the target when it is around the intended position. The time available for us not to miss the target when it is at the intended position is usually called the time window and depends on target's speed and size. These variables, among others, have been manipulated but kept constant across the trial or session in several studies. Here we present results of a hitting task in which targets underwent simple harmonic motion which is defined by a sinusoidal function. Target velocity changes continuously in this motion and so does the time window which is shorter in the center (peak velocity) and longer at the turning points (lowest velocity) within a single trial. We studied two different conditions in which the target moved with a reliable amplitude displacement or reliable peak velocity, respectively, and subjects were free to decide where and when to hit it. Results show that subjects made a compromise between maximum and minimum speeds indicating a tradeoff between temporal and spatial precision. In addition, the hitting movement was performed following one of two possible strategies: subjects either started moving or hit the target at a specific temporal window.

◆ **Dissociation between the control of functional grasp and object use in right-handers**

- 45 L Przybylski<sup>1</sup>, S P Bidula<sup>1</sup>, M Pawlak<sup>1,2</sup>, G Kroliczak<sup>1</sup> (<sup>1</sup>Action and Cognition Laboratory, Institute of Psychology, Adam Mickiewicz University in Poznan, Poland; <sup>2</sup>Department of Neurology and Cerebrovascular Disorders, Poznan University of Medical Sciences, Poland; e-mail: lukasz.przybylski@amu.edu.pl)

Neuropsychological evidence suggests the existence of independent representations for functional grasp and tool use. This idea was tested using fMRI in 16 right-handed participants who planned and executed a functionally-appropriate pantomimed grasp of a tool (vs. a non-tool control object), and simulated the use of a tool (vs. a control manual task directed at non-tools). The stimuli were high-resolution pictures presented at three different angles (0, 135, and 225 degrees) in their foreshortened perspectives (emulating 3D viewing). A 2 (hand: right, left) by 2 (task: grasp, use) repeated measure ANOVA revealed two main effects, and no interaction. The effect of hand indicated only greater engagement of respective sensorimotor cortices. The effect of task was such that all the areas involved more in the control of functional grasp (vs. use) were located in the parieto-frontal praxis network, whereas all the areas showing significantly greater modulations during the control of tool use were located outside of this network. They involved the ventral precuneus, dorsomedial prefrontal, and anterior divisions of the superior and middle temporal cortices. These results corroborate a partial dissociation of areas involved in the two tasks, and point to unexpected medial parieto-frontal and temporal contributions to the use of tools.

[This research was funded by National Science Center grant Maestro 2011/02/A/HS6/00174]

◆ **Agency attribution in goal-directed actions: active sampling supported comparison of causal inference models**

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Perception of own actions is influenced by visual information and predictions from internal forward models (Wolpert et al., 1995). Attribution of percepts to consequences of own actions (sense of agency) depends thus on the consistency between internally predicted and actual visual signals. However, is the attribution of agency rather a binary decision, or is this process based on a more gradual attribution of the degree of agency? Both alternatives result in different behaviours of causal inference models, which we try to distinguish by model comparison. **METHODS.** We used a virtual-reality setup to manipulate the consistency between pointing movements and their visual consequences. We investigated the influence of this manipulation on self-action perception. We compared Bayesian causal inference models to the experimental data, two with a binary latent agency variable (Körding et al., 2007), and one with a continuous latent agency variable (Beck et al., 2013). Here, subject-specific regions for stimulus conditions that maximally differentiate between the models were identified online using Active Sampling methods (MacKay 1992; Paninski 2005) to evaluate relative model evidences with a small number of samples. **RESULTS/CONCLUSION.** Both models correctly predict the data. Some participants show signatures of a binary internal representation of agency. In addition, relationships with other inference models (Marko et al., 2012; Ernst 2007) are discussed.

[This work was supported by: BMBF, FKZ: 01GQ1002A, AMARSi- EC FP7-ICT-248311; DFG GI 305/4-1, DFG GZ: KA 1258/15-1; FP7-PEOPLE-2011-ITN(Marie Curie): ABC PITN-GA-011-290011, HBP FP7-ICT-2013-FET-F/ 604102; Koroibot FP7-ICT-2013-10/ 611909.]

◆ **Interactive object tracking modulates attentional distribution**

- 47 A R Koning, M Leenders, C Wolk, R van Lier (Radboud University Nijmegen, Donders Institute for Brain Cognition and Behaviour, Netherlands; e-mail: a.koning@donders.ru.nl)

In this study we combined an interactive variant of a multiple-object tracking task with a probe-detection task, in order to study the distribution of attention around moving objects. More specifically, in displays with an equal number of targets and distractors, participants had to interact with the (to-be-tracked) targets by moving a centrally placed, vertically oriented paddle against which the targets (but not the distractors) had to be bounced. In a second experiment, the targets additionally had to be directed towards specific areas on the screen (i.e. goals). Similar to previous studies, we found that the distribution of attention, as expressed by probe detection rates, is anisotropic and does not readily take into account relatively complex object behaviour such as bounces. That is, in an attentionally demanding situation, like multiple object tracking, a default strategy by the visual selective attentional system seems to rely



Monday

on relatively simple extrapolations of object trajectories rather than taking upcoming bounces into account. Nevertheless, in line with current literature on perception-action couplings, when active control is involved (as in the case of the paddle) anticipation of bouncing behaviour is reflected in the way attention is distributed.

## POSTERS: EYE MOVEMENTS I

### ◆ Performance under unrestricted viewing may be more informative than speeded

#### 48 Localisation in measurement of orienting behaviour

K R Rutherford, C N Macrae, A R Hunt, A Sahraie (School of Psychology, University of Aberdeen, United Kingdom; e-mail: r01krr13@abdn.ac.uk)

Emotional expressions are preferentially processed in clinical populations, but reports on healthy adults have not been conclusive. A limitation of laboratory research is that repetitive task performance and behavioural monitoring can restrict the potential impact of biologically-relevant stimuli that would attract attention under more natural conditions. We compared orienting behaviour to images of faces and trucks in two settings: 1) a traditional laboratory task, in which participants make speeded localization responses to face and truck stimuli; 2) unrestricted viewing condition, where stimuli of the same type were presented in a waiting area before the experiment began, while participants were unaware that their eye movements were recorded. Under free viewing condition, participants (n=20) looked at faces more often and for longer than trucks or other locations, whereas there were no differences in manual reaction times (RT) in speeded localisation task. However, difference in total duration of fixations on face versus truck stimuli correlated negatively with the difference in RT to localisation of face and trucks, showing that those who looked longer to faces were faster to respond to face location. The findings indicate that free and unrestricted viewing conditions may be more informative of behaviour than measurements in repeated trials.

### ◆ Weak individualization of spontaneous eye movements in individuals with autism spectrum disorders

49

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We previously reported that humans spontaneously express their individual uniqueness through their eye movements when delivering a short speech and that human observers can identify others based on eye movement patterns alone (Shirama, Koizumi, & Kitagawa, ECVF 2012). We consider that the eyes communicate individual uniqueness to others. It is well known that individuals with autism spectrum disorder (ASD) also suffer from impairments in interpersonal communication via eye movements. In the present study, we measured spontaneous eye movements during speech for fifteen adults with ASD to examine whether individuals with ASD can express their identity implicitly through intrinsic eye movements. Although individuals with ASD showed intrinsic eye movement patterns regardless of speech content, the individualization of the spatial-temporal features was less apparent than the unique eye movement patterns expressed by individuals in a typically developing group. It is unlikely that the intergroup difference was caused by basic motor properties related to eye movement, because we confirmed that the individuals with ASD had normal eye movement functions by analyzing them in a simple saccade task and a visual search task. Presumably, the weak individualization in ASD participants' eye movement patterns reflects the impairment of higher brain functions.

### ◆ Microsaccade rate in “short” and “unexpectedly long” cue-target time intervals

50

E G Luniakova (Department of Psychology, Lomonosov Moscow State University, Russian Federation; e-mail: eluniakova@gmail.com)

Dynamics of the rate of rapid fixational movements during an interval between the start of the trial and attentional cue presentation and an interval between attentional cue presentation and target appearance was studied. The most part of trials had short cue-target latency periods lasted for 4 sec. Latency periods in 1/8 part of trials lasted for 8 sec. Participants were not instructed that latency periods could vary. They were told that a target would appear soon after a cue at the left or at the right of the fixational cross and the participant need to decide between its left or right positions. First 16 trials in each experiment had “short” (4 sec) cue-target intervals. A preliminary data analysis shows that an average rate of microsaccades in cue-target interval is lower than in the interval between the start of the trial and attentional cue presentation. But dynamics of the rate is similar in those two time periods: after a

short period of microsaccadic inhibition their rate increases and then slowly comes down. There is no significant difference between dynamics of microsaccades in “short” (4 sec) and “unexpectedly long” (8 sec) cue-target time intervals.

[Supported by RFBR (Grant 13-07-00834)]

◆ **People do not take the curvature of their saccades into account when localizing flashed targets**

51 M Matziridi, E Brenner, J B J Smeets (Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands; e-mail: m.matziridi@vu.nl)

People make systematic errors when localizing flashes that are presented around the time of saccades. To localize such flashes, retinal information must be combined with information about the orientation of the eyes. How do people take the orientation of their eyes at the time of the flash into account? Do they consider their actual, often slightly curved, eye movements, or do they assume that they make ideal, straight eye movements? To investigate this, we asked participants to make upward saccades and localize a target that was flashed during the saccade. We presented a distractor to the right or left of the vertical fixation-target-line to induce more leftward or rightward curved saccades. If people consider their actual saccade trajectory when localizing the flash, such curvature will not influence the judged horizontal location of the flash. If people assume that their saccades are straight, they will make systematic horizontal errors: leftward errors for rightward curvature and vice versa. Our participants' horizontal errors depended on the location of the distractor. The magnitude of the effect was close to what one would expect if participants had not considered the curvature of their saccades.

◆ **The effect of spatial probability on response time**

52 R Clark<sup>1</sup>, R Bogacz<sup>2</sup>, I D Gilchrist<sup>1</sup> (<sup>1</sup>School of Experimental Psychology, University of Bristol, UK; <sup>2</sup>Nuffield Department of Clinical Neurosciences, University of Oxford, UK; e-mail: r.clark@bristol.ac.uk)

Saccadic reaction times are faster to locations that occur more frequently (Carpenter and Williams, 1995). Within models of saccade latency (such as LATER) this change is accounted for by a modulation in the starting point of the accumulation process. Previous work using a search task has shown that such changes in saccadic reaction times could be the result of a temporally local mechanism. Saccadic reaction time to the current target is dependent on the repetition of target location on consecutive trials (Walthev and Gilchrist, 2006). Here we investigated this probability effect using a simple saccade-to-target paradigm incorporating a manual response to a letter. We show that these local mechanisms do not play a part in driving this affect in this simple task. In addition we show that the saccadic reaction time to more frequently occurring locations also changes across testing sessions within a single day and even in some cases across consecutive days of testing. This suggests that there are additional longer term mechanisms driving this effect.

◆ **Contribution of backward masking to saccadic suppression**

53 T L Watson (School of Social Science and Psychology, University of Western Sydney, Australia; e-mail: t.watson@uws.edu.au)

During saccadic eye movements we are generally unaware of visual input. It has been suggested that the post saccadic visual scene may mask both the scene created by execution of a saccade and pre-saccadic stimuli. Here masking of a pre-saccadic by a post saccadic stimulus was tested. Prior to a saccade a 20ms, low contrast gabor stimulus was presented above or below participants' fixation location. During the saccade a full screen white noise or grating mask was presented and remained onscreen for 400ms. Participants indicated the location of the test stimulus. The closer the onset of the test stimulus to the onset of a saccade and the higher the contrast of the mask the greater the expected masking effect. Relative to stimuli presented more than 70ms prior to saccade onset, task performance was reduced when an unmasked stimulus was presented within 70ms prior to saccade onset. No further deleterious effect on performance was caused by the mask for stimuli presented within 70ms of saccade onset. This is despite mask presentation reducing task accuracy for stimuli presented more than 70ms prior to saccade onset. This result suggests backward masking plays little role in inducing a lack of awareness of pre-saccadic stimuli.

[This work was supported by Australian Research Council Post-doctoral Fellowship DP11010217.]

Monday

◆ **Driven away by the target: Saccade length effects in multiple target search**

54 C Körner, M Höfler (Department of Psychology, University of Graz, Austria; e-mail: christof.koerner@uni-graz.at)

The search for a target in a complex environment is an everyday visual behavior that typically stops on finding the target. When we search for more than one target, however, we have to continue the search after finding the first target. Here we investigated whether individual phases in such multiple-target search differ in terms of oculomotor parameters (saccade lengths). In particular, we present data from three experiments (two previously published, one new) in which participants had to search for either one or two identical targets in a display while their eye movements were monitored. The kind of search stimuli (letters, abstract symbols) and the display size varied between experiments. In all experiments targets and distractors were randomly arranged in the display. We observed that saccades up until the fixation of the first target were of approximately equal length. However, the saccade following the target fixation was about 20% larger than the previous saccades in all the experiments. This could indicate that search was continued or restarted in a spatially different sector of the display after having found a target. We discuss this phenomenon in the context of other effects of finding a target that have been reported in the literature.

**POSTERS: COLOUR AND ILLUMINATION I**

◆ **Chromatic adaptation in the peripheral visual field**

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It is well-known that chromatic adaptation in the central visual field shifts color appearance of the following target in the opposite direction to the adaptation stimulus. However, the property of chromatic adaptation in the peripheral visual field is not clear. In the present study, we measured apparent color after chromatic adaptation in the peripheral visual field using a matching method. The eccentricities of the test stimulus were 0, 2.5, 5, 10 deg in the nasal visual field. The adaptation stimulus was a saturated purple ( $u^*=0.2096$ ,  $v^*=0.2126$ ) and its luminance was 6 cd/m<sup>2</sup>. Test stimuli were 9 colors (a dominant wavelength of 571 nm, 575 nm, or 579 nm and an excitation purity of 0.21, 0.45, or 0.71) and a white (D65). Their luminances were 15 cd/m<sup>2</sup>. A matching stimulus was presented at the eccentricity of 1.5 deg in the temporal visual field. Nine observers participated in the experiments. After chromatic adaptation the test stimuli in the peripheral visual field appeared reddish while color appearance in the central visual field shifted in the opposite direction to the adaptation stimulus. These results suggest that there are multiple adapted mechanisms and that these mechanisms differently contribute to color appearance across retinal eccentricities.

◆ **Changes in the Benham colours following full-field chromatic light adaptation**

56 R Stanikunas, A Svezgda, V Kulbokaite, A Daugirdiene, R Bliumas (Department of General Psychology, Vilnius University, Lithuania; e-mail: rytis.stanikunas@ff.vu.lt)

The Benham's disk is a popular device to investigate pattern-induced flicker colours. Disk rotation at optimal speed produces four rings with different colours. The objective of the experiments was to establish how the Benham colours change after full field adaptation to different chromatic illumination. Specially designed adaptation chamber covering full visual field was illuminated with D65 and four unique hue illuminants: "red", "yellow", "green" and "blue". The colours of four rings were evaluated with a colour naming procedure and by matching with Munsell samples. Colour evaluation was performed under D65 illumination, at the beginning of chromatic illumination and when complete adaptation was achieved. We found that hue and saturation of the Benham colours change when chromatic illumination is switched on. After complete chromatic adaptation some ring colours appear the same as under D65 illumination, while others exhibit a significant difference. The colour constancy phenomenon doesn't extend to all pattern-induced flicker colours when complete adaptation is achieved. [Supported by the Research Council of Lithuania MIP-013/2012]

◆ **Shape-to-color associations in non-synesthetes: Emotional and perceptual mediation**

- 57 M Malfatti<sup>1</sup>, K B Schloss<sup>2</sup>, L Albertazzi<sup>1,3</sup>, S E Palmer<sup>4</sup> (<sup>1</sup>Center for Mind/Brain Sciences (CIMEC), University of Trento, Italy; <sup>2</sup>Department of Cognitive, Linguistic & Psychological Sciences (CLPS), Brown University, USA; <sup>3</sup>Department of Humanities, University of Trento, Italy; <sup>4</sup>Psychology Department, University of California, Berkeley, USA; e-mail: malfatti.michela@gmail.com)

In previous research we assessed whether color associations of line-shapes were mediated by emotion in non-synesthetes (Malfatti et al., VSS-2014). Here we tested for similar effects with 45 closed geometric shapes that differed in line-number (3/4/9), curviness (curved/angular/pointy), concavities (0/1/>1) and symmetry-axes (0/1/>1). Participants picked the 3 most consistent (and 3 least consistent) among 37 colors for each shape. Ratings were also obtained for each color and each shape on 6 emotional dimensions (sad/happy, calm/agitated, not-angry/angry, passive/active, weak/strong, safe/harmful) and for each shape on 5 perceptual dimensions (simple/complex, smooth/pointy, open/closed, symmetric/asymmetric, convex/concave). Color associations for shapes were well predicted by both perceptual shape-features and emotional associations. Pointier shapes and those with more concavities mapped to more saturated, darker colors, whereas more symmetrical shapes and those with fewer line-segments mapped to more saturated, lighter colors. Emotional effects were also evident: pointier shapes with more concavities were judged as more agitated, angry, active, strong, and harmful. Consistent with the emotional mediation hypothesis, the emotional ratings of the colors associated with shapes were highly correlated with the emotional ratings of the corresponding shapes for all emotional dimensions ( $.46 < r < .68$ ,  $p < .001$ ). Similar to previous results with open-line shapes, safe/harmful emotions produced the strongest shape-to-color correlations.

◆ **Speakers of different colour lexicons differ only in post-perceptual processing of colour**

- 58 L Forder<sup>1</sup>, X He<sup>2</sup>, C Witzel<sup>3</sup>, A Franklin<sup>1</sup> (<sup>1</sup>The Sussex Colour Group, School of Psychology, University of Sussex, Brighton, UK; <sup>2</sup>Department of Psychology, Faculty of Science and Technology, Bournemouth University, UK; <sup>3</sup>Laboratoire Psychologie de la Perception, Université Paris Descartes, France; e-mail: L.Forder@sussex.ac.uk)

Speakers of different colour lexicons differ in performance on colour tasks (e.g., Winawer et al., 2007). An important question is whether cross-linguistic differences occur at early perceptual or later post-perceptual stages. We compared just-noticeable differences (JNDs) for native Russian and native English speakers on a 4-alternative-forced-choice task (Witzel & Gegenfurtner, 2013). JNDs were measured in a colour region spanning two basic linguistic colour categories for Russian speakers, but which is named uniformly "Blue" by English speakers. We found no cross-linguistic differences at the level of JNDs that could be accounted for by language. Secondly, we measured Event-Related Potentials (ERPs) for Russian and English speakers on a visual oddball task for JND-equated colours: a standard presented on 84% of trials, a same- and a different-category deviant (for Russian speakers) each presented on 8% of trials. Contrary to prior findings (e.g., Thierry et al., 2009), we found no cross-linguistic differences within early perceptual processes (P1, N1). We did find an effect within the later P2-N2 complex (290-320ms), where Russian speakers had significantly greater amplitude for different- than same-category deviants, whereas English speakers did not. This suggests that language modulates post-perceptual processing of colour, with no evidence for modulation of early perceptual processes.

[Supported by a European Research Council funded project ('CATEGORIES', 283605) to Anna Franklin.]

## POSTERS: CLINICAL I

◆ **Adaptive mechanisms in patients with homonymous hemianopia**

- 59 I V Ivanov, J Reinhard, I Damm, S Trauzettel-Klosinski (Vision Rehabilitation Research Unit, Center for Ophthalmology, Department of Experimental Ophthalmology, University of Tuebingen, Germany; e-mail: ivanov.iliya.v@gmail.com)

The aim is to detect potential spontaneous adaptive mechanisms in hemianopic patients. During saccadic and fixation tasks, we quantify the ocular motor performance of the patients and compare with healthy controls. Eye movements were recorded in 33 hemianopic patients (15 right, 18 left, disease duration 0.2-29 years) and 14 healthy subjects by scanning laser ophthalmoscope allowing determination of the absolute fovea position relative to the stimulus without calibration. We evaluated landing accuracy of saccades and fixation stability (FS) after landing. During continuous fixation of a central cross, FS and

Monday

distribution of fixational eye movements (FEMs) were also measured. Landing accuracy was decreased in hemianopic patients compared to controls. Patients did significantly more dysmetric saccades (DS: hypo- and hypermetric) to the blind side compared to the seeing side. The number of DS was greater in patients with macular sparing of  $< 4^\circ$ . FS after landing was lower after saccades to the blind side. Distribution of FEM during continuous fixation was asymmetrically shifted to the blind side, especially in cases of macular sparing of  $< 4^\circ$ . Our results suggest the importance of intact parafoveal vision for fixation stability and indicate an advantageous adaptive mechanism, which shifts the visual field border towards the hemianopic side.

◆ **Post-surgery visual and tactual perception of 2-dimensional figures in the case of the congenitally blind**

60

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The visual or tactual activities for the shape perception consist of two phases; the “grasping” phase at the beginning stage, and the following “verifying” phase. The acquisition processes of the shape perception and the mutual division systems between the visual activities and the tactual activities were investigated in a congenitally blind boy (KM) after an operation was performed to restore sight. KM underwent an aspiration of both cataractous lenses at the age of 9. Before the operation, his ERG was normal. KM had already established the tactual systems for shape perception throughout his blind life, and he had verbally retarded behavior. The experiment tasks were set up in order to form his visual functions of shape perception for a 2-dimensional triangle, circle, or square. As KM’s visual scanning strategies by means of his head movement were performed, (1) the percent of correct responses gradually went up, and (2) gradually his tactual activities disappeared, although in the first stage KM grasped and verified the shape by means of his hands/fingers. The tactual systems were replaced by the visual systems in shape perception.

◆ **Advantages of employing specially modified 3-bar stimuli for visual acuity monitoring in adults and children: Test-retest reliability**

61

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Visual monitoring, aimed at the earliest detection of visual deficits, requires regular examinations of each subject over a prolonged period by means of sufficiently accurate and reliable methods. The accuracy and reliability of visual acuity measurements are significantly dependent on the structure of optotypes, in particular, on the power of the low-frequency components in their Fourier spectra that could influence the optotype recognition. Recently it was shown that the well known 3-bar optotypes could be modified in such a way as to preclude the possibility of discriminating the optotype orientation on the basis of the low-frequency components, thus providing more stable results. Coupled with the simple structure of the modified 3-bar optotypes, this property makes them suitable for visual acuity monitoring. To confirm this, we assessed the test-retest reliability with modified 3-bar optotypes in comparison with widely used tumbling-E optotypes in adults and children of preschool and school age. All subjects were refracted and given proper optical correction. Examination was conducted in monocular viewing conditions. Both adults and children of all age groups revealed significantly better test-retest reliability with modified 3-bar optotypes: SDs for the values of individual test-retest difference were essentially less with these optotypes than with tumbling-E.

[Supported by the Program of DNIT Russ Acad Sci]

◆ **A colour vision test optimised for the clinical population**

62

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Most of the popular colour vision tests (e.g. Ishihara, FM100HT) developed to screen and classify dichromats, require relatively good visual acuity. Thus, individuals affected by low vision may fail to perform these tests. To solve this problem, we have developed a Universal Colour Discrimination Test (UCDT), which is suitable also for individuals with visual acuity worse than 1.0 logMAR. The test consists of a coloured 5-degree square which can be distinguished from the background only on the basis of its hue. Using a 2AFC, observers indicated the position of the square as its saturation changed during the experiment. The task was easy to perform, even by 7-year-old observers. Participants were labelled as Normal or Affected according to their performance to additional colour vision tests included

in the protocol. Normal saturation thresholds agreed with the ones obtained by the Cambridge Colour Test (CCT). Affected thresholds were consisted (when the comparison was possible) with the observer's performance at other tests. More importantly, Affected observers who failed to perform the conventional colour vision tests, were able to perform the UCDT. This result has important clinical implications, as it allows to determine chromatic discrimination baselines and monitor their changes in patients undergoing clinical treatments.

[Fight for Sight, BBSRC, Moorfields' Eye Hospital, NIHR Biomedical Research Centre for Ophthalmology at Moorfields and the UCL Institute of Ophthalmology.]

◆ **An “Eye Test” for the brain: component extraction and motion integration test (CEMIT) reveals its clinical potential**

63 L Bowns<sup>1</sup>, W Beaudot<sup>2</sup>, T Colvin<sup>1</sup>, J Steer<sup>1</sup> (<sup>1</sup>School of Psychology, University of Nottingham, United Kingdom; <sup>2</sup>R&D, KYBERVISION, Canada; e-mail: l.bowns@nottingham.ac.uk)

We previously presented an App “CEMIT” that is capable of measuring visual cortical performance. CEMIT is a novel direction discrimination test using unique plaids. Responses assess an observer's ability to extract both components and compute pattern direction. Here we measured normal performance to investigate robustness of the test. We also examined performance of observers with Asperger's Syndrome. Performance was measured over a 4-octave range (0.2 - 1.6 cpd.) for normal observers. In the Asperger's study we used a 6-octave range (0.2 – 6.4 cpd.) because we were interested in the spatial frequency related to face perception. Our results for 50 normal observers reveal a clear robust pattern of responses where pattern direction fails at a spatial frequency less than 0.4 cpd. Performance is not random at this spatial frequency but is perceived systematically in the component direction, suggesting failure to distinguish component orientation. Preliminary results for Asperger's performance was similar except at spatial frequency 6.4 where it significantly decreased compared with controls. We conclude that results from CEMIT are robust and have potential to identify specific characteristics of clinical populations.

## POSTERS: MULTISENSORY PROCESSING I

◆ **Spatial limits for audiovisual unity assumption**

64 C C L Silva<sup>1,2,3</sup>, S Mouta<sup>1,4</sup>, J A Santos<sup>1,5,6</sup>, J Creissac<sup>2,3</sup> (<sup>1</sup>Centro de Computação Gráfica, Portugal; <sup>2</sup>Informatics, University of Minho, Portugal; <sup>3</sup>HasLab - INESC TEC, INESC Porto, Portugal; <sup>4</sup>INESC TEC, INESC Porto, Portugal; <sup>5</sup>Psychology, University of Minho, Portugal; <sup>6</sup>Centro Algoritmi, University of Minho, Portugal; e-mail: carlos.cl.silva@gmail.com)

The unity assumption hypothesis states that the more information on amodal properties different signals share, the more likely it is that we perceive them as originating from a common source or object (Welch, 1999). Temporal coincidence has been the preferable amodal property to manipulate in unity assumption studies (Vatakis and Spence, 2007), and the studies that manipulate spatial coincidence often use misaligned audiovisual stimuli in order to check for crossmodal effects, as the ventriloquism effect (Hairston et al., 2003). Starting from the measurement of participants' auditory location capability, we proceeded finding the minimum angular disparity between two Point-Light Walkers (PLWs) that allowed participants' a correct audiovisual binding between visual and auditory co-located stimuli. In this task, participants had to discriminate which PLW was producing the auditory steps that were co-located with only one of the PLWs (right/left answer). We had different conditions regarding stimuli distance and stimuli familiarity. The data allowed us to accurately define absolute spatial thresholds for a correct audiovisual unity assumption and, furthermore, we could also explore the relation between those limits, the stimuli distance, and the auditory spatial resolution of each participant.

[This work has been supported by FCT – Fundação para a Ciência e Tecnologia: EXPL/MHC-PCN/0162/2013, SFRH/BPD/ 63393/2009; FCOMP-01-0124-FEDER-022674 and within the Project Scope: PESt-OE/EEI/UI0319/2014; FCOMP-01-0124-FEDER-037281 and PESt-C/EEI/LA0014/2013. This work was financed by FEDER grants through the Operational Competitiveness Program – COMPETE and by NORTE-07-0162-FEDER-000076-cave@CCG, ON.2 – Programa Operacional Regional do Norte.]

Monday

◆ **Influence of surface features of visual stimuli on sound-contingent visual motion aftereffects**

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The occurrence of visual motion aftereffects can be contingent on arbitrary sounds. Research has shown that, after several minutes' exposure to visual horizontal apparent motion produced by two circles whose onsets are accompanied by tone bursts of high and low frequencies, respectively (exposure phase), a blinking circle at a fixed location can be perceived as a lateral motion, depending on the order in which the sounds are replayed (test phase) (Teramoto et al., 2010). In the present study, we investigated the effects of surface features of visual stimuli on sound-contingent visual motion aftereffects. The features used to define apparent motion stimuli were shape (Experiment 1) and colour (Experiment 2). We compared the magnitude of sound-contingent motion aftereffects in conditions where test stimuli were defined by features identical to those in the exposure phase with that produced by conditions in which these features differed. The results showed that sound-contingent aftereffects occurred equally well, even when surface features varied between the exposure and subsequent test phases. This suggests that associations between visual motion and sounds are formed in a stage prior to the integration of motion information with visual surface features such as form and colour.

[This research was supported by Grant-in-Aids for Scientific Research (B) (No. 26285160) from the Japan Society for the Promotion of Science.]

◆ **Synergistic effect between image and sound in 3D audio visual communication system**

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We developed a natural telecommunication system from a realistic spatial composition made with a high-fidelity position representation (Takada et al., 2013). This position representation is induced using 3D imaging and acoustic technology. The image was produced using a stable 3D image (Date et al., 2013) generated by an edge detection method in depth-fused 3D (DFD) visual perception (Suyama et al., 2004). The sound was produced using acoustic wave field synthesis (Koyama et al., 2013). The system provides realistic, natural, and comfortable communication by reproducing the distance and position of the image and sound without inconsistency. Using our system, we evaluated how images and sound together influence the relation between vision and hearing. The experiment varied the 3D position and timing of an image and sound, and the results showed that eye movements were pulled in the direction of the sound. In the future, we will develop an innovative hyper-reality communication system in which 3D sounds can guide the gaze-point on 3D images.

◆ **Altering perception of low-level visual motion by audiovisual associations**

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Perception is affected by immediate pattern of sensory inputs and prior experiences acquired through multisensory associations. Recently, several studies reported that a quick association can be formed between directions of visual motion and static sounds with distinct frequencies (Hidaka et al., 2011; Teramoto et al., 2010). After the association is formed, sounds are able to change the perceived direction of visual motion. To determine whether this rapid audiovisual association and its influence on visual motion perception are dependent on the involvement of higher-order attentive tracking mechanisms, we used regular and reverse-phi random dot motions that isolated low-level pre-attentive visual motion processing (Cavanagh, 1992; Lu & Sperling, 1995). After a short association phase (8 mins), static sounds significantly changed the direction discrimination of these low-level motion types. Our results show that an association between the directions of low-level visual motion and static sounds can be formed and this association alters the subsequent perception of low-level visual motion. Based on these findings, we conclude that multisensory associations are not restricted to high-level attention based motion system and early level visual motion processing has some role.

[This work was supported by the Scientific and Technological Research Council of Turkey (TUBITAK Grant 112C010).]

**POSTERS: SENSORY DEVELOPMENT AND AGING I**

◆ **Age-related changes in visuomotor performance: Evidence hyper-responsiveness to stimuli appearing in the periphery underpins aging deficits**

68

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Healthy aging is accompanied by changes in visuomotor performance, particularly in relation to strategic inhibitory function. We investigated the nature of these changes by characterizing age-related performance changes across a range of tasks assessing strategic and reflexive visuomotor functioning, and determining performance interrelationships across the tasks. Sixty young and 60 older adults completed the following tasks: inhibition of return, anti-saccade, Stroop, flanker and Simon. The results indicate age-related decrements in strategic inhibitory control (demonstrated in each of the relevant tasks: anti-saccade, Stroop, flanker and Simon), and an age-related increase in reflexive inhibition (based on inhibition of return elicited by an uninformative peripheral flash). Weaker strategic inhibition combined with stronger reflexive inhibition suggests age-related deterioration of cortical structures may allow subcortical structures to operate hyperactively—an interpretation corroborated by an age-related increase in reflexive glances during the anti-saccade task. The correlation analyses showed that, in young adults, performance across the different tasks did not correlate, which suggests independent underlying mechanisms. In contrast, in older adults the anti-saccade error rates, flanker effect, and Simon effect positively correlated, suggesting a common age-related change underlies the impaired performance during these three tasks, which we propose may reflect hyper-responsivity to changes in the periphery. [University of Otago Research Grant]

◆ **Implied motion perception in infancy**

69

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Implied motion perception from a still image (cf. Kourtzi, 2004) was tested with 5-8 month-old infants. In Experiment 1a, each experimental trial began with a presentation of a still image of a person running toward either the left or right side (a cue figure). Soon after (600ms) two identical visual targets appeared on the right and left side of the cue figure simultaneously. Each infant participated 20 trials. We measured infants' visual preference for a target that consistently appeared on the same side as the running direction of the cue figure using the forced-choice preferential looking method (Teller, 1979). Results indicated the direction of a cue figure significantly enhance the infants' visual preference to a target on the cued direction. No significant enhancement of visual preference was observed when an image of the same person standing and facing the left/right side (Experiment 1b), that of the running figure covered with a set of opaque rectangles (Experiment 2), or that of the inverted running figure (Experiment 3) was used as a cue figure. These results suggest that infants as young as 5–8 months old are sensitive to visual information which contributes to perceive implied motion from static figures.

[This research was financially supported by Grant-in-Aid for Young Scientists (A) from the Japan Society for the Promotion of Science (No. 26705009 to N.S.) and Grant-in-Aid for Scientific Research (S) from the Japan Society for the Promotion of Science (No. 23220006 to T.I.). ]

◆ **Driving fitness in the elderly — validation of visual and driving-aptitude tests**

70

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Safe driving in traffic requires visual and cognitive abilities. The present study's aim was a validation of apparatus and methods of testing vision and cognitive aptitude with driving competence as validity criterion. We collected extensive data in a group of elderly drivers (n=151, median age 70), assessing foveal acuity, perimetric field size, peripheral vision ("PP") in Schuhfried's Vienna Test System (VTS), letter contrast thresholds in foveal and parafoveal vision, and a series of driving aptitude tests on the VTS. As validity criterion served ratings by driving instructors and trained observers in a standardized test drive. It included lane changes, motorway entering/exiting, orienting, and situations of right-of-way.



## Monday

Driving competence decreased overall with increasing age (15% explained variance), probably due to diminishing practice. Eighty percent of explained variance were person-specific and age-independent, stressing the importance of assessing fitness individually. Cognitive tests on the VTS had considerably higher predictive value than visual parameters; best singular predictor was lane tracking (20%). For visual-cognitive performance, Schuhfried's dynamical peripheral vision test and parafoveal letter contrast sensitivity were best (9% each). Acuity and kinetic perimetry – both typically required by regulations – were of rather limited importance.

◆ **Attention in adults and school-age children**

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Attention system appear to mature completely by the age of 15 (Baranov-Krylov, Kuznetsova, & Ratnikova, 2009). To understand attention in school-age children and adults, we made a computer-based visual search task consisting from Landolt-square stimulus and gave it to 66 school-age children (37 female, 29 male, 7-15 years old) and 32 adults (21 female, 11 male, 21-59 years old). Each participant started with a search through a set of 25 elements and continued with a set of 100 elements. We recorded time needed to complete the test, number of counted elements and errors. The results demonstrate that the visual search task is performed faster with age, fitted by logarithmic regression. That could demonstrate that attention is maturing with age. When looking at the errors, there are significantly more errors for school-age children ( $p < 0.05$ , ANOVA).

[This work has been supported by 2013/0021/1DP/1.1.1.2.0/13/APIA/VIAA/001]

◆ **Fixation shifts in typical infants and perinatal brain injury : attention measures from preferential looking, eye tracking and ERPs**

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The Fixation Shifts Paradigm (FS) has charted early development of attention control in typical infants and identified early deficits, in disengagement and switches of attention, in preterm-born infants, infants with hypoxic-ischemic encephalopathy, and children with developmental disorders (Atkinson and Braddick, 2012). Here we report findings using FS from two ongoing studies: (1) 'Dolphin' trial of preterm and term-born infants with perinatal brain injury (PBI) graded in severity by MRI; (2) measures of saccadic latencies in typical infants using the Tobii eye tracker, combined with simultaneous high-density ERP recordings. 33 PBI infants, tested between 4-8 months post-term with fixations recorded by a 'blind' observer, showed significantly more errors and longer latencies to shift attention compared to typically developing infants, with performance worsening across PBI severity. These deficits were more marked when two targets were competing for attention ('sticky fixation'). The eye tracker allowed increased numbers of trials with typically developing infants age 2-10 months (average 53 trials successfully recorded in a 5-10 minute testing time) and precise latency measures. Saccadic latencies, and the incidence of 'sticky fixation', significantly reduced in infants over 4 months of age. ERPs showed peak activation, related to the attentional shift, localized in a parieto-frontal cortical network.

[Supported by the Leverhulme Trust, Deutscher Akademischer Austausch Dienst, Castang Foundation, Oxford Biomedical Research Centre]

◆ **The effect of video gaming on facial emotion recognition.**

73 V E Lovett<sup>1</sup>, J French<sup>2</sup>, M V Roberts<sup>2</sup>, S J Johnston<sup>1</sup> (<sup>1</sup>Psychology, Swansea University, United Kingdom; <sup>2</sup>Psychology, Bangor University, United Kingdom; e-mail: v.e.lovett@swansea.ac.uk)

In recent years the way we spend our leisure time has changed greatly, most notable is the increasing use of video games, particularly amongst adolescents. Of concern is research suggesting that playing violent video games leads to the development of undesirable socio-emotional behaviour, particularly relating to aggression (e.g. Anderson et al., 2010). Adolescence is a time of considerable neurological change (Blakemore, 2008), therefore it is important to understand the possible implications of video game play during this critical developmental period (Kirsch, 2003). The current study examined changes in participants' behavioural and electroencephalography responses to emotional facial stimuli after playing a violent or non-violent video game. Eighteen adolescents participated in two experimental sessions, playing a different game type in each session. Results suggest that playing a violent video game impacts

on emotion recognition as indicated by changes in the N170 component elicited by the emotional face stimuli. Critically, participants' history of gaming predicted differences in late attentional and emotion processing components, after violent video gameplay. These findings shed light on the effect of violent video games on socio-emotional processing in a key developmental period, and may help to guide future research on this important, yet under-researched, topic.

[This work is supported by funding from a British Academy/Leverhulme Small Grant Scheme, ref no: SG122156.]

## POSTERS: MOTION

### ◆ Adaptation to implied motion affects random dot stimuli but motion extrapolation

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Motion extrapolation (ME) is the process of inferring the position in the space of a moving object travelling behind an occluder. Prior adaptation to real motion causes observers to misjudge when a target will reach the end of an occluder (Gilden et al., 1995). ME involves a large neural network involving higher visual areas and top-down processes. Here, our aim is to investigate whether images that imply motion can also interfere with the process of ME. If adaptation to implied motion manipulates temporal judgments then it can be assumed that it is processed by same or similar areas as ME. Thirty observers were adapted to pictures with or without implied motion. Luminance and Fourier spectrum were balanced for each picture. The first task required participants to indicate the coherent direction in a random-dot stimulus. In the second experiment they performed a time to contact task (indicate when a target moving behind an invisible occluder reached a visible cue). Results showed that adaptation to implied motion enhances the threshold to perceive coherent direction in the random-dot stimuli, but not influence the time to contact task (ME). This suggests that implied motion does not utilize those top-down processes responsible for ME.

### ◆ Camouflage and confusion: no evidence for an interaction between the confusion effect and camouflage patterns.

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The implications of how humans and other animals find objects, and conversely hide from pursuers, extend beyond animal colouration and military camouflage. We investigated the influence of surface patterns on the "confusion effect" (the phenomenon of increased difficulty in capturing a target item surrounded by many similar items). Dazzle camouflage (high contrast geometric patterns) is claimed to function through disruption of observers' estimations of speed, direction or form (Scott-Samuel et al., 2011). We looked for an interaction between two forms of camouflage and the confusion effect. Participants tracked one target square among identical moving distractors. The number of items (20 to 80 at intervals of 10) and their colouration relative to the background (matching, non-matching or dazzle) were manipulated. The magnitude of error in reporting the target's final location were recorded. At low numbers, background matching conditions impeded target tracking. For high numbers there were no differences between the colourations' success: the confusion effect renders all patterns equally hard to track. For background matching targets the relationship between target localisation and number of distractors had a shallower slope than the other conditions. However, this is probably due to a performance ceiling effect caused by the confusion effect at high numbers.

[Funded by a BBSRC SWDTP PhD studentship.]

### ◆ Measuring and modelling the effect of internal motion of a moving Gabor on speed perception

<sup>76</sup> A E Hughes, M Fawcett, D J Tolhurst (Department of Physiology, Development and Neuroscience, University of Cambridge, United Kingdom; e-mail: aeh60@cam.ac.uk)

We have previously shown that internal motion of the vertical stripes within a laterally moving Gabor patch can cause subjective biases in overall speed perception in an occlusion paradigm (Hughes, Stevens and Tolhurst, 2012). Here, we extend this result with a more objective two-alternative-forced-choice paradigm, where observers chose which of two stimulus intervals contained the faster moving Gabor patch; the patches in the two intervals differed in the internal movement of the stripes. A Gabor patch

Monday

with drifting stripes is perceived to move faster than a non drifting standard if the stripes drift in the same direction as the overall direction of movement. Alternatively, if the stripes drift in the opposite direction to the overall direction of movement, the patch is perceived to move slower. We show that this effect depends on the relationship between the stripe motion and the direction travelled; when the stripe motion is orthogonal to the overall patch movement, no directional speed bias is seen. Similarly, adding non-directional temporal flicker to the patch does not affect speed judgements. We also show that these effects can be qualitatively predicted by evaluating these stimuli using a modified version of a standard motion model (Mather, 2010).

[AH is supported by a BBSRC CASE PhD studentship.]

◆ **Individual differences in context-dependent motion perception**

77 D P McGovern, F N Newell (Trinity College Institute of Neuroscience, Trinity College Dublin, Ireland; e-mail: mcgoved1@tcd.ie)

Our perception of visual stimuli is affected by their spatial and temporal context. For instance, the perceived direction of a moving stimulus is biased by the presence of nearby moving stimuli (direction repulsion; DR) and by recently viewed motion (direction aftereffect; DAE). While the spatial tuning properties of these context-dependent effects have been well-documented, little is known about how they vary across individuals. Moreover, given the similarities in how they affect vision, it is often assumed that contextual effects, such as DR and DAE, share a common functional goal in motion processing. If this is the case, we should expect the size of these effects to be correlated within individuals. To test this hypothesis, we asked participants to judge whether a RDK moved clockwise or counterclockwise from upwards. Participants performed this task in conditions with no contextual modulation and where dots moving 30° from upwards were either surrounding (DR) or presented before the onset of (DAE) the test stimulus. Our results show pronounced individual differences in the magnitude of both DR and DAE. Furthermore, there was a significant correlation between the sizes of these effects within individuals. These results provide evidence for functional commonalities between spatial and temporal contextual modulation.

[This work was supported by an Irish Research Council, Government Of Ireland Fellowship awarded to DPM]

◆ **Do surface qualities of moving objects influence vection?**

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A great deal of research has examined the influences of various stimuli parameters on the strength of visually induced illusory self-motion (vection). However, the influences of surface qualities on vection strength have not been studied, despite their importance in the realistic perception of a scene. Here, we investigated whether differences in the surface qualities of moving objects affect induction or strength of vection. We employed nine different surface qualities derived from light-reflecting properties of materials that we encountered in our daily lives (bark, ceramic, fabric, fur, glass, leather, metal, stone and wood). We also obtained subjective impressions and low-level image statistics of those nine surface qualities. Although there was no significant main effect of material conditions on the vection measures (latency, duration and estimated magnitude), multiple regression analyses revealed that vection was partially explained by both spatial frequency and principal components extracted from the subjective impressions. Overall, our results raise the possibility that surface qualities play a role in vection modulation. Future investigations are necessary to understand more clearly the effect of surface qualities on vection.

[This work was supported by the Program to Disseminate Tenure Track System, MEXT, Japan.]

◆ **Evidence for a spatially-invariant, symbolic representation of motion direction in working memory**

79 T Seidel Malkinson<sup>1</sup>, Y Pertzov<sup>2</sup>, E Zohary<sup>1,3</sup> (<sup>1</sup>Department of Neurobiology, Hebrew University of Jerusalem, Israel; <sup>2</sup>Department of Psychology, Hebrew University of Jerusalem, Israel; <sup>3</sup>The Edmond and Lily Safra Center for Brain Sciences, Hebrew University of Jerusalem, Israel; e-mail: tal.seidel@mail.huji.ac.il)

What happens to the representation of a moving stimulus when it is no longer present and must be maintained in working memory (WM)? Is the initial, perceptual representation maintained across the delay period or is there another representation, at a higher level of abstraction? Alternatively, multiple representations may co-exist in WM, manifesting perceptual and more abstract features. We investigated

the mnemonic representation of motion in three psychophysical experiments, using a delayed motion-discrimination task (relative clockwise counter-clockwise judgment). First, we show that a change of contrast polarity between the "Sample" and "Test" stimuli does not hamper performance. Next, we demonstrate that performance is unaffected by a stimulus position change in either retinotopic or spatiotopic coordinates. Finally, we present a non-informative symbolic arrow-cue during the delay interval between the two stimuli. We find that motion-direction sensitivity is affected in a predictable manner, depending on the interfering cue's orientation. Thus, the mnemonic representation of motion is independent of the stimulus' physical features (polarity/position) and symbolic. It is therefore likely to be maintained at later stages of the visual processing hierarchy. Our results suggest that a symbolic mnemonic trace is activated alongside a more basic, analogue representation of the stimulus.

◆ **Duration thresholds show low-pass suppression of fine-scale motion-discrimination.**

80 I Serrano-Pedraza<sup>1</sup>, S Arranz-Paraiso<sup>1</sup>, A M Derrington<sup>2</sup> (<sup>1</sup>Department of Experimental Psychology, Universidad Complutense de Madrid, Spain; <sup>2</sup>Faculty of Humanities and Social Sciences, University of Liverpool, UK; e-mail: iserrano@ucm.es)

Motion direction discrimination is impaired when a static coarse-scale pattern is added to a moving fine-scale pattern. This impairment suggests antagonism between motion-sensors tuned to fine and coarse scales (high and low spatial frequencies). We wanted to test the range of spatial frequencies over which this coarse-fine antagonism occurs. We measured duration thresholds for motion discrimination of complex stimuli composed of vertical Gabor patches moving horizontally at 2 deg/sec, added to vertical, static, band-pass filtered noise, using Bayesian staircases. We tested four spatial frequencies (1, 3, 5, and 8c/deg) of moving pattern with noises of 8 centre spatial frequencies (from 0.125 to 8c/deg). Results of 4 subjects showed the following: a) Duration thresholds of 1 c/deg patterns were unaffected by the static pattern. b) For finer-scale moving patterns, duration thresholds were elevated by coarser static patterns (those with centre spatial frequencies lower than the moving pattern). c) The inhibition ratio, defined as the ratio between duration threshold of a complex stimulus and the duration threshold of the single moving pattern, increased with the spatial frequency of the moving pattern. d) The inhibition ratio showed a low-pass profile when represented as a function of the spatial frequency of the static pattern. [[Supported by Grant No. PSI2011-24491 from Ministerio de Economía y Competividad, Spain]]

◆ **Effects of visual field size and speed on acceleration and deceleration perception**

81 A S Mueller, B Timney (Psychology, University of Western Ontario, Canada; e-mail: amuelle4@alumni.uwo.ca)

We investigated two questions about how humans perceive acceleration in the fronto-parallel plane. The first is whether restricting the ability to visually track moving stimuli impairs the ability to detect acceleration. We tested this by manipulating the horizontal extent of the stimulus display. The second question is whether there is a difference in the ability to detect acceleration and deceleration. The literature is inconsistent on this issue, but it may be because some experiments presented different speed ranges for acceleration and deceleration by holding the starting velocity constant. We therefore measured acceleration and deceleration detection thresholds in terms of Weber fractions while holding the average speed of the stimuli constant for two different average speeds. Our results show that detection improves as the visual field size increases and that acceleration and deceleration are detected similarly, regardless of field size or speed. Weber fractions were higher in small fields than in medium and large fields, but there was no difference between medium and large fields, which suggests that perception is relatively consistent when the visual field is large enough to encourage smooth pursuit. Furthermore, normalized thresholds were higher for slow speeds and indicate that the task was easier at fast speeds.

[This study was funded by an Ontario Graduate Scholarship to ASM and a Provost's Research Grant to BT.]

◆ **Center-surround interactions in fine motion direction discrimination**

82 B Genova, N B Bocheva, M Stefanova (Sensory Neurobiology, Institute of Neurobiology, Bulgaria; e-mail: nbbocheva@hotmail.com)

Center-surround interactions play significant role in segmentation and integration of motion signals. Here we studied the influence of angular differences in motion direction and the speed distribution of the motion signals on fine motion direction discrimination. The stimuli consisted of band-pass dots presented in two concentric circular apertures positioned at the middle of the computer screen. The dot speeds of the surround motion were drawn from uniform distributions with different range. We used five levels of speed range and 12 motion directions in the range 0 to 360 deg for the surround stimuli.

Monday

The relative area of central and surround motion was also varied. The observers' task was to decide whether the direction of center motion appeared to the left or to the right of the vertical. Our data show that the direction of the surround motion significantly affected the perceived direction of the center motion. In all experimental conditions the largest bias was observed when the two motion directions were orthogonal. The enlargement of the central or surround stimulus area significantly affected the bias and the sensitivity to motion direction. The results are discussed in relation to the role of center-surround interactions in different tasks and induced motion perception.

◆ **Visual acuity for static and moving targets in the periphery**

83 J A Patrick, N W Roach, P V McGraw (Nottingham Visual Neuroscience, University of Nottingham, UK; e-mail: lpxjap@nottingham.ac.uk)

Super-resolution (SR) is a form of image processing whereby multiple low-resolution images are merged over time to create a higher-resolution image. Evidence for SR processing in human vision is based on the finding that motion improves acuity for artificially under-sampling visual targets (Frisén, 2009). Here we ask whether motion also improves performance in the peripheral field where neural under-sampling limits visual acuity. Improvements in acuity for slow moving vs. static peripheral targets (Brown, 1972) could theoretically result from SR processing, however the conditions under which these benefits hold are poorly understood. We asked observers to report the orientation of Landolt C targets moving at a range of speeds ( $0-20^\circ\text{s}^{-1}$ ) along an iso-eccentric arc ( $2.5-10^\circ$  eccentricity). Thresholds were measured for conditions where the critical detail was orthogonal, parallel or oblique to the motion path at the midpoint. Although improvements in acuity for slow-moving targets against static visual acuity were observed in some individual cases, there was no significant effect across observers. In contrast, fast motion across a smooth path significantly impaired visual acuity. Our results suggest that either SR processing does not occur in the normal peripheral field or that smooth translational motion is a sub-optimal stimulus for revealing it.

◆ **Motion-induced modulations of pattern sensitivity: spatiotemporal tuning**

84 A L Chambers, N W Roach (Nottingham Visual Neuroscience, University of Nottingham, United Kingdom; e-mail: Alison.Chambers@nottingham.ac.uk)

Contrast sensitivity can be substantially affected by the presence of nearby stimuli. Moving stimuli induce spatially asymmetric modulatory effects - the ability to detect a sinusoidal target abutting the leading edge of a drifting grating is highly dependent on the relative phase of the two stimuli, whereas performance at the trailing edge is not (Roach et al., 2011). To gain a more detailed understanding of the mechanisms underlying this phase-dependent modulation, here we investigated its dependency on the spatial and temporal characteristics of the stimuli. When inducing and target stimuli were manipulated together, we found clear evidence of band-pass tuning to spatial frequency, but invariance to changes in temporal frequency (and speed). Optimal spatial frequency declined systematically as a function of eccentricity whereas bandwidth remained relatively constant (2.2 octaves, full width at half height). Surprisingly, when the spatial frequency of the target was fixed and only the inducing pattern varied, contrast sensitivity remained dependent on the relative phase of the two stimuli at their boundary. This pattern of tuning to absolute but not relative spatial frequency presents a significant challenge for existing explanations of motion-induced modulations of pattern sensitivity, including those based on predictive interference and spatial summation.

[This work is supported by the Wellcome Trust [WT097387] ]

◆ **Effects of depth cues on vection**

85 Y Seya, H Shinoda (Department of Human and Computer Intelligence, Ritsumeikan University, Japan; e-mail: yseya@fc.ritsumei.ac.jp)

Depth information plays an important role in perceiving vection and it is well known that depth cues enhance vection. In the present study, we examined effects of depth cues on forward and backward vection. In an experiment, optical flow observed during forward or backward locomotion either at 2.5 km/h, 5 km/h, or 10 km/h was simulated by a random-dot pattern. We manipulated depth of dots in optical flow by adding changing-size cues and/or disparity cues. Participants were asked to view optical flow for 60 seconds and to report, by pressing a button, whether they perceived vection. After each trial, participants were also asked to rate subjective strength of vection. The results of vection onset latency, duration, and subjective strength showed that vection was induced more quickly and stronger when either or both depth cues were added than when none were added. Furthermore, there were no differences between conditions where either changing-size or disparity cues were added. These results support the

findings of previous studies that depth cues enhance vection and clearly suggest that changing-size and disparity cue affect vection in a similar manner.

## POSTERS: GROUPING PRINCIPLES

### ◆ Voluntary averaging of two-dimensional spatial position

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Although we are able to effortlessly extract statistical properties of visual textures (such as average-orientation) less is known about our ability to combine estimates of feature-position across space. Here we examined this process using an equivalent noise paradigm. We presented observers ( $n=4$ ) with a field of 16 cross-like elements, and asked them to judge if mean y-position of the horizontal bars (the target) was above or below the mid-point of vertical bars. By measuring the precision of this judgement as a function of the variability of target y-position we can infer both variability on local positional encoding and the number of positional estimates effectively pooled. When the x-position of the vertical bars was fixed we found robust averaging of position across elements. To examine if observers were exploiting the presence of certain features (e.g. 'T's) to perform the task we randomized the x-position of the vertical bars (drastically reducing the consistency of element-appearance). Although this manipulation leaves the distribution of target y-positions unaltered it raised local positional uncertainty but did not compromise pooling of position. These results are consistent with observers pooling 2-dimensional position (i.e. of line-intersections) not 1-dimensional position (i.e. y-position).

### ◆ The influence of saturation on figure-ground segregation of colored inducers and achromatic backgrounds

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While luminance contrast helps determine what is likely to stand out as figure against ground in complex patterns, the influence of color saturation on figure-ground organization is unclear. We investigated the effects of saturation on figure-ground organization and apparent background field brightness in configurations of colored inducers (blue, green, yellow, or red) on achromatic backgrounds. The stimuli and psychophysical forced-choice procedures have been described previously (Dresp-Langley & Reeves, 2012). Here, we varied the saturation level (weak or strong) and the luminance contrast of the colored inducers. We find that strongly saturated inducers, regardless which color, yield significantly higher probabilities of subjective background contrast than weakly saturated inducers, which yield higher probabilities of background assimilation. A significant interaction between saturation and luminance contrast (Michelson) is observed. Moreover, strongly saturated inducers or inducers with a strong luminance contrast yield significantly higher probabilities to stand out as figure against the background than weakly saturated inducers or inducers with a weak luminance contrast. We found significant interactions between luminance contrast polarity and saturation levels on the depth effects. The results point towards a functional role of color saturation as a cue to figure-ground.

[This work is supported by CNRS, PICS 05971 'QUALIA']

### ◆ The spatial frequency tuning of peripheral collinear facilitation

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The detection of a target Gabor patch can be influenced by the presence of similar co-oriented flanker stimuli. This phenomenon is known as lateral interaction (Polat & Sagi, 1993, 1994b). Depending on the distance between target and flankers, defined as multiple of the wavelength of the target ( $\lambda$ ), flankers can increase or decrease the target's detectability. In fovea, distances  $<2\lambda$  increase target's contrast detection thresholds, whereas larger distances ( $>3\lambda$ ) decrease them. Recently, collinear facilitation has been reported in the near-periphery of the visual field (i.e.,  $4^\circ$  of eccentricity) for medium-to-high spatial frequencies (3-8 cpd) and at large separations (7-8 $\lambda$ ) (Maniglia et al., 2011; Lev & Polat, 2011). However, since peripheral vision is tuned for lower spatial frequencies, collinear facilitation is expected to be stronger with low spatial frequency stimuli. In this study we investigated peripheral collinear

Monday

facilitation with low spatial frequency stimuli (1, 2 and 3 cpd). Results showed collinear facilitation at  $8\lambda$  for all the spatial frequencies tested, but at shorter target-to-flanker distance ( $6\lambda$ ) for the lowest spatial frequency (1 cpd). Moreover, the magnitude of collinear facilitation decreases as a function of spatial frequency. The results suggest a different spatial frequency tuning between foveal and peripheral lateral interactions.

◆ **Disparity cues subserving perceptual coupling of kinetic depth stimuli in normal and stereoblind subjects**

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Ambiguous kinetic depth cylinders can be perceptually coupled by coaxially presented and disparity defined half cylinders. In a previous study (Klink et al., 2009) we have shown that coupling is strongest for disparity defined cylinder backsides compared to frontsides. Those results suggest that lateral connections subserving perceptual coupling are stronger in the far field than in the near field, which is consistent with the observation that perceptual coupling of visual information is often necessary under occlusion conditions. In this study we investigated whether stereopsis is a prerequisite for disparity cues to be differentially used for perceptual coupling. In a stereoblind subject we find different degrees of coupling for cylinder backside compared to frontside, which indicates that stereopsis is not necessary for disparity cues to have a differential effect on perceptual coupling. These results suggest that disparity cues for stereopsis and perceptual binding might be processed in different visual pathways.

◆ **Individual contrast sensitivity predicts perceptual identity of moving objects**

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Paradoxical regimes of spatiotemporal grouping in suprathreshold displays have been successfully predicted (Gepshtein & Kubovy, 2007; Zharikova et al, 2013) from spatiotemporal contrast sensitivity thresholds averaged across observers (Kelly function; Kelly, 1979). If contrast thresholds are a reliable predictor of grouping of suprathreshold stimuli then variability of individual Kelly functions is expected to account for variability of individual grouping strength. To test this hypothesis we measure individual Kelly functions in a direction discrimination task using drifting luminance gratings. From the Kelly functions we find conditions of equivalent sensitivity and predict that they correspond to conditions of equivalent grouping strength. We measure individual conditions of equivalent spatiotemporal grouping in an ambiguous motion display in which multiple rotating dot pairs (“dipoles”) are arranged on an imaginary circle (Anstis & Kim, 2011). The display can be perceived two ways: as multiple small objects (rotating dipoles, when grouping within dipoles prevails) or as two larger objects (pulsating circles, when grouping between dipoles prevails). We measure transition points at which the alternative percepts are equally likely. The transition points and the individual conditions of isosensitivity are highly correlated: for seven observers, the correlation coefficients fall between 0.77 and 0.99.

[The work is supported by Odysseus grant from the Flemish Organization for Science FWO.]

◆ **Gestalts in scenes: Global consistency of luminance polarity at oriented edges in natural images.**

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Perceptual organization of visual input entails a global evaluation of spatially separated image parts. In figure-ground segregation, for instance, the global configuration determines the ownership of an edge to a foreground figure. Neurophysiological research has shown that this computation of “border-ownership” relies on long-distance interactions between neurons (Zhou et al., 2000). We analyze natural images and investigate to which extent spatially separated edges reveal statistical dependencies that could aid in global-scale organizational processes. Natural systems analysis has been successful in relating local image statistics to locally defined grouping principles. We build on this success to extract image statistics across larger spatial scales and to highlight their possible role in more global grouping processes. Specifically, we first record the contrast-polarity of luminance-defined oriented edges across the image space. We then investigate the consistency of contrast-polarity within a pair of spatially separated edges that depends on the geometrical relationship between them. The resulting spatial pattern of consistency suggests that it originates from globally defined regularities in the natural world. We hypothesize

that such large-scale statistical structure can be exploited by the visual system in global processes of perceptual organization in general, and in the computation of border-ownership in particular.  
[All three authors are supported by the Fund for Scientific Research Flanders(FWO).]

◆ **Detection of perturbation in chromatic and luminance stimuli**

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Chromatic and luminance cues may be combined differently depending on their spatial arrangement and content. Motivated by the Boynton illusion, in which a chromatically-defined area appears to fill the region defined by a spatially perturbed achromatic line, we measured thresholds for detecting perturbation in several masking conditions. In the first experiment we manipulated spatial arrangement. Perturbation discrimination thresholds were measured for targets presented alone and in combination with orthogonal or collinear sinusoidal gratings (masks). The gratings neither enhanced nor reduced the ability to detect perturbations irrespective of chromaticity or spatial relationship of target and mask. In a second experiment we tested the importance of spatial content using combinations of lines and square-waves. Line masks increased perturbation discrimination thresholds regardless of chromaticity of target and mask. However, square-wave chromatic gratings increased the percept of perturbation in luminance-defined lines. Conversely, a luminance-defined square-wave had little effect on the perturbation thresholds for chromatic lines. These results suggest that when a luminance line is presented along with a chromatic edge, such as the chromatic boundaries in a square-wave grating, the perceived location of the chromatic edge shifts to that of the luminance cue, paradoxically making the apparent perturbation of the luminance cue more salient.

◆ **A cue combination study of depth ordering from accretion/deletion and contour convexity**

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Although accretion/deletion of textured surfaces is generally considered an unambiguous cue to relative depth, it is also consistent with self-occlusion of a rotating 3D object. Indeed when accretion/deletion occurs on both sides of a contour, relative-depth ambiguity can be resolved by contour geometry, e.g. the convex side is perceived in front and rotating (Froyen et al., 2013, JoV). Moreover, the accreting/deleting region can be seen as rotating even when just one side has moving texture (Tanrikulu et al, 2013, VSS). We investigated how contour convexity and accretion/deletion combine. Our stimuli contained alternating light and dark regions with dots moving horizontally at constant speed, but in opposite directions. Convexity was manipulated via the curvature at negative minima. Accretion/deletion was manipulated by varying relative dot density. Conditions included both cue-cooperation and cue-competition. Increasing convexity strength on one side made that region more likely to be seen as figural (and rotating), whereas increasing dot density made it less likely. However convexity dominated whenever the two cues competed. Our results call into question the conventional view that accretion/deletion is an unambiguous cue to relative depth. We find that contour geometry interacts deeply with motion cues to determine depth ordering and 3D structure.

◆ **Launching awareness: Are causal events represented in the absence of awareness?**

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Michotte can be considered as the pioneering researcher with respect to the phenomenon of causality perception. Based on his findings, Michotte argued that human observers can directly perceive causality between objects. One basic and well known observation is the launching effect: Consider two objects A and B (e.g. circles); A starts moving towards B, stops right in front of it, and B subsequently starts moving. Most observers perceive this as an event in which A causes the movement of B. Manipulating temporal or spatial aspects of this event reduces the perception of causality. This observation led Michotte to argue that causality between objects indeed was perceived and that it acted like a fundamental Gestalt. In this study, we extend this work by testing whether a causal event is represented in the absence of awareness. Causal launch events and non-causal pass events were suppressed through continuous flash suppression and participants had to detect the direction of motion upon breakthrough of the events. Initial results indicate that launching events break suppression faster than pass events, indicating that the launching effect might still be represented while suppressed. These results are discussed in the context of whether interactions between objects are unconsciously processed.



Monday

◆ **Direction of eye movement biases perceived grouping**

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All well-established principles of grouping are based on stimulus statistics. However, visual perception is a result of the interaction between the physical stimulus and the visual system. Here we asked whether the perceptual organization of a given physical stimulus can be changed by manipulating the direction of an eye-movement. The experimental factors were the physical grouping cue (proximity) and the location on the screen (center, left, right, top, bottom). The stimulus was an array of dots that were physically biased to group horizontally/vertically by virtue of horizontal/vertical proximity or were ambiguous with equal distances between the dots. On each trial the stimulus was displayed at a different location on the screen and a green target appeared in the center of the array. The task of the observer was to make a reflexive eye-movement to the target and then to indicate the perceived orientation of grouping with a key-press. We found that the percentage of horizontal responses increased for each condition when the observers made a horizontal eye-movement compared to vertical or no eye-movements. The effect was more pronounced for the ambiguous stimuli. Thus, we propose direction of eye-movement as a novel factor that affects grouping.

◆ **Response priming evidence for feedforward processing of snake contours but not of ladder contours and texture**

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In contour integration, increased difficulty of linking a chain of parallel elements (ladder) compared to linking collinear elements (snake) suggests more extensive and slower processing of ladders than of snakes. In addition, conceptual similarities between ladders and textures - which also involve grouping of parallel elements - raises the question whether both require extensive processing and involvement of higher visual areas while snakes are processed in a fast feedforward sweep. We tested this in a response priming paradigm, where participants responded as quickly and accurately as possible to the orientation of a diagonal contour in a Gabor array (target), preceded with varying SOA by a prime consistent or inconsistent to the target's response demands. Target and prime were either both snakes, ladders, or textures, or the prime was any of these and the target was a continuous line. The resulting priming effects generally increased with SOA but were stronger for snakes and textures compared to ladders. Importantly, only the effects for snakes were fully present already in the fastest response times, in accordance with a simple feedforward processing model. We conclude that snakes, ladders, and textures do not share similar processing characteristics, with snakes exhibiting a pronounced processing advantage.

◆ **Local density metrics in perceptual grouping displays: psychophysical and ideal observer benchmarks**

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Local Density Metrics for Perceptual Grouping Displays: Psychophysical and Ideal Observer Benchmarks Contour integration research typically employs perceptual grouping displays based on a collinearity cue. This requires all other grouping cues to be eliminated - most importantly, the cue of local density (proximity). In GERT, the Grouping Elements Rendering Toolbox (<http://www.gestaltrevision.be/gert>; Demeyer and Machilsen, 2011 Behavior Research Methods), we implemented several methods to solve this problem. In the current research, we collected a large psychophysical dataset of local density judgments in a variety of perceptual grouping displays, to serve as a (subjective) benchmark for evaluating GERT's various metrics. In addition, we let simulated Ideal Observers employ these metrics to distinguish signal from noise displays (objective benchmark). The Voronoi method implemented in GERT was found to perform best. In addition, we confirm that local density cues in which the contour is less dense than the surrounding distractor elements are undetectable by human observers.

◆ **Disentangling the influence of prior knowledge and perceptual processes on amodal completion using electrophysiological measurements.**

98

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Using event-related potentials (ERPs) we investigated the influence of prior knowledge on amodal completion. We created stimuli based on well-known objects of which the middle part was occluded. Perceptually plausible completions comprised joining together the visible fragments by linearly connecting their relatable contours. In contrast, perceptually implausible completions comprised separate disconnected completions of the fragments. Furthermore, completions could follow or conflict with expectations based on knowledge. We measured ERPs when hidden parts were revealed by removing the occluder. We observed a large positive ERP peaking around 300-400 ms at parieto-occipital sites. Completions that were both perceptually plausible and followed knowledge-based expectation elicited the smallest amplitudes, while completions that conflicted with perception and knowledge elicited the largest amplitudes. Furthermore, completions based on either perception or knowledge elicited intermediate amplitudes. Earlier in time, we observed another positive ERP peaking around 115-140 ms at occipital sites that appeared to be influenced only by perceptual plausibility; perceptually implausible completions elicited larger amplitudes as compared to perceptually plausible completions. Corroborated by results from control conditions, these results suggest that initially, partly occluded objects are completed regardless of knowledge. At later stages, knowledge also influences how these objects are perceived.

**POSTERS: DEPTH, 3D, STEREO**

◆ **Head-movement direction, surface orientation, and individual differences in depth from motion parallax**

99

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Although human observers are able to move in any direction in the three-dimensional world, properties of depth from motion parallax have been examined almost exclusively when the observers moved in the right and left directions. In the present study, we compared apparent depth specified by motion parallax accompanied with “right & left”, “up & down”, and “composite” head-movement directions. Motion parallax introduced into monocularly viewed random dot patterns was modulated sinusoidally along a horizontal or vertical axis. The spatial frequencies of the modulation were 0.05, 0.1, or 0.2 cpd and the peak-to-trough depth amplitudes were 1, 2, or 4 cm. The period of the modulation was 1.5 cycles. Apparent depth was quantified using a matching method. On average for six observers, apparent depth depended neither on surface orientation nor head movement direction, i.e., anisotropies were not found, contrary to previous research, and the depth was overestimated at lower spatial frequencies. In addition, reversed depth was perceived by two of the six observers. Convex surfaces with higher spatial frequency and larger depth amplitude were more frequently perceived as having opposite depth to the geometrical prediction.

◆ **Dynamic cues for the perception of depth**

100

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Aim: Clinical tests of stereoacuity use static images. In real life, disparity is dynamic, which may explain reported depth perception in individuals with no clinically demonstrable binocular vision. Our aim was to test the effect of dynamic vs. static cues. Methods: Motion in depth was assessed by either providing both cues (Changing Disparity Over Time (CDOT) + IntraOcular Velocity Difference (IOVD)) or CDOT only. A control condition was created, to assess the effect of changing stimuli pattern on static stereoacuity (StaticCS). A 4-spatial AFC adaptive procedure was used to measure thresholds for foveally presented stimuli (1s duration). Stereoacuity thresholds were derived by fitting a psychometric function (Weibull) to the data of each condition, for each observer. Results: 21 (aged 18-41), subjects with good static stereoacuity, were assessed. Mean(SD) for Static, StaticCS, Combined and CDOT conditions in arc seconds were: 183(101), 241(129), 120(60), 167(111). A 2-way ANOVA revealed that dynamic cues (CDOT+IOVD; CDOT) lead to lower thresholds than static cues (Static; StaticCS)

## Monday

( $p < 0.01$ ). Changing stimuli pattern worsened stereoacuity ( $p < 0.01$ ). There was no significant interaction ( $p = 0.81$ ). Conclusions: Dynamic disparity cues lead to better stereoacuity in comparison to static cues. Further work is required to establish the value of the IOVD cue.

◆ **Does stereoscopic depth information affect a colored version of the Munker-White illusion?**

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We tested the illusory effects elicited by a Munker-White figure with red bars superimposed on alternating black and yellow stripes. Three versions of the illusion were created. In one version/viewing condition, the illusory figure was a two-dimensional depiction. In the other two conditions, binocular disparity was manipulated to shift the red bars into either the background or the foreground. Thirty-two adult participants were asked to select the colors from the Natural Color System most properly describing the perceived colors of the red bars. The illusory effect was robust across all viewing conditions. The illusion mainly consisted of a subjective lightness shift of the red patches positioned on the yellow stripes towards black, a subjective hue shift of the red patches positioned on the black stripes away from red to yellow, and a subjective decrease in saturation of both kinds of red patches. Finally, the results largely confirmed Anderson's (e.g., 1997) scission theory, which predicts the strongest illusory effect if the red bars are shifted into the foreground, the smallest effect if they are shifted into the background, and an intermediate effect in the 2D condition.

◆ **3D structure, geometrical texture, and light direction in Patrick Hughes'**

102 "reverspectives"

T Agostini<sup>1</sup>, C Malisano<sup>2</sup> (<sup>1</sup>Department of Life Sciences, University of Trieste, Italy; <sup>2</sup>Department of Human Sciences, University of Udine, Italy; e-mail: agostini@units.it)

Patrick Hughes' paintings, called "reverspectives", consist of tridimensional structures (pyramids or prisms) painted in such a way to elicit an illusory depth percept that is the reverse of the physical depth arrangement. It has been shown that reverspectives having a simple grid of lines are more effective compared to those with a more naturalistic representation (Rogers & Gyani, 2010). To investigate which kind of geometrical texture is more effective in eliciting the perspective reversal, twenty-eight observers were tested. Three independent variables were manipulated: 1) 3D structure (one or two pyramids); 2) geometrical texture (9 different textures), and 3) light direction (3 different directions). The dependent variable was the distance (observer-stimulus) in which the "switch-off" takes place. The results shows that: a) our visual system prefers an "incorrect" construction that aims to rotate the foreshortened surfaces to the front parallel plane; b) the grid elicits a stronger illusion than the textures with oblique or orthogonal lines; c) the grids drawn with the "incorrect" Hughes' logic are more coercive; and d) the light direction play a significant role in producing the illusion.

◆ **Distortion and comfort for 3D images at crossed and uncrossed disparities**

103 R H Black, S Wuerger, G Meyer (Department of Psychological Sciences, IPHS, University of Liverpool, UK; e-mail: r.black@liv.ac.uk)

Aim: To examine the effect of stereo acquisition parameters on shape distortion and comfort. Methods: 250 stereoscopic hinges (50-130°) were rendered at different camera separations (interaxial and HIT linked at 20-100mm). The screen field of view and observer angle of view were matched at 45°. Disparities were either crossed (Exp1) or uncrossed (Exp2). The task of the observers (n=40) was to judge the angle of the hinge and to rate the viewing comfort. Results: (1) In both experiments the perceived distortions of the hinge angle are smaller than predicted by the ray-tracing model. For the 60mm camera separation right angles are perceived as right angles. (2) Comfort is largely independent of the hinge angle; only for the 60mm camera separation is comfort decreasing with an increase in hinge angle, and only for out-of-screen stimuli. Conclusions: Only for the camera separation close to eye separation (60mm) does viewing comfort depend on the hinge angle. Viewing comfort is not dependent on the disparity of the hinges.

[EPSRC Grant No. 113300095 'Human factors in the design of stereoscopic 3D' Creative Industries KTN & Sony Computer Entertainment Europe]

◆ **Factors affecting size constancy in photographic space**

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A classic example of size constancy depicts two human figures standing at substantially different distances from the viewer. Despite the fact that their retinal sizes differ, their size is perceived unbiased. In a set of experiments using photographic stimuli and adjustment procedure, we demonstrated that even when a rich set of visual cues for spatial layout are present, size constancy is rarely exact. The relative perceived size was found to be determined by numerous factors, including the relative order of test and reference figures, the difference between their egocentric distances and two same versus two different figures presented in the image. For instance, the size of the test figure was systematically set too small when it was positioned closer in the scene than the reference figures and conversely, too large when it was positioned farther away, this tendency toward underconstancy being more pronounced when two different as opposed to two same figures were perceptually compared. The effect of some other factors such as the camera height or the height of the observer was not so strong.

[Supported by Czech Science Foundation grant (P407/13-28709S).]

◆ **Numerosity and density estimation: biases for 2D area but not for 3D volume**

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Introduction: Human observers can quickly and fairly accurately estimate the number of items in a scene. This ability is underpinned by specific mechanisms encoding number and/or density. We investigated whether estimates of number and of density are biased by a change in 3D volume, as they are by a change in 2D area. Method: Stimuli were constructed using non-overlapping black and white luminance-defined dots. A mirror stereoscope was used to present the dots as though in a 3D volume. Using a temporal 2AFC and MOCS, we measured the precision and bias (PSE shift) of numerosity and density judgments, separately, for stimuli differing in 2D area, or 3D volume. Results: For 2D stimuli, consistent with previous literature, perceived density reduced as 2D area increased. However, perceived number was not affected. For 3D stimuli, despite a vivid impression of the dots filling a volume there was no change in perceived number or density as 3D volume increased. A control experiment showed that all six observers could easily perceive disparity in our stimuli. Conclusions: Our findings reveal that disparity cues are not used when calculating number or density, instead these computations appear strictly 2D.

[This research was supported by an Australian Research Council (ARC) Discovery Project grant #DP110101511 given to J.B.]

◆ **The shape of the empirical horopter for eccentric gaze directions**

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It is known that the shape of empirical horopter surface in the frontal direction is curved horizontally and slanted top away vertically. For eccentric visual directions, the shape of horopter has not been measured and is not clearly identified. In this study, we measured the binocular corresponding points and estimated the shape of empirical horopter for horizontal and vertical gaze directions. Display was placed at the angle perpendicular to the gaze direction and observers fixated the centre of the display. We measured binocular corresponding points using a criterion of minimal apparent interocular horizontal and vertical motion. The result showed that the shape of the empirical horopter for horizontal eccentric gaze directions was distorted along by the locus of Vieth-Muller circle, which was consistent with the prediction from the eye positions. For the upper and lower gaze directions, the backward inclination of the empirical horopter as compared to that in the frontal gaze direction increased and decreased, respectively. These results indicated that ex-cyclovergence and in-cyclovergence occurred for upper and lower gaze directions, respectively. The shape of empirical horopter estimated from eccentric gaze directions of wide angle could be related to the shape of comfortable personal space.

◆ **Eccentricity of landmark configuration influences distribution of place recognition errors**

107 S Lancier, A Link, M Admard, H A Mallot (Department of Biology, University of Tübingen, Germany; e-mail: stephan.lancier@uni-tuebingen.de)

The present study focuses on the influence of distance information in different landmark configurations. In a virtual reality setup one group of participants navigated in a configuration of four landmarks which build up a parallelogram and another group was tested in a non-regular quadrilateral configuration. Participants were trained to the junction of a plus-shaped board-walk across a pond featuring four

Monday

distinguishable landmark objects. In the learning phase participants always passed the crossing point turning left or right on the way to the goal thereby learning the crossing point incidentally. In the test phase the whole environment was covered by ground fog. Participants were asked to recognize the crossing point via the outstanding landmarks. The results showed that the non-regular quadrilateral group was displaced from the crossing point and the error ellipse was elongated towards landmarks further away from the crossing point. In contrast the decision points in the parallelogram group were not displaced. However, the error ellipse was again elongated towards more distant landmarks. We conclude that the relative distances of a set of landmarks available at the goal location is relevant for place encoding. This may be related to the decreasing reliability of depth estimates for more distant landmarks.

◆ **On the role of two-dimensional cues for perceived differences in slant**

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An experimental paradigm frequently used in the study of human depth perception is the inference of surface slant from texture. Previous work has shown that slant is consistently underestimated when close to fronto-parallel, and this has been interpreted as a reduced sensitivity to fronto-parallel slants. For textures with discrete elements, such as 'polka dots', a number of two-dimensional cues change concomitantly with slant. While it was assumed that these cues are used to infer slant, and that differences in discrimination performance reflect thus differences in slant sensitivity, it has been recently suggested that some differences might rather reflect sensitivity differences to the two-dimensional cues themselves (Todd et al., 2010). To further test this possibility, we derived perceptual scales for slants defined by texture using the maximum likelihood difference scaling method (Maloney & Yang, 2003). We studied the influence of different two-dimensional cues that varied contingently with slant (elements' aspect and area ratios, scaling contrast, among others), and compared the experimental results with observer models that selectively responded to each cue. The derived perceptual scales confirm lower sensitivities at slants close to fronto-parallel. Interestingly, none of the different cues was sufficient in explaining the sensitivity differences across the entire perceptual scale.

[This work was supported by the German Research Foundation, Research Training Group GRK1589/1 and grant DFG MA5127/1-1.]

## POSTERS: AFTEREFFECTS

◆ **Adaption to orientation regularity with respect to spatial position**

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A recent study by Ouhana, Bell, Solomon & Kingdom (2013) has provided evidence for adaptation to the positional regularity of elements within a grid. Using arrays of Gabor patches we find similar effects for orientation regularity. However it is unclear which neural mechanisms underlie this phenomenon, in particular whether contrast adaptation can account for the effects observed. In order to test this we first randomised the spatial position of individual Gabor patches within a 2AFC orientation regularity discrimination task. We then computed the amount of spatial overlap between adapter and test arrays to ascertain whether spatial overlap of adapters can predict perceived orientation regularity at each trial. If adaptation to orientation regularity was being mediated solely by means of contrast adaptation we should observe an increase in the strength of adaptation as spatial overlap increases. However we find no difference in the amount of overlap with respect to perceived regularity ( $p > 0.05$ ,  $n = 3$ , 1260 trials each). This suggests that adaptation to orientation regularity cannot solely be accounted for by contrast adaptation alone.

◆ **Point me in the right direction**

110 N Brady, S M Cooney (School of Psychology, University College Dublin, IRELAND; e-mail: nuala.brady@ucd.ie)

Of the many hand gestures that we use in communication pointing is one of the most common and powerful in its role as a visual referent that directs joint attention (Tomasello, Carpenter & Liszkowski, 2007). But while the perception of eye gaze and head turning have been studied as cues to social attention, there is a paucity of research on pointing. Across two studies we use an adaptation paradigm to explore the mechanisms underlying the perception of proto-declarative hand pointing. Twelve participants

judged whether (3D modelled) hands pointed at or to the left or right of a target (test angles of 0°, and 2° and 4° left and right) both before and after adapting to either hands (Study 1) or arrows (Study 2) which pointed 25° to the right or left of target. After adaptation, the perception of the pointing direction of the test hands shifted with respect to the adapted direction, revealing separate mechanisms for coding right and leftward pointing directions (Study 1). The considerable cross adaptation found when arrows were used as adapting stimuli (Study 2) suggests that, as in the case of perceiving eye gaze direction, simple geometric cues are central to the perception of pointing direction.

◆ **Heads up: cross adaptation to head and body orientation**

111 S M Cooney (Psychology, University College Dublin, Ireland; e-mail: sarah.cooney@gmail.com)

Head and body turning direction provide important information about another person's focus of attention, especially in the absence of information from the eyes. Previous research using perceptual adaptation provides evidence of populations of neurons tuned to different views of the human body (Lawson et., al, 2009). The question of how information from these sources is combined to gauge social attention is relatively unexplored. In separate experiments, twelve participants judged the facing direction of either heads or bodies oriented at 0°, 4° and 8° to the right and left, both before and after adaptation to more extremely oriented heads or bodies. As expected, after visual adaptation to a body oriented 25° to one side, perception of the orientation of subsequent body probes shifted in the opposite direction to the adapted viewpoint. A similar aftereffect was observed for head stimuli. Here we report evidence of a novel cross-category adaptation aftereffect demonstrating that prolonged viewing of a head oriented 25° to one side shifts subsequent perception of body orientation. Adapting to a body oriented 25° to one side did not influence subsequent perception of head orientation. These results support a hierarchical model of cues to social attention with head orientation superseding body orientation.

◆ **Surround-contingent tilt aftereffect**

112 Y Nakashima, Y Sugita (Department of Psychology, Waseda University, Japan; e-mail: y.sugita@waseda.jp)

Variety of contingent aftereffects have been demonstrated, such as color-contingent orientation and motion aftereffects and spatial frequency- and motion-contingent color aftereffects. We investigated whether aftereffects can be contingent on surroundings. Gabor patches tilted clockwise and counterclockwise off vertical were presented in alternation and each patch was surrounded by an open circle or an open square. After prolonged exposure to these stimuli, tilt aftereffects were found to be contingent upon the surrounding frames: vertical test patches appeared tilted clockwise when surrounded by the frame that was presented in conjunction with the adaptation patch tilted counterclockwise. The effect lasted at least 24 hours and was observed only when adaptation and test stimuli were presented at retinotopically same position, but not observed when they were presented at spatiotopically same position. These results indicate that the aftereffect would be influenced not only by stimulus features but by their surroundings.

◆ **Temporal phase tuning of texture-surround suppression of contour shape**

113 E Gheorghiu<sup>1</sup>, F A A Kingdom<sup>2</sup> (<sup>1</sup>Department of Psychology, University of Stirling, United Kingdom; <sup>2</sup>McGill Vision Research, McGill University, Canada; e-mail: elena.gheorghiu@stir.ac.uk)

Surround textures prevent the shape of a contour from being processed as a contour but instead as part of a texture, a phenomenon named texture-surround suppression of contour-shape. Here we use the shape-frequency aftereffect (SFAE) to examine whether the effect of a surround-texture on contour-shape processing is selective to their temporal phase-relationship. Texture adaptors consisted of a central contour flanked by a non-overlapping surround-texture comprising a series of contours arranged in parallel. Subjects adapted to pairs of contours, with and without surround-texture, that differed in shape-frequency, and the SFAE was measured as the difference in shape-frequency of a corresponding pair of single-contour tests when their shape-frequencies were adjusted to be perceptually equal. Center-contours and surround-textures drifted in the same direction while counterphasing at various temporal frequencies and with various temporal phase-differences. For in-temporal-phase center-surrounds, the SFAE was strongly suppressed by the surround-texture irrespective of temporal frequency, while for anti-temporal-phase center-surrounds, the suppression increased with temporal frequency. The SFAE reduction was broadly tuned for center-surround temporal-phase differences, and was slightly bigger when the surround texture preceded rather than followed the central contour in temporal phase. Texture-surround suppression of contour-shape processing is selective to the temporal phase-relationships between contour and surround texture.

Monday

◆ **Evidence for visual feature representations in both retinocentric and headcentric, but not body or world-centric reference frames.**

114

S Parwaga, P A Duke (Psychology, University of Leicester, United Kingdom;  
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Perception of the world is generally stable and allows us to interact successfully with the environment despite movements of the eyes, head and body. How are such perceptions formed? One possibility is that retino-centric image features are transformed into representations at higher levels, such as head-, body-, or perhaps world-centred representations. The present study investigated this hypothesis using a contingent tilt aftereffect paradigm designed to reveal adaptive representations beyond the retino-centric level. We found tilt aftereffects contingent on eye-gaze direction, but not head- or body-direction. This demonstrates that visual features are represented in a head-centric frame and suggests no higher levels of perceptual representation. Having found evidence for an adaptive head-centric representation, we examined its contribution to the classical tilt aftereffect using a method designed to isolate retino-centric and head-centric components and examine their temporal characteristics. We found evidence that tilt representation involves 1) a retino-centric tilt encoding mechanism, which is sensitive to test stimulus duration, and 2) an eye-gaze direction encoding mechanism, which is not. Our results suggest that retino-centric visual feature orientation is jointly encoded with eye-gaze direction to produce head-centric - but not body- or world-centric - representations.

◆ **Adaptation decorrelates neural activation patterns in visual cortex**

115

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Adaptation is a fundamental property of neural responses, changing response strengths as well as tuning properties of single cells when stimuli are repeated. Some single cells and theoretical studies suggest that adaptation may reflect efficient coding. However, the prevailing models of functional magnetic resonance imaging adaptation (fMRI-A) have not considered adaptation as a part of active coding, but simply as a fatigue of a neural response. In the present work, we designed fMRI-A experiments to study the effect of temporal context on dependency between macroscopic activation patterns. Our data shows that adaptation is associated with changes in statistical dependency between the adapting and the adapted patterns. In particular, we found that the adapted fMRI activation patterns showed less statistical dependency than non-adapted patterns, and that this effect attenuated as a function of time. In addition, our results showed that similar decrease of dependency was found both in the active and subthreshold voxels. This suggests that there is a feedforward-feedback loop involved in transmitting the effect of adaptation. In summary, these results show that the temporal contextual information can lead to more efficient code at system level. Moreover, the decrease of statistical dependency is distributed all over the relevant processing network.

◆ **High-level action adaptation and low-level motion adaptation correlate with Autism traits**

116

J J A van Boxtel<sup>1</sup>, H Lu<sup>2,3</sup> (<sup>1</sup>School of Psychological Sciences, Monash University, Australia; <sup>2</sup>Department of Psychology, University of California, Los Angeles, USA; <sup>3</sup>Department of Statistics, University of California, Los Angeles, USA; e-mail: j.j.a.vanboxtel@gmail.com)

We previously showed that when adapting to a biological motion stimulus, a space invariant (global) action aftereffect can be observed in people with few autistic traits (Autism Spectrum Quotient (AQ); Baron-Cohen et al 2001), while healthy people with many such traits do not show this global aftereffect (van Boxtel & Lu, 2013). Here we wanted to investigate both high and low level adaptation. The adaptation stimulus was an array of point-light walkers or runners, of which we only showed the leftward or rightward moving dots during the 6s adaptation period. This allowed for action adaptation, while the imbalance in motion energy allowed for a motion aftereffect to build up. The test stimulus differed between action and motion adaptation trials, being a morphed action (50% walker-50% runner), or a static random dot array, respectively. People with a high AQ showed less action adaptation (consistent with our previous finding), but more motion adaptation. This inverse relationship between high- and low-level adaptation is consistent with a predictive coding account. Interestingly, the finding that people

with an increased number of autistic traits show increased motion adaptation is inconsistent with the idea that people with Autism Spectrum Disorder are generally less sensitive to visual illusions.

## POSTERS: SURFACE, TEXTURE AND MATERIAL PERCEPTION

### ◆ **Thick and thin priors for shape from shading**

117 R F Murray (Department of Psychology and Centre for Vision Research, York University, Canada; e-mail: rfm@yorku.ca)

Recovering surface shape and reflectance from image shading is a difficult problem because it is underconstrained. The generalized bas-relief (GBR) ambiguity formally describes a special case of this problem. What statistical knowledge about real-world surfaces would help us overcome the GBR ambiguity? Do we need detailed measurements of real-world surfaces (thick priors), or is general knowledge (thin priors) that avoids pathological interpretations enough? We measured statistical properties of orientation, reflectance, and illuminance in digital models of 1000 objects. We tested which of several of the resulting statistical models selected the correct 3D interpretation of a 2D image of an object, out of a range of GBR transformations of the object. We found that pixel-to-pixel reflectance changes were small, and that this constraint tended to produce correct 3D interpretations. Pixel-to-pixel orientation changes were also small, but this constraint did not produce correct 3D interpretations. A simple prior stating that pixel-to-pixel changes in reflectance and illuminance should be as statistically independent as possible also worked well in finding correct 3D interpretations. Thus statistical measurements of real-world surfaces can be useful in recovering 3D shape from 2D images, but general knowledge that largely just avoids pathological interpretations can also work surprisingly well.

[Natural Sciences and Engineering Research Council of Canada; Canada Foundation for Innovation]

### ◆ **Local shape of pictorial relief**

118 J J Koenderink<sup>1,2</sup>, A J van Doorn<sup>2</sup>, J Wagemans<sup>1</sup> (<sup>1</sup>Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; <sup>2</sup>Psychologische Functieeler, University of Utrecht, the Netherlands; e-mail: jan.koenderink@ppw.kuleuven.be)

How is pictorial relief represented in visual awareness? Not as a “depth map”, but perhaps as a map of local surface attitudes? Here we consider the possibility that observers might represent local surface shape, a geometrical invariant with respect to motions. Observers judge local surface shape, in a picture of a piece of sculpture, on a five-point categorical scale: cap - ridge - saddle - rut - cup, augmented with a special “flat” category. For the three authors we find that each readily performs such a task, with full resolution of the scale, and with excellent self-consistency over days. Naive observers also find the task easy. However, there exist very significant inter-observer differences. Over a group of ten naive observers we find that the spread in judgments peaks at the saddle category. There may be a relation of this finding to the history of the topic, namely Alberti’s (1436) omission of the saddle category in his purportedly complete taxonomy in *Della Pictura*.

### ◆ **Viewpoint effects on glossiness perception**

119 S Hansmann-Roth, P Mamassian (Laboratoire des Systèmes Perceptifs (CNRS), Ecole Normale Supérieure, France; e-mail: roth.sabrina@gmx.de)

Different materials, such as metal, wood or plastic exhibit different light-reflectance patterns due to their different material properties. We can use such patterns to characterize a material. However, changing the viewpoint influences the appearance of highlights even though the material is identical. Those changes should be interpreted as consequences of viewpoint changes and not as consequences of material changes. In the present study we investigate whether perceived brightness and glossiness are invariant to viewpoint changes. One large surface was rendered with 5 different materials from 7 different viewpoints and presented to the observer for 2s. The observers’ task was to reproduce the brightness (diffuse reflection) and glossiness (specular reflection) of a second image so that this latter image had the same material as the first one. Participants could select one image out of 36 possible glossiness and brightness combinations. The analysis of the data reveals that glossiness perception is fragile and highly dependent on the viewpoint. Brightness was recovered accurately and precisely even in the presence of highlights and for different viewpoints. In summary, glossiness constancy does not seem to occur with viewpoint changes in contrast to brightness perception which is invariant across viewpoints.

[EC FP7-PEOPLE PITN-GA-2012-316746 (PRISM)]



Monday

◆ **Perception of bounce height is influenced by surface smoothness**

120 K Ó Ingvarsdóttir<sup>1</sup>, G R Patching<sup>2</sup> (<sup>1</sup>Lund University Cognitive Science, Sweden; <sup>2</sup>Department of Psychology, Lund University, Sweden; e-mail: Kristin.Osk\_Ingvarsdottir@lucs.lu.se)

Systematic asymmetries are known to arise in comparison and discrimination of paired visual magnitudes. Such asymmetries are thought to arise as a result of the use of stored knowledge about the environment in the judgement process. However, the precise role that context plays in determining the magnitude and direction of such asymmetries has yet to be fully determined. In the present study, participants observed animations of a ball bouncing on a surface plane with either matte or shiny features. Using the method of paired comparisons, each trial comprised an animation of two ball bounces in temporal sequence, one bounce on a rough plane, and one bounce on a smooth plane. The heights of the two bounces in each stimulus pair were varied systematically in semi factorial combination. The findings include characteristic asymmetries that were found to change systematically in magnitude depending on the surface properties of the plane; bounce height was perceived to be higher for smooth as compared to rough surfaces, for both matte and shiny materials. The results are interpreted in terms of Hellström's (1979) Sensation Weighting model.

◆ **Visual inference of material properties of fabrics from videos**

121 B Xiao, W Kistler (Department of Computer Science, , American University, USA; e-mail: bxiao@american.edu)

Humans can effectively estimate the intrinsic material properties of deformable objects in dynamic scenes by using vision alone. Recently, Bouman et. al (2013) developed an algorithm to recover mechanical properties of fabrics under unknown forces from videos. Complementing this research, we measure here how humans estimate the mechanical properties of fabrics using computer animations. Blender 3-D modeling software was utilized for this experiment. The internal Cloth Solver and particle physics engine were used to simulate 3 fabric types with different physical qualities and corresponding textures, each blown at 3 separate wind speeds, resulting in 9 videos and 36 paired comparisons. Two videos of one fabric type each were presented to observers per trial. Participants were asked to indicate which fabric was "stiffer" or "heavier". In a separate block, we used the same animations but with the fabrics all having the same image texture. Observers can recover the stiffness consistently when the corresponding textures of the fabrics are shown. When the texture information is removed, less stiff fabrics under higher wind speeds are often confused with stiffer fabrics under lower wind speeds. In addition, we find judgments of stiffness and mass are correlated, with heavier cloths tending to appear stiffer.

## POSTERS: PERCEPTUAL LEARNING

◆ **Alpha ERD reflects learning and uncertainty during the acquisition of novel categories**

122 S Jellinek, J Fiser (Cognitive Science, Central European University, Hungary; e-mail: jellinek\_sara@ceu-budapest.edu)

How are the learning process of a novel category and uncertainty about the category reflected in the alpha-band suppression of the brain? We built an experimental procedure on the oddball paradigm frequently used to investigate the nature of category representations in humans, but contrary to similar studies, we used a continuous stimulus dimension and recorded EEG signals from the beginning of learning. Behaviorally, we found that participants mapped correctly the statistical distribution of the input in their implicit judgments with higher uncertainty reports along the implicit category boundary. Confirming earlier results, we found significant differences in alpha ERD elicited by frequent and infrequent stimuli [ $t(11)=2.66$ ,  $p<.02$ ]. Importantly, learning was reflected in the difference of alpha-band suppression between neural responses collected early vs. late during the experiment, especially for exemplars at the extremes of stimulus range [ $t(11)=2.98$ ,  $p = .012$ ]. This difference was less articulate for stimuli sampled around the category boundary where confidence was also lower, suggesting that alpha ERD and subjective confidence in acquired knowledge are correlated. These results support the ideas that alpha-suppression is not only a reliable measure of the already acquired structure of concepts, but it also allows for tracking the ongoing acquisition of categories.

◆ **Short term and baseline effect in the estimation of probabilistic visual event sequences**

123 J Arató, J Fiser (Department of Cognitive Science, Central European University, Hungary; e-mail: arato\_jozsef@ceu-budapest.edu)

Humans' reliance on expectations based on past experience to evaluate uncertain sensory events of their environment has been interpreted either as local adaptation or probabilistic implicit inference. However

the exact interplay between immediate past and longer-term sensory experiences in influencing these expectations has not yet been experimentally explored. In a simple probabilistic visual 2-AFC task, we assessed how human judgments depended on unbalanced base-rate appearance statistics and the immediate history of possible events. Participants detected the appearance of visual shapes in blocked random visual sequences, where base-rate appearances were systematically manipulated throughout the blocks. Expectations were assessed implicitly by reaction times and explicitly by interspersed numerical estimates and confidence judgments. Implicit expectations were reliably influenced by both probabilities of the immediate past ( $F(3,14)=34.733, p < .000$ ) and the base-rate ( $F(3,14)=28.674, p < .000$ ) in an additive manner. In addition, implicit and explicit measures were consistent, as participants' accuracy and confidence judgments in estimating the probability of likely and unlikely events followed the same pattern for the two measures. The results confirm previously untested assumptions about the interaction of base-rate statistics and short-term effects in forming visual expectations, and suggest that behavioral changes are based on internal probabilistic models not just on local adaptation mechanisms.

◆ **Dissociated mechanisms for objective and subjective judgments during target-absent but not target-present processing**  
124

A Grieco, A M Oliveira (Institute of Cognitive Psychology (IPC- FCT), University of Coimbra, Portugal; e-mail: alba.grieco@fpce.uc.pt)

Most research on visual perceptual learning has focused on assessing the effects of practice on objective measures of task-performance, such as sensitivity- $d'$  or percent correct-responses. This study uses confidence-rate and response-time as dependent variables to examine the learning mechanisms in the detection of contrast polarity cues. Nine subjects participated in the experiment. We found that 1) accuracy at target-present and target-absent were similar across training sessions, though the latter was associated, at the beginning of training, with lower confidence ratings; 2) subjective-confidence increased remarkably during the learning phase only for target-absent displays; 3) response-times, faster for target-present than target-absent displays, were reduced by practice more for target-absent than target-present; 4) the reduction of response-time was found to correlate with increased task performance at both target-present and target-absent displays and with reduction of less-confident response only for target-absent stimuli. The data show that for target-absent displays, accuracy and confidence rate rely on different mechanisms. In contrast, for target-present processing, an early-control mechanism seems to be involved from the start of training, manifesting itself by promoting high-confident target-experience and fast response-times. We provide good evidence that the mechanisms underlying objective and subjective judgments of target-absent displays contribute separately at reducing response-times.

◆ **Transfer of perceptual learning between first and second order pattern analyzers.**

125 L A Olzak, M Gong (Department of Psychology, Miami University of Ohio, USA; e-mail: olzakla@miamioh.edu)

Perceptual learning may or may not transfer between 1st and 2nd order systems. In second-order motion systems, learning transfers between contrast and luminance defined motion, although the reverse does not occur (Lu & Sperling, 1995; Scott-Samuel & Georgeson, 1999). Vaina & Chubb (2012), however, reported no transfer in either direction. We investigated transfer in mechanisms mediating fine orientation differences with static patterns. Observers initially learned to discriminate between two luminance-modulated (LM) or contrast-modulated (CM) patterns (4 cpd, LM contrast = 0.1; CM modulation depth = 0.4), then were tested with the opposite stimulus type. A 6-point rating judgment indicating certainty that pattern A or Pattern B had been presented was used to calculate  $d'$  values. We first tested them at the same orientation difference that yielded a  $d'$  of 1.5 with LM gratings (approximately  $\pm 0.5$  deg). No observer could perform the task above chance. We had to revert to  $\pm 45$  deg and shape responses over a period of months. Thresholds were about 10 times higher than found with LM gratings. When compared to control groups with no prior training, learning trajectories were similar, suggesting no transfer had taken place. Our results suggest that the two systems are independent.

Monday

**POSTERS: SCENE PERCEPTION**

◆ **Follow me! A spatial compatibility effect of perspective changes on viewing directions in cinematic cuts**

126

F Goller, C Valuch, U Ansorge (Department of Basic Psychological Research and Research Methods, University of Vienna, Austria; e-mail: florian.goller@univie.ac.at)

Movies are highly edited. Even within a single movie episode, there are multiple cuts. Such cuts frequently cause changes of camera perspective. Here, we studied whether such perspective changes elicit a spatial compatibility effect on viewing directions. We let participants watch 52 short videos of actors performing everyday actions (e.g. typing on a keyboard). After a fixed period of time, the camera perspective changed in different but standardised ways (e.g. from left to right). Using eye tracking, the viewing direction was monitored. Our data revealed that the change of the camera perspective influences viewing direction: If the cut was such that the camera perspective shifted towards the right (e.g. from a centre perspective towards a view from the right side), the first fixations after the cut were directed more to the right. This compared to a perspective change towards the left. A second experiment studied whether the perspective changes also influenced saccadic reaction times towards a laterally presented target after the cut. Our results point to a spatial compatibility effect as the likely origin of the effect. We discuss our results with respect to theories of attention and fixation behaviour.

◆ **Image-independent biases in scene viewing: deriving an appropriate baseline**

127

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When observers view scenes, they display image-independent biases in viewing behaviour. Notably, humans display a marked bias to fixate near the centre of an image, irrespective of its content. If we are to understand viewing behaviour, we must characterize these biases accurately. Doing so provides (1) a necessary baseline for quantifying the extent to which visual features are selected at fixation; (2) a benchmark for evaluating the performance of models of fixation behaviour; and (3) a component for models that can improve their ability to describe viewing behaviour. We compare four commonly used approaches to describing image-independent biases and report their ability to describe observed data and correctly classify fixations across 10 eye movement datasets. We considered the susceptibility of existing approaches to the amount of data collected in experiments. We show that all 10 datasets are well-fitted by a single anisotropic Gaussian function that provides a robust baseline for describing image-independent biases without the need to fit functions to individual datasets or subjects, and which is free from issues of small sample sizes. This function can be used as a baseline for evaluating models of fixation behaviour and can be incorporated into generative models of eye movements.

◆ **The origin of the universal power law of natural images**

128

L Zhao (Brain and Cognitive Sciences Institute, Henan University of Science and Technology, China; e-mail: bcshaust@163.com)

One of the most striking properties of natural images is that their power spectra conform to the universal power law. However, the question like what is the origin of the universal power law leaves unanswered. Here we tried to approach this question from two simulation studies. In the first simulation, the objects in 3D space were represented as opaque spheres of different sizes. The sizes and positions of the spheres were assumed to be uniformly distributed, Then images of these spheres were rendered by Computer Graphics algorithm. It is found that the power spectra of the simulated images conformed to the universal power law with deviation around 0.3 0.7 (corresponding to different camera setups). Moreover the sizes of the circular disks in the simulated images conformed to  $1/size^2$  for small disks while conformed to  $1/size^5$  for large disks. This led to the second simulation in 2D which assumed the sizes of circular disks conformed to  $1/size^a$  ( $a=1.5$ ). It was found that the power spectra of the simulated images conformed to universal power law with deviation 0.5, 0.1, -0.2, -0.9, -1.2. These simulations may shed light for the final understanding of the origin of the universal power law of natural images.

[Supported by China NSF 60475021 and Fund from China Department of Education NCET-05-0611.]

◆ **The carry-over effect on recognition task**

129

K Hine, Y Itoh (Department of Psychology, Keio University, JAPAN; e-mail: hine@psy.flet.keio.ac.jp)

We investigated the effect of the mental-spatial distance to be imagined on subsequent scene recognition. According to Construal Level Theory (Liberman & Trope, 1998), local information is activated when

Monday

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one is imagining the near distance. It is known that local processing harms visual perception, such as face and scene perception. Previous work suggested that local processing in the imagination task was carried over and impaired a subsequent face recognition task (Hine & Itoh, 2011). Therefore, we predicted that scene recognition also impaired by imaging near spatial distance. Participants (N=123) were randomly assigned to one of the three conditions (near distance, far distance, control). Participants watched a photo presenting clouds in the sky (target). After that, participants in the near distance condition imagined what they did in their hometowns whereas participants in the far distance condition imagined what they did in a foreign country. Participants in the control condition were assigned the filler task. Finally, all participants took a recognition test, in which they were asked to select the target from six photos. The accuracy of recognition in the near distance condition was significantly lower than that in the far distance. This result supported that mental-spatial distance influenced visual recognition.

Tuesday

**TUESDAY****SYMPOSIUM: PUTTING VISION INTO CONTEXT: A FRESH LOOK AT CONTEXTUAL MODULATION**◆ **Putting Vision into Context: a fresh look at contextual modulation**

M H Herzog<sup>1</sup>, F A A Kingdom<sup>2</sup> (<sup>1</sup>Laboratory of Psychophysics, Brain Mind Institute, EPFL, Switzerland; <sup>2</sup>Department of Ophthalmology, McGill University, Canada;  
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It is widely believed that vision proceeds from a low level to a high level of analysis, from processing lines and edges to figures and objects. Much of vision research is devoted to understanding basic processing, such as of contrast, colour, motion, etc. Most experiments use single isolated stimuli such as drifting gratings. However, in the real world, elements are rarely encountered in isolation. How do elements combine into objects when surrounded by other objects? This is the research area of contextual modulation. The current symposium brings together neurophysiological, clinical, behavioural and computational approaches to offer a fresh look at contextual modulation.

◆ **Surround suppression supports second-order feature encoding by macaque V1 and V2 neurons**

J A Movshon, L E Hallum (Center for Neural Science, New York University, USA;  
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Single neurons in macaque visual cortex respond preferentially to stimuli defined by the modulation of luminance in their classical receptive fields (CRFs). These responses are often influenced by context, for example when stimuli extend outside the CRF. These response phenomena reflect a fundamental cortical computation, and may inform perception by signaling second-order visual features which are defined by spatial relationships of contrast, form, and time. We measured single-unit responses to a preferred sinusoidal grating drifting in one direction, which was modulated in contrast by a second, raised sinusoid that varied in orientation and spatial frequency (Tanaka & Ohzawa, 2009). Most neurons responded selectively to the orientation of the contrast modulation of the preferred grating and were therefore second-order orientation-selective. This selectivity reflects the spatial structure of the contrast sensitive regions of the receptive field. We modeled these regions as the difference of two generalized Gaussian distributions of sensitivity to the modulation of contrast (not luminance). The model recovers asymmetric RF organization and can be validated with conventional measurements of receptive field structure. The results suggest that second-order selectivity arises from both elongated excitatory CRFs and from asymmetric surround suppression.

◆ **Psychophysical correlates of lateral inhibition**

J A Solomon (Centre for Applied Vision Research, City University, UK;  
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The visual system exaggerates the differences between spatially adjacent regions in an image. It may seem strange that evolution has favoured a sensory apparatus that distorts the relative intensities of its stimuli, but contextually induced repulsion may simply be an inescapable by-product of inhibition between neurones that respond to neighbouring regions of the visual field. One benefit of this lateral inhibition is gain control, which effectively extends each neurone's dynamic range. The neurones may also become more sharply tuned for their preferred feature values. I am particularly interested to find psychophysical evidence of these benefits. Extended dynamic ranges and sharper tuning could manifest as increased sensitivity to the differences between stimuli. We might expect to find high levels of discriminability along those feature dimensions for which repulsion is strong, and low levels of discriminability along those feature dimensions for which repulsion is not strong. Failing that, we might expect stimulus manipulations that affect repulsion to have an analogous effect upon discrimination. Failing that, we might need to revisit the question of what lateral inhibition is good for, in the first place. [EPSRC grant EP/H033955/1]

◆ **Colour constancy in context: the role of different temporal and spatial scales**

A Werner (Centre for Ophthalmology, University of Tübingen, Germany;  
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Colour constancy is a prime example for contextual phenomena in colour vision, whereby three-dimensional, natural scenes pose major computational challenges. I will discuss the functional role and

task relevance of contextual influences at different spatial and temporal scales for colour constancy in natural scenes. In particular, two major types of sensory colour constancy are distinguished: a slow type, operating at a global scale for the compensation of the ambient illumination; and a fast colour constancy, which is locally restricted and well suited to compensate region-specific variations in the light field of three dimensional scenes

[DFG grants WE 1710/1-1, We 1710/1-2; fortune grants F 1222597, F 1222651; BMBF (BCCN Tübingen)]

◆ **Contextual modulation improves motion coding in area MT**

L D Liu, C C Pack (Montreal Neurological Institute, McGill University, Canada;  
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One of the most common types of contextual modulation is surround suppression, which is typically observed as a reduction in neuronal firing rate with increasing stimulus size. Many neurons in macaque area MT show surround suppression for moving stimuli. To assess the possible functional role of surround suppression in motion processing, we recorded from MT neurons in monkeys trained to discriminate the motion of a briefly presented Gabor stimulus. Consistent with human studies (Tadin et al., 2003), we found that discrimination performance was worse for larger stimuli. However, many MT neurons showed little or no surround suppression, suggesting that perceptual performance was not due simply to a strategy of decoding from the neurons that were individually the most sensitive to the task parameters. By examining data from simultaneously-recorded MT neurons, we found that the population of surround-suppressed neurons had a weaker dependence of correlated noise on tuning similarity. As a result, an ideal observer was able to extract more information from the population of surround-suppressed MT neurons, with the side effect of reduced performance for larger stimuli. Overall, these results suggest that surround suppression improves population coding in MT, with occasionally counter-intuitive effects on behavioral performance.

[Supported by a grant from the CIHR (MOP-115178) to C.C.P. and a Canadian Graduate Scholarship-Doctoral Grant (CGSD-121719) to L.D.L.]

◆ **Contextual modulation as de-texturizer**

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Contextual modulation refers to the effect of texture placed outside of a neuron's classical receptive field as well as the effect of surround texture on the perceptual properties of variegated regions within. Here we argue that one role of contextual modulation is to enhance the perception of contours at the expense of textures, in short to de-texturize the image. This presentation highlights evidence for this role which comes mainly from three sources: psychophysical studies of texture-surround suppression of contour shape using shape after-effects, computational models of neurons that exhibit iso-orientation surround inhibition, and fMRI studies revealing specialized visual areas for contour as opposed to texture processing. In addition, we discuss the relationship between psychophysical studies that support contextual modulation as de-texturizer and those that investigate contour integration and crowding.

◆ **Contextual Interpretation and Contextual Modulation across the entire visual field**

M H Herzog (Laboratory of Psychophysics, Brain Mind Institute, EPFL, Switzerland;  
e-mail: michael.herzog@epfl.ch)

Perception of an element can be strongly modulated by surround. Likewise, neural firing of a neuron can strongly be influenced by stimuli outside the classical receptive field. Contextual modulation is often seen as a limitation of the visual system, where nearby flankers impede spatial resolution and thus deteriorate performance on target elements. Accordingly, contextual modulation is usually explained by models, in which only nearby elements influence each other. Here, I will show that perception of an element depends on all elements in the entire visual field. Contextual modulation is rather an interpretation than a limitation. Performance on a target depends on how it groups with all elements in the entire visual field. Performance is good when the target ungroups from the context and deteriorates when it groups with the context.

[Supported by the Swiss National Science Foundation (SNF) project "Basics of visual processing: What crowds in crowding"]

Tuesday

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## **SYMPOSIUM: MOTION PROCESSING IN TYPICAL AND ATYPICAL DEVELOPMENT: SYMPOSIUM IN MEMORY OF JOHN WATTAM-BELL**

### ◆ **Motion processing in typical and atypical development: symposium in memory of John Wattam-Bell**

O Braddick<sup>1</sup>, J Atkinson<sup>2</sup> (<sup>1</sup>Department of Experimental Psychology, University of Oxford, UK; <sup>2</sup>Visual Development Unit, Department of Developmental Science, University College London, UK; e-mail: oliver.braddick@psy.ox.ac.uk)

Motion is a key area of early human visual development, and has proved to be a revealing signature of brain function in many neurodevelopmental disorders. The symposium will review the state-of-the-art in studies of infants' capabilities for local and global motion processing, and present new evidence from EEG, ERPs and fMRI on the development of the underlying cortical networks in infancy and beyond, including those that link motion processing to attention networks. New findings will be presented on the specific anomalies of motion processing found in autistic spectrum disorders, and in children at risk for brain injury following preterm birth. It will include new data on the links between individual children's mathematical ability, global motion processing, and variation in brain structure. As well as presenting advances in these areas, the symposium will honour the memory of John Wattam-Bell (University College London), whose sudden death in December 2013 robbed the field of a pioneer of motion studies in infancy. A number of the participants were John's collaborators and friends in this research.

### ◆ **From local to global motion in development: John Wattam-Bell's contributions**

O Braddick<sup>1</sup>, J Atkinson<sup>2</sup> (<sup>1</sup>Department of Experimental Psychology, University of Oxford, UK; <sup>2</sup>Visual Development Unit, Department of Developmental Science, University College London, UK; e-mail: oliver.braddick@psy.ox.ac.uk)

Processing of motion information, and its integration, play a key role in the development of the infant's visual world. Work by John Wattam Bell and colleagues at the Visual Development Unit provided the first evidence on how basic directional selectivity develops in the infant's visual cortex. VEP and behavioural evidence concur that such selectivity is not present at birth, but starts to emerge around 7 weeks of age. Wattam-Bell and colleagues showed that VEPs specific to the global processing of coherent motion emerge very soon afterwards, but show a change in anatomical organization between infancy and adulthood. We are beginning to integrate these findings to consider how the motion processing network of the brain is organized and re-organized during development. In particular, development of feedback pathways from extrastriate motion areas to V1 may be a major element in this changing organization. Sensitivity to global motion and global form provide signatures of extrastriate processing in the dorsal and ventral cortical streams respectively. Work with neurodevelopmental disorders, beginning with our work with John Wattam-Bell in the 90's, has highlighted the relative vulnerability of the dorsal stream. Presentations in this symposium will update this evidence for the cases of autism, premature birth, and cognitive variations in the normal range. Understanding the link between this vulnerability, and the changing networks revealed by VEP studies, provides a task for future research.

### ◆ **Global motion, mathematics and movement: dorsal stream sensitivity relates to children's individual differences in cognitive abilities and regional brain development**

J Atkinson<sup>1</sup>, O Braddick<sup>2</sup>, J Wattam-Bell<sup>1</sup>, N Akshoomoff<sup>3,4</sup>, E Newman<sup>3</sup>, H Girard<sup>5</sup>, A Dale<sup>6,7</sup>, T Jernigan<sup>3,4,6,8</sup> (<sup>1</sup>Visual Development Unit, Department of Developmental Science, University College London, UK; <sup>2</sup>Department of Experimental Psychology, University of Oxford, UK; <sup>3</sup>Center for Human Development, University of California San Diego, USA; <sup>4</sup>Psychiatry, University of California San Diego, USA; <sup>5</sup>Joint Doctoral Program in Clinical Psychology, SDSU/UCSD, USA; <sup>6</sup>Radiology, University of California San Diego, USA; <sup>7</sup>Neurosciences, University of California San Diego, USA; <sup>8</sup>Cognitive Science, University of California San Diego, USA; e-mail: j.atkinson@ucl.ac.uk)

Global motion sensitivity is impaired, relative to global static form, in many different developmental disorders. These measures reflect extrastriate dorsal and ventral stream processing respectively, suggesting a general 'dorsal stream vulnerability' (Braddick et al, *Neuropsychologia* 2003) associated with visuo-motor, spatial, and attentional deficits. Within the large scale PLING study (Pediatric Longitudinal Imaging, Neurocognition and Genetics), we examined how global motion and form thresholds in 161 typically developing children (ages 5-12 years) correlated with a range of cognitive abilities, and with quantitative MRI measures of regional brain development. Children's global motion

thresholds showed highly significant correlations ( $p < 0.001$ ) with visuo-motor integration (VMI test, shape copying), rapid object naming (CTOPP test), and ( $p < 0.03$ ) with Woodcock-Johnson tests of mathematical achievement. Global form thresholds were correlated only with the CTOPP rapid object naming test. We computed association maps of cortical surface area over a grid of vertices defined in FreeSurfer, with age- and gender-adjusted coherence thresholds. Higher motion coherence sensitivity correlated with relative expansion of parietal cortex and negatively with occipital cortex. No such relationships were found for form coherence. Within the parietal area, the strongest relationship was with an area on the lateral bank of the intraparietal sulcus, partly overlapping with the pattern of expansion associated with calculation and VMI scores. Thus in typical development, as in disorders, dorsal stream motion sensitivity is closely associated with cognitive abilities, particularly visuospatial and mathematical. The associated region of parietal expansion may represent a variable bottleneck within a wider network for these processing domains.

[Supported by the Leverhulme Trust and by grants from the US National Institutes of Child Health and Human Development, and National Institute on Drug Abuse]

◆ **Development and plasticity of human cortical network for motion analysis**

M C Morrone<sup>1,2</sup> (<sup>1</sup>Department of Translational Research on New Technologies in Medicine and Surgery, University of Pisa, Italy; <sup>2</sup>Scientific Institute Stella Maris, Italy; e-mail: concetta@in.cnr.it)

In adults, motion perception is mediated by an extensive network of occipital, parietal and temporal cortical areas; in infants motion perception is very rudimentary, suggesting immaturity of this network. Last year at ECVF we reported that BOLD responses to flow-motion versus random-motion in 7-week-old infants are nearly adult-like, and that the major circuits for motion perception are operative with stronger response to coherent spiral flow-motion than random speed-matched motion in parietal-occipital area, cuneus, posterior parietal and posterior insular cortex, which in adults receives visual-vestibular input. The results revealed an unexpected maturation of motion direction-selectivity, suggesting that the development of motion perception may be limited by the slow development of subcortical input and of cortical-cortical connections. These results further suggested that MT may receive independent input from V1 perinatally. Consistent with this suggestion I will report a single case study of a child with a complete unilateral lesion of optical radiation due to post-natal surgery, but with near normal vision. DTI and BOLD results show strong innervation from LGN to MT, but not V1 in the lesioned hemisphere, suggesting that high plasticity of MT allows to take over functions normally performed by V1.

◆ **Immature ERP topography, MRI and global motion responses in preterm-born infants**

D B Birtles<sup>1</sup>, J Atkinson<sup>1</sup>, S Anker<sup>1</sup>, J Wattam-Bell<sup>1</sup>, M Rutherford<sup>2</sup>, F Cowan<sup>2</sup>, D Edwards<sup>2</sup>, M Groppo<sup>2</sup>, O Braddick<sup>3</sup> (<sup>1</sup>Visual Development Unit, Department of Developmental Science, University College London, UK; <sup>2</sup>Department of Paediatrics & MRC Clinical Sciences Centre, Hammersmith Hospital, Imperial College London, UK; <sup>3</sup>Department of Experimental Psychology, University of Oxford, UK; e-mail: d.b.birtles@uel.ac.uk)

In typical development, infants' global motion brain responses are located more laterally compared to the midline occipital focus in adults, suggesting developmental reorganization of cortical motion networks (Wattam-Bell, Birtles, Nyström et al. 2010). We studied global motion and form VERP responses in infants born preterm ( $N = 22$ ) at 5 months post-term age using a high-density geodesic sensor array alongside behavioural measures of acuity, binocularity, visual fields and accommodation. Term-equivalent MRI scans were assessed qualitatively for abnormalities in relevant areas including optic tract, putamen, extrastriate and occipital-parietal cortex and graded as mild, moderate or severe. Global motion responses were absent or minimal in preterm infants with severe brain abnormalities although responses to global form or contrast were often present. Preterm infants with mild/moderate abnormalities showed reliable global motion responses but with more immature lateral focus of activation compared to term-born control infants. The results support previous studies suggesting perinatal factors such as premature birth adversely affect global motion responses relative to global form responses early in development. Immaturity in the reorganization of cortical motion areas may be an early signature of the developmental motion processing deficit commonly observed at later ages in children born preterm. [Medical Research Council, the Garfield Weston Foundation, and Wellbeing NIHR Biomedical Research Centre funding scheme]



Tuesday

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◆ **Global motion processing as a measure of a nutritional intervention in very low birth weight infants**

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(<sup>1</sup>Department of Child and Adolescent Medicine, Akershus University Hospital, Norway; <sup>2</sup>Institute for Clinical Medicine, Campus Ahus, University of Oslo, Norway; <sup>3</sup>Department of Psychology, Uppsala University, Sweden; <sup>4</sup>Visual Development Unit, Department of Developmental Science, University College London, UK; e-mail: claes.von\_hofsten@psyk.uu.se)

Global form and motion processing was measured with VERP in two studies of VLBW infants. Study A consisted of 24 VLBW infants, whose gestational age at birth varied from 22 to 32 weeks. Study B consisted of 50 VLBW infants who were randomized to either an intervention or a control group within 24 hours after birth. The intervention group was given increased supply of energy, protein, vitamin A, docosahexaenoic acid and arachidonic acid whereas the control group was given a standard nutrient supply. John Wattam Bell was heavily involved in the design and acquisition of these data. The sensitivity and topographical organization of response to global form and motion was investigated in 5-month-old infants. EEG signals were recorded using the EGI 300 system (Electrical Geodesics Inc, Eugene, Oregon, USA) with a 128-electrodes HydroGel Geodesic Sensor Net and the vertex electrode as a reference. Study A found that brain activity was significantly less enhanced in the infants born between 22-27 weeks gestational age than for those born between 27-32 weeks gestational age. Study B found that VLBW infants who had received increased nutrient supply after birth showed a more consistent response to global motion, suggesting promoted maturation of the cortical motion pathways. The results indicate that the maturation of motion sensitive structures in the brain is substantially influenced by processes occurring during the later part of pregnancy. Prematurity has a negative influence on these processes and the supply of extra nutrient may partly compensate for these negative effects.

◆ **Visual motion processing in Autism Spectrum Disorder: What is the research telling us?**

D R Simmons (School of Psychology, University of Glasgow, UK;  
e-mail: David.Simmons@glasgow.ac.uk)

John Wattam-Bell, was an author of one of the earliest studies of motion perception in Autism Spectrum Disorder (ASD) (Spencer et al, 2000). This, and other studies up until the mid-2000s, told the consistent story that there was a particular difficulty with coherent motion perception in ASD, despite intact 1st-order motion perception with sine-wave gratings. However, studies since then have presented a much more mixed picture (see Simmons et al, 2009; Manning et al, this meeting). Biological motion perception in ASD does seem to be intact in adults, at least for simple judgements, although the developmental progression and neural pathways employed may be different from those of typical individuals (Annaz et al, 2010; McKay et al, 2012). In this presentation I shall critically analyse recent studies of motion perception in ASD with three goals in mind: (1) To what extent can consistently contradictory results be explained by methodological differences? (2) What is the fit with recent theoretical developments in our understanding of ASD? (3) How can we explain the visual symptoms consistently reported by individuals with ASD and their families (e.g. Simmons & Robertson, ECVF 2012)?

◆ **Increased integration of motion information in children with autism**

C Manning<sup>1</sup>, S C Dakin<sup>2,3</sup>, M S Tibber<sup>2</sup>, E Pellicano<sup>1</sup> (<sup>1</sup>Centre for Research in Autism and Education (CRAE), Institute of Education, University of London, UK; <sup>2</sup>UCL Institute of Ophthalmology, University College London, UK; <sup>3</sup>NIHR Biomedical Research Centre, Moorfields Eye Hospital, UK; e-mail: c.manning@ioe.ac.uk)

Elevated motion coherence thresholds in autism have been interpreted both within the context of dorsal stream vulnerability, and reduced integration of local information. However, motion coherence thresholds are not a pure measure of integration, and could also be limited by imprecision in estimating the direction of individual elements, or by difficulties segregating signal from noise. Here, children with autism and age- and ability-matched typical children performed both equivalent noise direction integration and motion coherence tasks. In the equivalent noise task, children with autism could discriminate direction similarly to typical children in the absence of noise, and, remarkably, were more sensitive to the average direction of stimulus elements in the presence of noise. Equivalent noise analysis suggested that children with autism can pool information across more stimulus elements than typical children, yet have comparable levels of internal noise. In the motion coherence task, children with autism were just

as sensitive to the direction of coherently moving dots amidst randomly moving noise dots as typical children. Our findings challenge the widespread assumption that children with autism have difficulties with global motion integration, and suggest that we need a more nuanced account of motion processing in autism.

◆ **Development of neural mechanisms for spatial attention**

L V Kulke<sup>1</sup>, J Wattam-Bell<sup>1</sup>, J Atkinson<sup>1</sup>, O Braddick<sup>2</sup> (<sup>1</sup>Department of Developmental Science, University College London, UK; <sup>2</sup>Department of Experimental Psychology, University of Oxford, UK; e-mail: lousia.kulke.12@ucl.ac.uk)

The ability of infants to switch attention from a central fixation stimulus to a peripheral visual target, measured in the Fixation Shift Paradigm (FSP), is a reliable measure of normal and abnormal attention development in infancy (cf. Atkinson & Braddick, 2012). Latencies of shifts of visual attention towards the target are higher if the central stimulus remains visible and competes for attention with the target, than if it disappears. This difference decreases with age, most likely as a result of emerging cortical control of attention. We have developed an automated approach for measuring infants' ability to shift attention, using remote eye-tracking (Tobii X120) which offers improved accuracy and shorter testing times in comparison to former methods. High-density electroencephalography (EEG, 128 channel system from Electrical Geodesics, Inc.) was used in combination with eye-tracking to investigate gaze behaviour and its underlying neural mechanisms simultaneously. Our results from infant and adult subjects confirm a developing ability to disengage attention as measured in the FSP. Adult subjects showed a clear increase in neuronal responses towards the attended target stimulus, whereas infants' brain responses varied. EEG results show differences in patterns of activation between adults and infants, indicating a restructuring of cortical activation during development.

[Funding acknowledgements: The Leverhulme Trust, German Academic Exchange Service (DAAD)]

## TALKS: VISUAL SEARCH

◆ **From tools to tumors? A meta-analysis of the prevalence effect in visual search experiments and medical image perception**

T S Horowitz (National Cancer Institute, National Institutes of Health, United States of America; e-mail: todd.horowitz@nih.gov)

In laboratory visual perception studies, observers tend to miss rare targets more often than frequent targets. It has been suggested that similar processes may be at work in radiological performance. But can findings from naïve observers searching for tools among clip-art objects be generalized to expert radiologists searching for pulmonary lesions? I identified 10 medical imaging studies, including 8 laboratory-based (using radiologist observers), and 2 analyses summarizing 17 field studies. Prevalence ranged from .00032 to .83. This provides a ground for testing hypotheses generated in the perception literature. Wolfe et al. (2007) explained the prevalence effect as a shift of criterion, rather than detectability. In laboratory studies, detectability tends to increase with prevalence (mean slope = 1.07), while criterion becomes more liberal with increasing prevalence (mean slope = - 0.33), as predicted. However, across field studies, detectability shows small, non-significant declines as prevalence increases (mean slope = -1.20), but criterion becomes substantially more conservative (mean slope = 1.91), contrary to predictions. These data suggest that there is still an important gap in our theoretical understanding of the prevalence effect in complex applied search tasks.

◆ **What makes the preview benefit: Foreknowledge of features, locations, or both?**

G Meinhardt, M Persike (Psychology, University of Mainz, Germany; e-mail: meinhard@uni-mainz.de)

Previewing distracters enhances visual search (Watson & Humphreys (1997). We studied the effects of previewing distracter locations, distracter features, or both in color-form conjunction search tasks. Using isoluminant colors search items could be changed without disrupting the preview benefit (Braithwaite, Humphreys, Watson, & Hulleman, 2005). In preview of locations items changed their color-to-form assignment with no form change. In preview of distracter features the target appeared in the set of previewed distracters in 50% of the trials. Again, a distracter was changed into the target by reversing the color-to-form assignment, having color change but no form change. Preview of both distracter positions and distracter features was realized by preview of distracter items and letting the target appear only at the new positions. We found a preview benefit for preview of distracter locations with an about 25% faster search per item compared to no preview. However, for preview of distracter features and preview of both

Tuesday

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features and locations the search time per item was halved. The results indicate that foreknowledge of features is most crucial for the preview benefit, and suggest that it is an anticipatory feature set rather than inhibition of old locations which enhances item processing speed.

◆ **Visual search in heterogeneous displays is not a categorical process: evidence from genetic algorithms**

G Kong, D Alais, E van der Burg (Psychology, University of Sydney, Australia;  
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In this study we examine how observers search heterogeneous displays, far too complex to understand using factorial designs. In two experiments, participants were asked to either search for a vertical target line amongst 23 distractor lines of various orientations (ranging from  $-40^\circ$  to  $40^\circ$  from vertical), or a pink target amongst 23 distractor lines of varying colours (from white to red). We evolved the search displays using a genetic algorithm, where the displays with the fastest RTs ('survival of the fittest') were selected and recombined to create new displays. In both experiments, search times declined over generations. This decline was due to a reduction of distractors within a certain orientation and colour range. Interestingly, within this window of interference, the decrease in distractors was strongest for distractors closest to the target orientation or colour, and weaker for distractors further away. The results suggest that top-down driven visual search is not a strict categorical process as proposed by some models of visual search.

◆ **Super foragers – a population unaffected by feature integration theory?**

Á Kristjánsson<sup>1</sup>, Ó I Jóhannesson<sup>1</sup>, I M Thornton<sup>2</sup> (<sup>1</sup>Faculty of Psychology, University of Iceland, Iceland; <sup>2</sup>Department of Cognitive Science, University of Malta, Malta; e-mail: ak@hi.is)

Recently we developed an iPad task that reveals striking differences in the way individuals forage for multiple targets (Kristjánsson, Jóhannesson & Thornton, VSS, 2014). In our feature-foraging condition, observers cancelled green and red disks among yellow and blue distractors (or vice versa) until all were gone. In conjunction-foraging they cancelled red disks and green squares among green disks and red squares (or vice versa). During feature foraging, all observers switched easily back and forth between target types. During conjunction foraging, 75% of observers focused exclusively on one target type until all were gone, before switching to the other target type. However, the remaining 25% switched just as frequently with conjunction targets as they had with feature targets. Importantly, these "super-foragers" did so without sacrificing speed or accuracy. Here we replicated this 75/25 division with a new set of observers also testing them on foraging by eye-movements, working memory, and attention-related measures. The existence of super-foragers suggests that individuals differ in their ability for top-down guidance and object-file integration. This finding has strong implications for attentional theory, since the concept of top-down guidance for object-assembly plays a central role in theories of visual attention, with little room for individual variation.

[Supported by the Icelandic Research fund and the Research fund of the University of Iceland]

◆ **Human visual search performance for military camouflage patterns**

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There is an absence of systematic research investigating object detection within the military theatre. In the current investigation we establish baseline human detection performance for five military camouflage patterns. Stimuli were drawn from a database of 1242 calibrated images of a mixed deciduous woodland environment in Bristol, UK. Images either contained a helmet (PASGT) or didn't. Subjects (N = 20) discriminated between the two image types in a temporal 2AFC task (500ms presentation for each interval). Distance from the observer (3.5/5/7.5m), colour (colour/greyscale) and cueing (target location cued/not-cued) were manipulated - as was helmet camouflage pattern. A GLMM revealed statistically significant interactions between all variables on participant detection performance, with greater accuracy when stimuli were in colour, and the target location was cued. There was also a clear ranking of pattern in terms of camouflage pattern efficacy. We also compare the results to a computational model designed according to low-level vision, with encouraging results. Our methodology provides a systematic and robust means of assessing camouflage patterns in any environment, with the potential to implement a machine vision solution to assessment. In this instance, we show that existing solutions to the problem of concealment on the battlefield are not equally efficacious.

◆ **The schematic angry face effect: threat detection or V1 processes?**

M J Kennett<sup>1</sup>, G Wallis<sup>1</sup>, L Zhaoping<sup>2</sup> (<sup>1</sup>School of Human Movement Studies, University of Queensland, Australia; <sup>2</sup>Department of Computer Science, University College London, UK; e-mail: mattkennett@hotmail.com)

Are people biologically prepared for the rapid detection of threat posed by an angry facial expression, even when it is conveyed in the form of a schematic line drawing? The current literature would suggest that, based on visual search times, the answer is yes. But are there low-level explanations for this effect? Here, we present visual search results using current best practice (a concentric search array, search slopes as a measure of efficiency) for schematic faces both with and without their circular surrounds. We replicate the search advantage for angry faces: i.e., differences in search slopes, consistent with more efficient detection of an angry face among happy distractors, than a happy face among angry distractors. However, we also report a comparable effect when abstract cross and diamond shaped stimuli are used within the same paradigm: i.e., asymmetrical search slopes favouring the angry face derived schematic drawing. We finally show that the effects can be explained by iso-feature suppression and co-linear facilitation in Li's bottom-up saliency model of V1 (1999, 2002); and thus conclude that any attribution to threat detection for this effect often found in schematic face visual search experiments is unnecessary.

## TALKS: MOTION

◆ **The effect of implied motion on the motion after-effect**

G Mather, R J Sharman (Psychology, University of Lincoln, UK; e-mail: gmather@lincoln.ac.uk)

Directional motion adaptation has previously been reported following exposure to sequences of unrelated still photographs depicting implied motion ('implied motion after-effect', IMAE; Winawer et al., 2008). To investigate the relationship between processes activated by implied motion and by explicit dynamic motion, we tested whether the IMAE can combine with the classical motion after-effect (CMAE) elicited by adaptation to drifting dot patterns. Participants adapted to stimuli which combined moving dot patterns with sequences of static implied-motion images. Motion adaptation was measured using a forced-choice staircase procedure in which the displacement of drifting test dots was varied to find the observer's motion 'null' point. Following adaptation to combinations of still images and incoherently moving dots, the null point shifted by a small amount in the direction predicted by earlier IMAE reports. Adaptation to combinations of still images and coherently moving dots also affected the magnitude of the CMAE, consistent with a modulatory effect of implied motion on directional adaptation. These psychophysical results indicate that implied motion can influence adaptation in motion selective processes, but the underlying mechanism remains to be established.

[This research was supported by the Economic and Social Research Council, UK (ESRC).]

◆ **Revisiting the influence of spatial frequency on the perception of rotating speed**

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Ho and Anstis (2013) demonstrated in the Best Illusion of the Year Contest that perceived speed increases when more objects revolve in the same circular path, suggesting visual blur as a possible cause. Here we propose an alternative explanation. Influence of spatial frequency on perceived speed has been reported with linear motion (e.g. Diener et al, 1976) or rotating linear gratings (Campbell & Maffei, 1981). We examined if the same applies for rotating radial sinusoidal gratings by a speed matching experiment with a 2AFC double staircase method. The results showed general decrease of matching speed with increasing spatial cycles, i.e., overestimation of speed with more cycles per round, with the matched speed typically falling between the speed and the temporal frequency criteria. This means that perception of rotation speed is not invariant but is often a compromise between them. With horizontally-moving linear gratings, similar tendencies were found for naïve observers, while better speed invariance was found for an expert observer (one of the authors). The overall results qualitatively support the previous studies that speed perception depends on spatial frequency, suggesting that the illusion of Ho and Anstis reflects an inherent property of speed perception across spatio-temporal frequencies.

[Supported by JSPS grant-in-aid for scientific research #22243044 and #26285165.]

Tuesday

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◆ **Separating different motion processes with hypocycloid motion**

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The human visual system seems to have many different processes for creating the perception of motion: 1st- or 2nd-order motion processes rely on extracting motion energy in environment; 3rd-order motion processes seem to rely on tracking the location of features and objects. Here we discuss a series of novel methods for separating these types of motion. The basic method consists of six dots that move in an asteroid-like pattern within the framework of a larger circle. When the temporal phases of the dots are aligned, the dots group to form a circle that rotates along the inner circumference of a larger circle (i.e., the dots form a hypocycloid pattern similar to Tusi motion, but with an inner circle 1/5 the diameter of the outer circle). We demonstrate that when the dots are all the same color, the inner circle appears to rotate with backspin; and when the dots are different colors, the inner circle appears to rotate with topspin. The sudden shift in the direction of perceived spin direction corresponds to a shift between 1st-order motion and 3rd-order motion. We extend our findings to show conditions in which limitations of cortical processing speed for features can prevent effective attentional tracking.

◆ **Neural correlates of non-retinotopic processing in human visual cortex as determined by 7T fMRI and high-density EEG**

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Human perception is largely non-retinotopic. A bike passes by; we perceive the reflectors on its wheels rotating on a circular orbit. However, the “real” motion is truly different, namely cycloidal. The real, retinotopic motion is invisible because the bike motion is subtracted from the reflector trajectory. Thus, the bike creates a non-retinotopic reference frame within which the reflector motion is perceived. Almost nothing is known about how this feat is achieved. Here, we acquired high-resolution 7T fMRI data while participants viewed a Ternus-Pikler display, where we pitted retinotopic vs. non-retinotopic motion processing. Three checkerboards moved horizontally back and forth. The checkerboards either did or did not alternate in contrast polarity with each frame. Because of the non-retinotopic reference frame, the percept was inverted such that the non-alternating checkerboards were perceived to alternate and vice versa. In V1, V2, and V3, the BOLD signal reflected retinotopic processing. In hMT+, activity correlated with the non-retinotopic percept. We propose that the motion of the reference frame (bike, checkerboards) is first detected in hMT+ and immediately subtracted from the motion of its parts, in line with our EEG results reflecting non-retinotopic processing from 120 ms on.

[This work was supported by the Swiss National Science Foundation (SNF).]

◆ **Particularly good judgments about the timing of impending collisions**

E Brenner, I García Calvo, J B J Smeets (Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands; e-mail: e.brenner@fbw.vu.nl)

People are not very good at judging which of two targets flashed first, or where a moving target had been at the time of a flash. They are better at judging whether their hand passed ahead of or behind a moving target that they are trying to intercept. Why? We compared judgments about whether a white target flashed before or after a small red moving disk had passed, with similar judgments when the flash was part of a white target’s orthogonal apparent motion. In the latter case, the question was whether the white target passed ahead of or behind the red disk. Presenting the flash as part of a motion sequence improved performance (mean standard deviation decreased from about 80ms to about 25ms). We varied the time for which the moving target was visible. If it was visible for as little as 17ms (two frames) before it crossed the red disk’s path, performance was better than for flashes. The duration of its motion after the targets passed each other did not matter. Performance was worse if the red disk was only visible for 100ms before it passed the target, so pursuing the disk with one’s eyes may be important.

◆ **A common rate controller for all mental updating?**

A D J Makin (Psychological Sciences, University of Liverpool, United Kingdom;  
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Interestingly, people can update mental representations without sensory input, and they can do so at an appropriate rate. In this work, we explored the brain's rate control systems. We tested whether a common rate controller guides all mental updating, or whether separate rate controllers guide updating in different dimensions. We measured performance on various extrapolation tasks. All tasks began with a period of visible change. In the standard position extrapolation task, a single, visible target moved along a track. In the accumulation extrapolation task, an empty matrix filled with Gabors at a constant rate. In the number extrapolation task, numbers counted down from 10 towards 0. Finally, in the color extrapolation task, a colored patch changed from blue to yellow (or vice versa). In all extrapolation tasks, the dynamic stimuli were hidden before completion. However, participants assumed continuation of the hidden processes, and then pressed when they judged the hidden processes to be complete. All the tasks were matched for temporal parameters. Response time accuracy and variability was comparable across task, and differences did not multiply with occlusion duration. This supports the idea that a common rate control system guides all forms of mental updating.

## TALKS: COLOUR

◆ **Combining S-cone and luminance signals adversely affects discrimination of objects within backgrounds**

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e-mail: jasn@iname.com)

The visual system processes objects embedded in complex scenes that spatially vary in both luminance and colour. Therefore, we investigated if luminance (L+M) and chromatic (L-M and S-(L+M)) signals sustain processing of objects embedded in backgrounds similarly. In the first experiment thresholds for object/non-object discrimination of Gaborised shapes were obtained from conditions that modulated contrast along single colour/luminance dimensions (L-M, S-(L+M) and L+M) or co-modulated contrast along multiple dimensions. Thresholds were elevated when a background was present for combined S-(L+M) and L+M signals. The second experiment replicated and extended this finding by demonstrating that the effect is dependent on the presence of relatively high S-(L+M) contrast. Finally, the third experiment tested orientation discrimination of a parafoveal Gabor target surrounded by flankers at three target-flanker separations. The effect of flankers was again most pronounced when luminance contrast was combined with S-(L+M) signals. In conclusion, when S-(L+M) signals above a certain level are combined with luminance signals, discrimination of parafoveal features is compromised. This is likely to underlie the adverse effect of such signals on the discrimination of objects within backgrounds, implying a significant role for S-(L+M) signals in spatial vision.

[Research was supported by a BBSRC New Investigator grant to JM.]

◆ **Color appearance and color language depend on sensory singularities in the natural environment**

C Witzel, J K O'Regan (Laboratoire Psychologie de la Perception, Université Paris Descartes, France; e-mail: cwitzel@daad-alumni.de)

The sensory color signal (LMS) that is produced by light reflected from a surface generally changes in three dimensions when illumination changes. However, for some surfaces the color signal is restricted to a two- or one dimensional subset of three-dimensional color space. The dimensionality can be estimated from the singular values of the matrix that transforms the LMS signal of the illuminant to the LMS signal of the reflected light. We investigated whether singularity depends on hue and saturation. For this purpose, we determined singularities for surfaces while systematically controlling perceived hue and saturation based on just-noticeable differences measured under neutral illumination. To do this, we simulated different kinds of surface reflectances based on different basis functions, including the three principal components of natural reflectances. Results indicate that singularity increases with saturation, no matter which basis functions were used. Moreover, they show that when using natural basis functions, for constant saturation, singularities increase towards focal and unique hues. These findings suggest that subjective color appearance and language are organized around surface colors that give rise to LMS

Tuesday

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signal distributions that have reduced dimensionality across illumination changes, and thus may act as perceptual anchors.

[European Research Council funded project “FEEL”, ref 323674.]

◆ **Binocular luminance contrast reduces inter-ocular competition between dichoptic colour contrasts**

F A A Kingdom, D Wang, L Libenson (McGill Vision Research, Department of Ophthalmology, McGill University, Canada; e-mail: fred.kingdom@mcgill.ca)

We have revealed a profound interaction between colour and luminance contrast in binocular vision. In the luminance domain, inter-ocular suppression (IOS) results in pronounced threshold elevation of tests in one eye from masks in the other eye, termed ‘dichoptic masking’. IOS also results in the apparent contrast of a dichoptic mixture of contrasts approximating that of the higher contrast when the latter is presented binocularly, termed ‘winner-take-all’. Using isoluminant coloured disks we show that both these phenomena occur in the chromatic domain. Importantly however, adding binocular luminance contrast to the coloured disks reduces the amount of dichoptic colour masking and shifts the apparent colour contrast of a dichoptic mixture of colour contrasts away from winner-take-all towards averaging. This effect of binocular luminance contrast cannot be explained by either monocular or binocular masking of colour contrast, instead implicating the interaction between colour and luminance in IOS. We examine the possible bases for these interactions, including the idea that IOS involves a common chromatic-luminance pathway (as suggested by others) as well as the idea that binocularly-correlated luminance signals adjust the gain of chromatic IOS.

[Canadian Institute of Health Research grant #MOP 123349 given to F.K.]

◆ **Colour induction concurrently shifts a subjective category boundary and a locus of optimal discrimination.**

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A fundamental boundary in colour space is that between reddish and greenish hues. Under neutral adaptation, chromatic discrimination is optimal near this category boundary (Danilova and Mollon, 2012, *Vision Research*, 56, 162-172). We have proposed that the phenomenological boundary and the locus of optimal discrimination both correspond to the neutral point of a channel that draws signals of one sign from long- and short-wave cones and of opposite sign from middle-wave cones. In two manipulations we find that the phenomenological equilibrium and the locus of optimal discrimination are concomitantly shifted. In Experiment 1 steady coloured adapting fields were used. In Experiment 2 we used inducing fields of the type described by Monnier and Shevell (2004, *Vision Research*, 44, 849-856). The inducing fields were of the same duration as the target. In both experiments 2AFC thresholds were measured along lines approximately orthogonal to the red-green boundary. In separate, interleaved runs, the subjective hue boundary was measured empirically for each condition and for each observer. The target duration was 150 ms. In both experiments phenomenological and the performance measures were similarly displaced. The second experiment suggests that discrimination thresholds are not determined merely by the adaptive state of the cones.

[Russian Foundation for Basic Research Grant 12-04-01797Royal Society International Exchanges Grant IE110252]

◆ **The map is the itinerary: Cognitive color space reconstructed from listing data for 11 European languages**

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Judgments of similarity among color terms are largely congruent with similarities among the colors they denote. However, the relationship between perception and color language is complex and two-way. We examine the associations among color terms, derived from a listing task, for 11 languages spoken in Europe. Subjects listed all the terms they knew: typically starting with salient, prototypical colors, then accessing semantic knowledge along a trail of associations to less obvious terms. We applied multidimensional scaling and hierarchical clustering to inter-term proximities, defined as average degree of adjacency across lists, to reconstruct the organization of the color domain in each language. The resulting structures depart from a purely perceptual arrangement. Many features recur across languages,

extending Berlin and Kay's universality model, with implications for perception. Basic color terms were consistently separated from non-basics, and then divided into primary and secondary terms. A cognitive feature of 'lightness/achromacy' linked the counterparts of 'black', 'white' and 'gray' with 'brown' and often 'pink', separating them from primaries and secondaries defined by chromatic content; this distinction continued into non-basic terms. Some structure is specific to culture and color lexicon; of special interest are languages like Russian, with more than one basic term for 'blue'.

[Author MU was the recipient of Estonian Science Foundation grant no. 8168]

◆ **Representations of colour in human visual cortex: from chromatic signals on the retina to representations of object surfaces.**

K Seymour, M A Williams, A N Rich (Cognitive Science, Macquarie University, Australia;  
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Many theories of visual object perception assume the visual system initially extracts borders between objects and their backgrounds and then "binds" colour to the resulting object surfaces. We investigated the transformation of chromatic signals across the human visual cortex, with particular interest in separating where representations are driven more by early chromatic signals from the retina and where the representations are more related to the surface colour of the object. Using fMRI, we measured brain activity while participants viewed stimuli that differed only in the position at which two colours stimulated their retina and whether these colours formed part of an object or its background. Multivariate pattern analysis revealed that classifiers could decode information about which colour was presented at a particular retinal location from early visual areas, whereas regions further along the ventral stream exhibited biases for object surface colour. Additional analyses showed that although activity in retinotopic areas contained strong figure-ground information to support the parsing of objects within a visual scene, activity in V2 also signalled information about object colour. These findings are consistent with the view that colour is bound to object surfaces after figure-ground segmentation and suggest a critical involvement of V2 in this process.

[This work was supported under the Australian Research Council (ARC)'s Discovery Projects funding scheme (ANR: DP0984494) and Macquarie University internal grant schemes. MAW and ANR are recipients of ARC Fellowships (Queen Elizabeth II Research Fellowship DP0984919, and Australian Postdoctoral Fellowship DP0984494, respectively).]

## TALKS: BIOLOGICAL MOTION

◆ **Neurodynamical model for multi-stability and adaptation in motion recognition**

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The perception of body motion can show multi-stability with respect to the perceived walking direction (Vanrie, Dekeyser, Verfaillie, 2004). This phenomenon is not captured by existing neural models. I present a new neurodynamical model that is based on a 2D neural field of snapshot neurons. encoding individual views of keyframes of actions. These (nonlinear) neurons are coupled by lateral connections, which are symmetric with respect to neurons encoding different views, and asymmetric for neurons encoding different snapshots, resulting in temporal sequence selectivity. In addition, the neurons adapt after they have been activated, where the adaptation dynamics was fitted to electrophysiological data on repetition-suppression in area IT (deBaene & Vogels, 2010). The model reproduces perceptual switching and sequence selectivity of visual action recognition. In addition, quantitative fitting of neural and psychophysical data leads to the following conclusions: 1) Perceptual switching in action perception is driven by noise, not adaptation. 2) Consistent with recent data (Caggiano et al. 2013), the model predicts correctly that repetition-suppression in action-selective neurons is much smaller than in shape-selective neurons. 3) It predicts a new action stimulus that should result in much stronger repetition-suppression than the stimuli used in previous physiological and imaging-experiments.

[German Federal Ministry of Education and Research: FP7-PEOPLE-2011-ITN(Marie Curie): ABC PITN-GA-011-290011, BMBF, FKZ: 01GQ1002A; DFG GI 305/4-1, DFG GZ: KA 1258/15-1, EU Commission, 7th Framework Programme: EC FP7-ICT-249858 TANGO, EC FP7-ICT-248311 AMARSi, and the Human Brain Project (FP7 Flagship).]



Tuesday

◆ **Schizotypy is associated with individual differences in biological motion perception**

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Biological motion perception is impaired in people with schizophrenia. So far, the mechanisms underlying this deficit are unclear. Here, we tested whether differences in schizotypy, which are closely linked with the pathological expression in schizophrenia, are related to differences in biological motion perception in healthy young adults. Schizotypy was assessed with the short scales for schizotypy that measure positive and negative schizotypy, and cognitive disorganisation. To assess biological motion perception, participants (N=74) had to discriminate the walking direction of normal point-light walkers that contain both local motion and global form information, random-position walkers that primarily contained global form information, and scrambled walkers that contain primarily local motion information. Using these different walkers, it is possible to test the contribution of local motion and global form information to biological motion processing within one stimulus set. Results showed that accuracy for scrambled walkers was impaired in participants scoring high on the cognitive disorganisation dimension. In addition, reaction times for scrambled walkers correlated with overall schizotypy scores. We found no relation between differences in schizotypy and walkers that contained form information. Our results therefore suggest that deficit in biological motion perception in schizophrenia are related to a deficit in processing local motion.

◆ **Plasticity within the cerebro-cerebellar circuitry for biological motion processing**

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Biological motion (BM) perception is of crucial importance for everyday life. In addition to a widespread cortical network (Puce and Perrett, 2003; Blake and Shiffrar, 2007; Pavlova, 2012), recent findings show left lateral cerebellar tumors impair visual sensitivity to BM (Sokolov et al., 2010). Left lateral cerebellar involvement in visual processing of BM is mediated through direct effective and structural reciprocal connectivity with the right superior temporal sulcus (STS), the major hub of the action observation network (Sokolov et al., 2012; 2014). Here, we examined BM processing after neurosurgical left cerebellar tumor removal. While preoperative visual BM sensitivity was close to chance level, it substantially improved after neurosurgery attaining the level of healthy controls. Functional MRI showed activation of the left cerebellar lobules III and IX, implying a midline shift of left cerebellar activation to BM. Psychophysiological interaction (PPI) analysis indicated preserved effective connectivity between the left cerebellum and a right STS region, but shifted to the anterior. The study suggests a remarkable potential for recovery of BM processing after cerebellar damage, paralleled by topographical reorganization of the underlying cerebro-cerebellar circuitry. The findings open a window for further research on cerebellar plasticity and cognitive processing.

◆ **Residual biological motion perception in a case of cortical blindness**

N Ruffieux<sup>1,2</sup>, J Lao<sup>1</sup>, S Mielle<sup>1</sup>, F Colombo<sup>2</sup>, J M Annoni<sup>2</sup>, R Caldara<sup>1</sup> (<sup>1</sup>Psychology, Fribourg University, Switzerland; <sup>2</sup>Neuropsychology and Aphasiology, Fribourg State Hospital, Switzerland; e-mail: nicolasruffieux@yahoo.fr)

The visual system shows a remarkable sensitivity to biological motion from birth, regardless of the species of the stimuli. The superior temporal sulcus (STS) plays a key role in decoding biological motion. Yet, the extent to which this region relies from inputs from the visual cortex and/or preserved object recognition to achieve this feat remains unclear. Here we tested the sensitivity to human and non-human biological motion in a single-case of cortical blindness: BC. BC is impaired to visually recognize shapes, letters, faces, objects, animals and colors, despite normal ophthalmological examination and normal oculomotor responses to visual saliency. He suffers from chronic post anoxic encephalopathy with moderate global atrophy and bilateral posterior white matter MRI hyperintensity in striate areas. CB was unable to categorize either static or motion point-light stimuli of human or animal walkers in stand-alone presentation. In stark contrast, he was able to correctly identify biological motion for all the species in matching tasks (intact vs. inverted or scrambled stimuli presented simultaneously), displaying appropriate eye movements towards diagnostic information. Our data strengthen the idea of

a specialized region for the perception of non-species-specific biological motion. This striking visual ability might relate to evolutionary forces predisposing humans to attend to biological agents.

◆ **Sex differences in the MEG response to biological motion**

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Body motion is a rich source of information for social interaction, and visual biological motion processing may be considered as a hallmark of social cognition. Sex differences are often evident in the comprehension of social signals, but the underlying neurobiological basis for these differences is unclear. Here we assess sex impact on the magnetoencephalographic (MEG) cortical response to point-light human locomotion. Sex differences in the cortical MEG response to biological motion occur mostly over the right brain hemisphere. At early latencies, females exhibit a greater activation than males over the right parietal, left temporal, and right temporal cortex, a core of the social brain. At later latencies, the boosts of activation are greater in males over the right frontal and occipital cortices. The findings deliver the first evidence for gender dependent modes in the time course and topography of the neural circuitry underpinning visual processing of biological motion. The outcome represents a framework for studying sex differences in the social brain in psychiatric and neurodevelopmental disorders.

◆ **Actions in motion: Separate perceptual channels for processing dynamic and static action information**

S de la Rosa, M Hohmann, H H Bühlhoff (Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Germany; e-mail: stephan.delarosa@gmail.com)

Visual action recognition is a prerequisite for humans to physically interact with other humans. Do we use similar perceptual mechanisms when recognizing actions from a photo (static) or a movie (dynamic)? We used an adaptation paradigm to explore whether static and dynamic action information is processed in separate or interdependent action-sensitive channels. In an adaptation paradigm participants' perception of an ambiguous test stimulus is biased after the prolonged exposure to an adapting stimulus (adaptation aftereffect (AA)). This is often taken as evidence for the existence of interdependent perceptual channels. We used a novel action morphing technique to produce ambiguous test actions that were a weighted linear combination of the two adaptor actions. We varied the dynamics of the content (i.e. static vs. dynamic) of the test and adaptor stimuli independently and were interested in whether the AA was modulated by the congruency of motion information between test and adaptor. The results indicated that the AA only occurred when the dynamics of the content between the test and adaptor were congruent ( $p < 0.05$ ) but not when they were incongruent ( $p > 0.05$ ). These results provide evidence that static and dynamic action information are processed to some degree separately.

## POSTERS: FACE PERCEPTION II

◆ **Perceiving facial expression from varying face orientations – an eye-tracking study**

<sup>1</sup> K Guo, H Shaw (School of Psychology, University of Lincoln, UK; e-mail: kguo@lincoln.ac.uk)

We frequently encounter expressive faces from different viewing angles; invariant expression perception would be to our advantage in social interactions. Previous research is inconsistent about how face orientation affects expression categorization. It is also unknown how gaze behaviour accommodates this variable given diagnostic cues from local facial features for decoding expressions tend to vary with orientation. Here we manipulated orientation of faces (frontal, three-quarter and profile view) displaying six basic facial expressions of emotion, and measured participants' expression categorization accuracy, perceived expression intensity and associated gaze patterns. The analysis of pooled data from all expressions showed that profile faces led to lower categorization accuracy and attracted fewer but longer fixations. The detailed gaze distribution at eyes, nose and mouth regions were also manipulated by face orientation, in line with the amount of available cues from a given feature at a given orientation. Further comparison between individual expressions revealed these orientation-induced perceptual and gaze behavioural changes were expression-specific. The perceived expression intensity was affected by face orientation, even for those expressions with invariant categorization accuracy. The results suggest face orientation-invariant expression perception is categorical and is restricted to those expressions displaying expressive cues dominantly through eyes and/or mouth region.

Tuesday

◆ **Impaired perceptual sensitivity to the locations of facial features in developmental prosopagnosia**

2 J Towler, J Parketny, M Eimer (Department of Psychological Sciences, Birkbeck, University of London, United Kingdom; e-mail: johntowler@hotmail.com)

Developmental prosopagnosia (DP) is an impairment in face recognition ability despite normal low-level vision and general cognitive ability. Prosopagnosia may be caused by visual perceptual deficits or by memory impairments accompanied by normal perception. Here we provide evidence from event-related brain potentials (ERPs) that early visual perceptual stages of face-sensitive neural processing, occurring within the first 200ms after stimulus onset, are atypical in DP. Face images were created with the locations of the internal features (eyes, nose and mouth) spatially scrambled within the upright face outline. ERPs triggered by scrambled faces were compared to intact upright faces. Age matched control participants show both N170 amplitude enhancements and latency delays for scrambled faces as compared to intact faces. In contrast, DP participants do not reliably demonstrate these facial configuration sensitive neural markers, and importantly, the between group difference in N170 amplitude enhancement for scrambled faces was also statistically reliable. These ERP findings suggest that perceptual deficits in DP may be characterised by a lack of sensitivity to deviations in the locations of facial features from a canonical upright face template.

◆ **Subtypes of developmental prosopagnosia: the role of the perceptual and memory factors**

3 K Németh<sup>1</sup>, P Kovács<sup>1</sup>, P Vakli<sup>1</sup>, G Kovács<sup>1,2,3</sup>, M Zimmer<sup>1</sup> (<sup>1</sup>Department of Cognitive Science, Budapest University of Technology and Economics, Hungary; <sup>2</sup>Institute of Psychology, Friedrich Schiller University of Jena, Germany; <sup>3</sup>DFG Research Unit Person Perception, Friedrich Schiller University of Jena, Germany; e-mail: knemeth@cogsci.bme.hu)

Individuals with developmental prosopagnosia are unable to identify familiar people via their faces, despite normal low-level vision and intellect and in the absence of any obvious damage of the central nervous system. Previous results suggested the existence of different types of prosopagnosia, however to date the selective role of the perceptual, and memory factors in face recognition processes formally never been tested in this disorder. Additionally, the reliable evaluation of the possible subtypes was impossible in most prior studies due to the small number of participants. To this end we have recruited a group of developmental prosopagnosics (n=26) and individually matched neurotypical participants (n=26) to analyse various aspects of the impairment. Our results suggest the existence of two different subtypes in developmental prosopagnosia, one related to impaired memory and associative, while the other to impaired perceptual functions. Our findings help us to understand the heterogeneity of previous results and may also provide better tools for developing efficient training techniques in prosopagnosia. [This work was supported by the Hungarian Scientific Research Fund (OTKA) PD 101499 (MZ) and by the Deutsche Forschungsgemeinschaft (KO 3918/1-1) (GK).]

◆ **Noise-induced perceptual processing demands in developmental prosopagnosia**

4 M Zimmer<sup>1</sup>, K Németh<sup>1</sup>, P Kovács<sup>1</sup>, P Vakli<sup>1</sup>, G Kovács<sup>1,2,3</sup> (<sup>1</sup>Department of Cognitive Science, Budapest University of Technology and Economics, Hungary; <sup>2</sup>Institute of Psychology, Friedrich Schiller University of Jena, Germany; <sup>3</sup>DFG Research Unit Person Perception, Friedrich Schiller University of Jena, Germany; e-mail: mzimmer@cogsci.bme.hu)

It is known that the amplitude of early face evoked event-related potential (ERP) components, such as the N170 and P2, changes systematically as a function of added noise. In a previous study we investigated whether phase-noise manipulation affects the neural correlates of face versus non-face decisions similarly. To this end, using an age-discrimination task we measured the ERPs for faces and cars at three different phase-noise levels. We have found that the amplitude of P1 showed category-specific noise dependence. Moreover, noise modulation altered the category-selectivity of the N170, while P2 was larger for the more noisy stimuli regardless of stimulus category. In the present study 30 adults of developmental prosopagnosia (DP) and 30 matched neurotypical participants were tested using the above-mentioned paradigm. We have found that the first ERP component showing differences between DP and controls was the P2, typically associated either with task-difficulty or with noise-processing. While added noise increased the amplitude of P2 for faces more than for cars in DP participants, the P2 enhancement by noise was more pronounced for car stimuli in neurotypical subjects. Our results suggest that the

processing of noisy face stimuli requires larger perceptual processing efforts when compared to non-face stimuli in DPs.

[This work was supported by the Hungarian Scientific Research Fund (OTKA) PD 101499 (MZ) and by the Deutsche Forschungsgemeinschaft (KO 3918/1-1) (GK).]

◆ **The relative use of fixated and peripheral information in face identification tasks: a gaze-contingent morphing approach.**

5 G Van Belle, R Laguesse, B Rossion (Institute of Neuroscience, University of Louvain, Belgium; e-mail: goedele.vanbelle@uclouvain.be)

Using gaze-contingent morphing, we asked 23 human observers to choose one of two faces that best matched the identity of a target face: one face corresponded to the reference face's fixated part only ("local information"), the other to the unfixated area of the reference face ("peripheral information"). We parametrically manipulated the relative size of the foveal vs. peripheral information to test how this affected the relative use of information in the matching task. Although the proportion of foveal responses monotonically increased with the percentage of the reference face belonging to the foveally presented face, the increase was steeper between 22% and 29% presence of the foveally presented face, representing one vs. more than one facial part respectively. Furthermore, when the foveal part size was sufficiently large to at least partly contain all internal features, participants recognizing more the foveally presented identity were more accurate, but generally slower in an unrelated 4AFC matching face task than observers relying more on peripheral information. This might explain the influence of qualitative strategy differences in the use of internal feature vs. global shape information on speed-accuracy trade-offs, as commonly observed in face perception performance tasks.

◆ **Microsaccades boost face identification as a function of culture**

6 J Lao<sup>1</sup>, L He<sup>2</sup>, R Caldara<sup>1</sup> (<sup>1</sup>Department of Psychology, University of Fribourg, Switzerland; <sup>2</sup>The School of Communication and Design, Sun Yat-Sen University, China; e-mail: junpeng.lao@unifr.ch)

Human observers flexibly engage in distinct oculomotor strategies to gather visual information, with a mixture of global and local information sampling during face processing. Westerners preferentially fixate on the eyes and mouth, by using high-spatial frequencies information. Whereas Easterners allocate their gaze more on the center of the face, by using low spatial-frequencies information. Yet, whether such spatial-frequency tuning modulates the fine-spatial details enhancement effect of microsaccades remains unknown. To this aim, Western Caucasian (WC) and Eastern Asian (EA) observers learned eight face identities. We then examined the occurrence of microsaccades during the identification of these identities. Faces were presented at a random facial feature centered on the fixation cross, while observers maintained central fixation. Notably, WC observers showed faster response times and highest microsaccade rates at their preferred facial feature (as determined in the free-viewing learning task), between 400-500ms after stimulus onset. EA observers also showed high microsaccade rates at their preferred fixation location and in the same time window, but did not show a speed identification advantage. Our data show that the conjunction between preferred fixation location and high-frequency information is crucial to achieve optimal face identification performance, only for observers tuned for high-spatial frequency information sampling.

[This study was supported by the Swiss National Science Foundation (no 100014\_138627) awarded to Dr Roberto Caldara.]

◆ **Electrophysiological correlates of subjective perception of face identity: Evidence from mistaken identities**

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Although much research has focused on the neural basis of face processing, little is known about the neural mechanisms responsible for misidentification. Here we used the face identity-sensitive N250r component of the event-related brain potential as a measure of the identity matching process in visual working memory. It is currently unclear to what extent N250r components reflect the degree of physical match between two face images, or the degree of subjective similarity as reported by the observer. Participants performed a rapid sequential face identity matching task with three conditions: identity repetition, similar identity change (two different but physically similar faces), and dissimilar identity change (two physically very different faces). As expected, we observed generic N250r components

Tuesday

for the difference between correctly classified identity repetition and dissimilar identity change trials. Additionally, we observed reliable but delayed and attenuated N250r components for similar identity change trials that were falsely reported as the same identity. Importantly, N250r components were entirely eliminated on similar identity change trials that participants correctly reported as belonging to different facial identities. Results suggest that the N250r component is triggered by a categorical match between two high-level visual face identity representations as subjectively perceived by the observer. [BEW's research is supported by the International Research Training Group "Adaptive Minds" (GRK: 1457), Saarland University]

◆ **The Facespan: isolating the perceptual span for face recognition**

8 M Papinutto, R Caldara, J Lao, S Miellet (Department of Psychology, University of Fribourg, Switzerland; e-mail: michael.papinutto@unifr.ch)

The region of effective vision during eye fixations in reading – the perceptual span – is a robust phenomenon that was already described almost 40 years ago. Surprisingly, the perceptual span for the biologically relevant stimulus class of faces has not been isolated yet, despite the on-going debate on the information use for face recognition. To directly address this question, we parametrically modulated gaze-contingent moving-window apertures (i.e., Spotlights) during an old-new face recognition task. We tested 198 observers with natural vision and 11 Spotlight aperture sizes (from 9° to 19°). We then used robust data-driven methods to objectively determine the minimal window aperture size on which face recognition performance was comparable to the natural vision condition. In addition, we categorized the observers according to their information sampling strategies (i.e., global versus local), by employing Bayesian classifiers based on Gaussian-mixture distributions. The perceptual span was isolated on average between 15° to 17°. However, this threshold was shifted according to the global or local sampling strategies; the more global the strategy, the larger the perceptual span. Our data show that the visual information intake for faces is flexibly adjusted by idiosyncratic perceptual biases.

◆ **Categorical perception of intentions from visual cues in faces**

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Categorical perception has been shown for social information from faces such as gender (Bülthoff, & Newell, 2004) and expressions (Calder, et al., 1996), but it is unclear if intentions, as determined from static images of faces, are perceived as categorical. We investigated whether faces with either 'good' or 'bad' intentions are discrete categories at the perceptual level. Face images of 140 'hero' and 'villain' characters from the media, in full-face view with neutral expressions, were pre-rated for perceived intentions. Based on the ratings, 7 faces highly rated as having 'good' intentions and 6 faces rated as having 'bad' intentions were chosen and morph continua were created between each intention. Participants first performed an XAB discrimination task, in which they were required to match a face to a target. This task was followed by a categorization task in which each face was categorised as a 'hero' or a 'villain'. We found evidence for a categorical effect for perceived intentions from faces, with a categorical boundary between each intention and better discrimination of images each side of the boundary. These findings have implications for models proposing two functionally and neurologically separate face processing routes (Haxby, et al., 2000).

[Science Foundation Ireland]

◆ **The contribution of facial shape and surface to individual face discrimination as revealed by fast periodic visual stimulation**

10 M Dzhelyova, B Rossion (Institute of research in Psychology (IPSY), Institute of Neuroscience (IoNS), University of Louvain (UCL), Belgium; e-mail: dzhelyova@yahoo.com)

Face perception depends on two sources of information – shape and surface-based cues (texture, color). According to behavioral studies, both of them contribute equally to face discrimination, with little advantage provided by their combination. However, these behavioral measures can be contaminated by decisional factors, not allowing to distinguish and to quantify the respective contribution of each source of information. Four individual faces (2 males) were morphed with another 10 same-sex faces varying shape only, surface only or both. EEG was recorded from 10 participants during a rapid periodic visual stimulation (frequency of 5.88Hz). Stimuli were presented in an oddball paradigm, in which the same face (one of the 4 faces) was presented four times and the fifth face was one of the corresponding morphed faces (AAAABAAAACAAAAD). Thus, the frequency of 1.18Hz (5.88Hz/5) and its harmonics

could be used as a measure of face discrimination response. Results indicated that individual faces were discriminated at occipito-temporal sites, particularly over the right hemisphere. Shape and surface changes alone were associated with much weaker responses than when both sources of information were combined (i.e., supra-additive effect). While shape was also discriminated at right occipito-temporal electrode sites, surface information was coded bilaterally.

[This work was supported by a grant from the European Research Council (facessvcp 284025) and a postdoctoral UCL/Marie-Curie fellowship to MD.]

◆ **A general shift towards direct gaze with uncertainty**

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Introduction: Increasing uncertainty by adding noise to the leftwards or rightwards looking eyes of synthetic faces reveals a prior for direct gaze (Mareschal et al. 2013). Here we examine the generality of this prior when gaze deviates along various axes in direct and rotated heads. Methods: Observers viewed computer-generated faces (500ms) whose gaze could deviate from direct along 8 axes (up/down; left/right and obliques) in steps of 3°. Following each stimulus presentation, observers used a pointer to indicate the direction of gaze in forward facing and 15° rotated heads that were either noiseless or had noise added to the eyes. Results: When noise was added to the eyes of the forward facing heads, observers' perceived the direction of gaze as being more direct across all gaze deviations tested. In the noiseless rotated heads, observers' perception of gaze was influenced by head rotation. Adding noise to the eyes of the rotated heads did not bias observers towards reporting the head orientation, but again resulted in a shift in perceived gaze towards direct. Conclusion: Our data suggest that the observers internally represent a prior for gaze as close to direct, regardless of head rotation or the axis of gaze deviation.

◆ **Is Congenital Prosopagnosics' eye movements pattern specific in self compared to others' faces discrimination?**

12 M Malaspina, A Albonico, R Daini (Psychology Department, Università degli Studi di Milano-Bicocca, Milano, Italy; e-mail: m.malaspina1@campus.unimib.it)

Congenital prosopagnosics' (CPs) scan patterns during familiar and unfamiliar faces identification show a dispersed gaze, focused mostly on the less salient external facial features (e.g. Schwarzer et al., 2007). Despite this evidence, it has never been investigated if the same eye movement pattern is also detectable during the exploration of the most familiar face of all: the self-face. Thus, we aimed to investigate the presence of different fixation patterns and bias laterality in a group of 7 CPs and 13 controls, during a face recognition task involving upright and inverted chimeric stimuli depicting participants' self-face and unknown faces. CPs made more inaccurate fixations in the upright condition compared to the inverted. Fixation numbers and durations differed between the two groups; moreover, while controls explored more the part of the upright face that allows a global facial analysis (i.e. the nose), switching to a feature-based strategy in the inverted condition, CPs adopted the same feature-based strategy for both conditions, a not optimal processing for face recognition. Nevertheless, CPs oculo-motor behaviour did not influence self-face recognition, such as both groups showed a self-face advantage in terms of accuracy and RTs. We suggest that self-face advantage is not face-specific but self-specific.

◆ **Increased sensitivity to happy compared with fearful faces in a temporal two-interval forced-choice paradigm.**

13 L S Delicato, J Finn, J Morris, B Smith (Psychology, University of Sunderland, United Kingdom; e-mail: Louise.Delicato@sunderland.ac.uk)

A temporal two-interval forced-choice paradigm is used to evaluate the strength of the visual signals contained in facial expressions. Stimuli were black and white images of faces expressing a neutral, positive (happy) or negative affect (e.g. fear or anger). A range of signal strengths (0-100%) of expressions were created by morphing the neutral and expressive images. Stimuli were presented for durations of 8, 83 or 200ms. One interval contained the neutral face (0%) and the other the expressive face (varied from 0 – 100%). Observers indicated the interval that contained the image that was more expressive. Performance increased from chance (50%) to 100% correct as signal strength increased for both happy and fearful expressions. The psychometric functions for happy expressions were shifted to the left of those for fearful expressions indicating that observers were more sensitive to the happy expressions. This suggests that the emotion signals conveyed by a happy face are more salient than those conveyed by a fearful face. This approach could be used to perceptually equate stimuli with

Tuesday

different expressions thereby removing signal strength as a possible confound. Future research is aimed at understanding the nature of the visual signals that are important for this perceptual difference.

◆ **The role of spatial modulations of local visual features in image recognition**

14 D V Yavna, V V Babenko (Faculty of Psychology, Southern Federal University, Russian Federation; e-mail: yavna@fortran.su)

Second-order visual filters (SOVFs) are considered as a texture segmentation mechanism. The segmentation becomes possible due to integration of distributed visual information. Yet spatial binding is also necessary for image formation. We investigated whether the information extracted by SOFVs is useful for recognition. Basing on psychophysical data, we created SOFV model following the scheme "filtering-rectification-filtering." The fixed relation of frequency tunings for the first – and the second-order filters has been used. Any input image is decomposed by our model into 6 frequency slices (according to the spatial frequency tuning of the first-order filters). On each of them SOVFs gate pattern areas containing spatial modulations of features. Among SOFVs we determined the outputs which were greater than adjacent. Face images were processed by our model. Observers viewed extracted areas. We found the information passed from the first slice (carrier has 4 cpi) allows to identify the presented image as a face. Adding to that the information passed from the next slice (8 cpi) makes possible to determine the gender. The next similar step (+ 16 cpi) allows to identify the person. The result suggests that the pattern areas containing spatial modulations of local features can be useful for image recognition.

◆ **Peripheral processing of gaze**

15 J A Florey<sup>1</sup>, C W G Clifford<sup>2</sup>, S C Dakin<sup>3</sup>, I Mareschal<sup>1</sup> (<sup>1</sup>Psychology, Queen Mary University of London, UK; <sup>2</sup>Psychology, University of New South Wales, Australia; <sup>3</sup>Ophthalmology, University College London, UK; e-mail: j.a.florey@qmul.ac.uk)

Introduction: Observers combine information about head rotation and eye deviation when judging gaze direction. However, little is known about how these influences interact when stimuli are viewed peripherally. Methods: Participants were required to categorise gaze in synthetic face stimuli as either directed towards them, averted to their left or to their right. Eye deviation varied from 20° leftwards to 20° rightwards in 5° steps using 5 different head rotations (-30°, -15°, 0°, 15°, 30°). Participants viewed the faces directly (0° eccentricity), or were instructed to fixate to the left (or right) of the faces at two locations; 6° and 9° eccentricity from the centre of the face. Results: Direct Fixation – When observers viewed the face directly, head rotation biased the perceived direction of gaze away from that of the head rotation (repulsion). Eccentric fixation – When heads were forward facing, observers responded "direct" to a wider range of eye deviations than for direct fixation. When the heads were turned, the number of "direct" responses was reduced across gaze deviations, as was the repulsive effect of head rotation. Conclusions: The relative influence of eye deviation and head rotation on perceived gaze direction depends on viewing eccentricity.

◆ **Long-term memory for own- and other-race faces**

16 M Zhao, I Bühlhoff (Human Perception, Cognition, and Action, Max Planck Institute for Biological Cybernetics, Germany; e-mail: Isabelle.Bühlhoff@tuebingen.mpg.de)

Many studies have demonstrated better recognition of own- than other-race faces. However, little is known about whether memories of unfamiliar own- and other-race faces decay similarly with time. We addressed this question by probing participants' memory about own- and other-race faces both immediately after learning (immediate test) and one week later (delayed test). In both learning and test phases, participants saw short movie wherein a person was talking in front of the camera (the sound was turned off). Two main results emerged. First, we observed a cross-race deficit in recognizing other-race faces in both immediate and delayed tests, but the cross-race deficit was reduced in the latter. Second, recognizing faces immediately after learning was not better than recognizing them one week later. Instead, overall performance was even better at delayed test than at immediate test. This result was mainly due to improved recognition for other-race female faces, which showed comparatively low performance when tested immediately. These results demonstrate that memories of both own- and other-race faces sustain for a relative long time. Although other-race faces are less well recognized than own-race faces, they seem to be maintained in long-term memory as well as, and even better than, own-race faces.

[This research was supported by Max Planck Society.]

**POSTERS: ILLUSIONS II**◆ **Tilt blindness: the different tilt thresholds for objects**

- 17 T Yasuda<sup>1</sup>, T Ueda<sup>2</sup>, K Shiina<sup>2</sup> (<sup>1</sup>Department of Psychology and Early Childhood Education, Faculty of Human Sciences, Matsuyama Shinonome College, Japan; <sup>2</sup>Faculty of Education and Integrated Arts and Sciences, Waseda University, Japan; e-mail: shiina@waseda.jp)

Tilt blindness is the phenomenon that we may ignore small tilts of objects as shown in Okuma illusion (Yasuda, et al., 2012). The purpose of this study was to find out the cause of this phenomenon by using 10 objects in a round photo frame. An original frame was printed on the center of a sheet and 5 exact copies and 7 rotated copies of the original frame were randomly placed around the center of the sheet. The rotated frames were oriented from 2° to 14° by 2° interval. Participants were required to search for the oriented objects in the sheet. The tilt thresholds for 10 objects were compared and it was found that the tilt perception was more accurate when objects have some straightness, and tilt blindness occurred when objects did not have such an element. Differential thresholds of human faces, however, showed a different tendency.

◆ **Edge detection hypothesis of the fluttering-heart illusion**

- 18 K Yanaka<sup>1,2</sup>, M Suzuki<sup>1</sup> (<sup>1</sup>Human Media Research Center, Kanagawa Institute of Technology, Japan; <sup>2</sup>Department of Information Media, Kanagawa Institute of Technology, Japan; e-mail: yanaka@ic.kanagawa-it.ac.jp)

We proposed and examined a new hypothesis that the fluttering-heart illusion occurs based on different latencies of edge detection. This illusion manifests as a phenomenon that an inner figure's motion is apparently unsynchronized with a surrounding outer figure's motion, while both motions objectively synchronize. The illusion typically occurs when inner figures are a different color than outer figures. Previous studies have argued that color difference causes the illusion. Furthermore, recent studies have also revealed that the illusion occurred when using monochrome stimuli in which edges and patterns of inner figures had different luminance contrasts from those in outer figures. Given these conditions, we hypothesized that different latencies of edge detection caused the illusion. We examined this hypothesis through experiments with stimuli, in which edges of outer figures were defined by luminance and edges of inner figures by texture or temporal modulation of luminance. Since the results indicated that the illusion occurred under these conditions, our hypothesis was proven.

◆ **Perceptual asymmetry in the corridor illusion**

- 19 F Aedo-Jury<sup>1,2</sup>, B R Cottureau<sup>1,2</sup>, Y Trotter<sup>1,2</sup>, J B Durand<sup>1,2</sup> (<sup>1</sup>Centre de Recherche Cerveau et Cognition, Université de Toulouse, France; <sup>2</sup>Centre National de la Recherche Scientifique, Toulouse, France; e-mail: felipe.aedo-jury@cerco.ups-tlse.fr)

Many visual size illusions rely on pairs of similarly sized objects that are nevertheless perceived differently because of distinct regional contexts (near versus far location in the "corridor illusion", small versus large surrounding inducers in the "Ebbinghaus illusion"). It is assumed that such illusions are "symmetrical": the illusory size difference remains the same when interchanging the objects' regional contexts. Here, we report results questioning this assumption. Seventeen subjects were tested with a version of the corridor illusion in which the objects' near and far contexts were interchanged by orienting the corridor either left to right (LR) or right to left (RL). All the subjects perceived the illusion but surprisingly, for most of them (13/17), the illusory size difference was significantly larger (bootstrap,  $p < 10^{-3}$ ) for one particular orientation of the corridor, either LR ( $n=10$ ) or RL ( $n=3$ ). Interestingly, no such asymmetry was found when interchanging the small and large inducers in the Ebbinghaus illusion, despite a correlation between the overall strength of both illusions across subjects. These results reveal a specific perceptual asymmetry in the corridor illusion, which might be caused either by idiosyncratic preferences for particular spatial configurations or by hemispheric specializations for far versus near spatial contexts.

[This work was supported by grants from the Agence Nationale de la Recherche (ANR-13-JSV4-0007-01 PERCEPTOPY and ANR-12-BSV4-0005-01 OPTIVISION) and a grant from the Fyssen Foundation.]



Tuesday

◆ **Tilt blindness influenced by the straightness of the contour and the aspect ratio of an object**

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Judging the tilt of objects seems not to be so difficult. However, in certain conditions, the accuracy of the upright judgment decreases. We call the phenomenon the tilt blindness. The Okuma illusion (Yasuda, et al., 2012) is an example of the tilt blindness. The purpose of this study was to find out the cause of the phenomenon with respect to object properties, in particular the straightness of objects' contour and their aspect ratio. In the experiment, two juxtaposed figures, an original one and a slightly rotated one, were shown to the participants, and they were required to decide as quickly and accurately as possible if one of the figures had a different tilt. Results of the experiment indicated that both the straightness and the aspect ratio of objects affected the participants' judgment, which suggested the detecting process of the centerline of an object as well as an apparent straightness concerned the tilt blindness.

◆ **The illusion of the snow tire traffic sign**

21 T Gulan<sup>1</sup>, P Valerjev<sup>2</sup>, M Dujmović<sup>2</sup> (<sup>1</sup>Department of Psychology, University of Zagreb, Croatia; <sup>2</sup>Department of Psychology, University of Zadar, Croatia; e-mail: tanja.gulan@gmail.com)

The traffic sign B45 shows a chained automobile tire that is oriented towards the observer and which is placed inside the blue circle. It has been noticed that the outer blue circle appears distorted in horizontal manner. The aim of this study was to demonstrate and to measure the size of this illusion. Two experiments were conducted; one using the method of adjustment, and the other the method of constant stimuli. Both experiments consisted of three situations – blue circle (control), blue circle with the white ellipse inside, and the B45 sign. The point of subjective equality was measured. Participants' task was to set the width of the object that varied randomly so that it forms a perfect circle. The ANOVA analysis showed significant effect, but only the "ellipse" situation differed significantly from the control situation. In the second experiment the participants had to decide whether the presented stimuli were distorted in horizontal or vertical manner. The ANOVA analysis on the points of subjective equality showed significant effect where both – "ellipse" and B45 situations significantly differed from the control situation. This indicates that there is a moderate but significant tendency to perceive such circles as horizontally distorted.

◆ **On the problem of shape formation: New effects related to the Oppel-Kundt and the Helmholtz's square illusions**

22 B Pinna, K Deiana (Dept. of Humanities and Social Sciences, University of Sassari, Italy; e-mail: baingio@uniss.it)

According to the Oppel-Kundt illusion, an empty (unfilled) space looks wider than a space filled by some objects (Oppel, 1854-1855). This illusion is related to the Helmholtz's square illusion, where a square appears wider when it is filled with vertical lines and higher when filled with horizontal lines (Helmholtz, 1866). Recently, Pinna (2010) demonstrated the rectangle illusion, according to which, given a large square shape made up of small black squares, the grouping of the small squares influences the shape perception of both small and large squares. The rectangle illusion is opposite to what expected on the basis of Oppel-Kundt and Helmholtz's square illusions. Aim of this work is to solve the antinomy between the two sets of illusions and to demonstrate a common explanation based on the interaction between different sources of directional organization. This was accomplished by introducing some new phenomena and through phenomenological experiments. According to our results the Oppel-Kundt and the Helmholtz's square illusions show at least two synergistic sources of directional organization: the direction of the grouping of the lines due to their similarity of the luminance contrast and the direction of the grouping of the lines due to the good continuation.

◆ **The effects of first-order and second-order orientation of inducers on the Zöllner illusion**

23 J Park, W H Jung (Psychology, Chungbuk National University, Republic of Korea; e-mail: girlsking3@gmail.com)

Two experiments were conducted to examine the effect of second-order orientation (figure) on the Zöllner illusion. For this, inducers of the original Zöllner illusion stimuli were altered by second-order figure. In experiment 1, it was investigated whether orientation of second-order can generate the Zöllner illusion using short line segments arranged along orientation of inducers. The results of experiment 1 showed that second-order orientation made the Zöllner illusion. Interestingly, when short line segments

were horizontal, the illusion was strong while the illusion was weak when segments were vertical. In experiment 2, real lines were added to second-order orientation of the stimuli of experiment 1. According to the result of experiment 2, the magnitude of the Zöllner illusion was decreased in condition that there are first-order orientation and second-order orientation. These results suggest that the Zöllner illusion is related to early visual information process and later visual information process in the cortex.

◆ **The effect of the Zöllner illusion on angle perception**

24 J S Song, W H Jung (Psychology, Chungbuk National University, Republic of Korea; e-mail: com4man@gmail.com)

The Zöllner illusion can make differ the perceived orientation from the real orientation of lines. In this work, it was examined that the Zöllner illusion can also affect angle perception. The stimuli of experiment 1 were angles whose size were various (including acute angles and obtuse angles) and whose lines had inducing segments of the Zöllner illusion. Perceived size of angles were compared with real size of angles. The result of experiment 1 showed that the effect of the Zöllner illusion was dependent on size of angles. Just in very small angle condition angle perception was influenced by the Zöllner illusion, not in relatively large angle condition. In experiment 2, perceived sizes of angles were measured in two conditions of inducers that were inside or outside of two converging lines. While inside-inducers affected angle perception in small angle condition, outside- inducers affected angle perception in large angle condition. These results suggest that process of angle perception and orientation perception may be independent.

◆ **Do tactile size illusions reflect a coherent stretch of tactile space?**

25 M R Longo, F Fiori (Department of Psychological Sciences, Birkbeck, University of London, United Kingdom; e-mail: m.longo@bbk.ac.uk)

Since the classic work of E. H. Weber in the 19th century, it has been known that the perceived size of objects touching the body is bigger on relatively sensitive compared to less sensitive skin surfaces. This effect, commonly known as Weber's illusion, suggests that distortions characteristic of the somatosensory homunculus are retained in tactile size judgments, a failure of tactile size constancy. More recently, analogous anisotropies of tactile size perception have been found, with stimuli oriented medio-laterally generally being perceived as larger than stimuli oriented proximo-distally. We investigated whether such size illusions reflect a coherent affine stretch affecting tactile space on the hand and the forehead. We obtained measures of the perceived size of tactile distances in eight orientations. A coherent stretch applied to tactile space predicts a specific sinusoidal pattern relating orientation to perceived size. On both the hand and the forehead, the results showed a pattern highly similar to predictions, allowing estimation of the magnitude and orientation of stretch. These results suggest that tactile size illusions can be well explained by a coherent stretch of tactile space.

[This research was supported by European Research Council grant (ERC-2013-StG-336050) to MRL.]

## POSTERS: BRAIN MECHANISMS II

◆ **Stochastic accumulation by cortical columns explains scalar property of multi-stable perception**

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In multi-stable phenomena, perception reverses suddenly and seemingly spontaneously between alternative interpretations. The timing of these stochastic 'reversals' is quite unlike that of volitional responses in perceptual tasks: even though timing densities vary widely (20-fold), higher moments stay in particular proportions to the mean, so that a characteristic distribution shape is preserved: Gamma-like with coefficient of variation 0.6. Although multi-stable phenomena have been studied extensively, neither the large observer variation nor the 'scalar property' has been explained. We show that a simple stochastic process – realizing a generalized Ehrenfest urn model – explains these puzzling observations. Its key ingredients are a stochastic accumulation of activity in a finite number of discrete neural nodes, such as cortical columns, and, internal to each node, a spontaneous dynamics modulated by sensory input. The stochastic accumulation to threshold reproduces the Gamma-like distribution and the internal, stimulus-dependent dynamics of nodes explains the observer variation. Comparison with other stochastic processes suggests that only a granular representation (with finite number of discrete units) offers a

Tuesday

simple account for the unique timing distribution of reversals. Thus, our findings reveal a granularity of perceptual representations and an exceedingly simple physics underlying multi-stable phenomena. [EU-project CORONET (FP7-ICT-269459)]

◆ **Excessive neural responses and visual discomfort**

27 L O'Hare<sup>1</sup>, P Pollux<sup>1</sup>, A D F Clarke<sup>2</sup> (<sup>1</sup>School of Psychology, University of Lincoln, UK; <sup>2</sup>School of Psychology, University of Aberdeen, UK; e-mail: lohare@lincoln.ac.uk)

Visual discomfort is the adverse effects of viewing certain stimuli, for example striped patterns and op-art stimuli. This could be due to eye-movements (Zanker, Hermens and Walker, 2010), alternatively discomfort could arise from excessive neural responses (Juricevic, Land, Wilkins and Webster, 2010). If excessive neural responses are responsible for discomfort, this judgements should relate to the magnitude of the EEG response. Spatial frequency content affects the level of discomfort (Wilkins et al, 1984; Fernandez and Wilkins, 2008). As the visual system is differentially sensitive to spatial frequency (Campbell and Robson, 1968), particularly those judged most uncomfortable (Wilkins et al, 1984), stimuli were matched for perceived contrast. Two measures of EEG amplitude were taken, transient responses from pattern reversal at 1Hz, and steady-state responses, from 5 and 10Hz. Results show that the transient response amplitude follows the same pattern as discomfort judgements, in accordance with the predictions of hyperexcitation. However, the steady state stimuli show a different pattern of results for the discomfort judgements, possibly due to perceptual phenomena such as frequency doubling. [This was funded by a BA/Leverhume Small Research Grant.]

◆ **The time course of the closure superiority effect: an ERP study**

28 W Zhu<sup>1,2,3</sup>, X Du<sup>1</sup>, Y Ma<sup>3</sup> (<sup>1</sup>College of information science, Yunnan university, china; <sup>2</sup>Department of Psychology, Giessen University, China; <sup>3</sup>Kunming Institute of Zoology, Chinese Academy of Science, China; e-mail: zhuweina.cn@gmail.com)

The discrimination of closure is typically faster and easier than that of other geometrical features (Donnelly et al., 1991; Pomerantz et al., 1977; Treisman and Paterson, 1984). However, the time course of the closure-superiority-effect is still unclear. We recorded event-related potentials (ERPs) during an odd-quadrant task. Four stimulus groups were used (Chen, 2005): Stimuli required discrimination based on a difference in orientation of angles (A), in parallelism (B), in collinearity (C) and in closure (D). The stimulus with closure difference (D) had the shortest Response Time (585.2 ms) and highest Accuracy (99.3%) compared with the other three stimulus groups (RT: F=104.9, P<0.001; Accuracy: F=7.64, P<0.001). There was no significant difference between the other stimuli. ERP results showed stimuli with closure difference induced smaller N1 amplitudes than other kinds of stimuli (F (3, 51)=15.0, p<0.001). There were no significant differences between the other three stimuli. The stimuli with closure difference induced the biggest P3 (F (3,51)=31.2, P<0.001), and showed the biggest difference from other stimuli (D-A: 4.37uv, P<0.001; D-B: 3.85uv, P<0.001; D-C: 2.80uv, P<0.001). Our results indicate that the closure superiority effect in the brain starts around 150ms (N1) after stimulus onset, and arrived at the max value around 400ms (P3).

[This work was supported by the National Natural Science Foundation of China (61005087, 61263042), Science and Technology Project of Yunnan Province, China (2009CD018), Key Science and Technology Project of Department of Education, Yunnan Province, China (2010Z067).]

◆ **Cortical Connective Field Estimates from Resting State fMRI Activity**

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One way to study intrinsic connectivity in visual cortical areas is by examining spontaneous fluctuations in resting state activity. Such fluctuations are – at least partly – shaped by the underlying functional and anatomical topography. Here, we applied connective field modeling to estimate intrinsic connectivity in the early visual cortex during resting state functional magnetic resonance imaging (fMRI). This model-based analysis estimates the spatial integration between blood-oxygen level dependent (BOLD) signals in distinct cortical field maps using fMRI. Just as a population receptive field predicts the collective activity in a voxel as a function of stimulus position, a voxel's connective field estimates the activity in a voxel as a function of activity in voxels in a neighboring visual area. Based on a population

receptive field mapping in hand, connective field positions on the cortical surface can be visualized in retinotopic space. We found that reliable estimates of retinotopic organization based on V1→V2 and V1→V3 connective field maps can be obtained from resting state data, even in only a few minutes.

◆ **The influence of eye vergence on retinotopic organization in human early visual cortex**

30 B R Cottureau<sup>1,2</sup>, J B Durand<sup>1,2</sup>, N Vayssière<sup>1,2</sup>, Y Trotter<sup>1,2</sup> (<sup>1</sup>Centre de Recherche Cerveau & Cognition, Université de Toulouse, France; <sup>2</sup>Centre National de la Recherche Scientifique, Toulouse, France; e-mail: cottureau@cerco.ups-tlse.fr)

Human early visual cortex is usually believed to rigorously reflect the projection of the visual scene on the retina. This view was however challenged by recent imaging studies that demonstrated that depth cues can modify a stimulus representation in area V1 (Murray et al., 2006; Sperandio et al., 2012). In this study, we investigated whether eye vergence influences retinotopic mapping in early visual cortex. fMRI recordings (3 Teslas) were performed while subjects (n = 5) saw classical retinotopic stimuli consisting of expanding rings. The viewing distance was fixed at 130cm. In half of the recordings, stimuli were seen through base-out prisms (4 dioptres), an optical device that modifies the vergence angle while letting the retinal images unchanged. In this case, the vergence angle was consistent with a viewing distance of 40cm. Fourier analysis revealed that eye vergence significantly modified eccentricity maps in areas V1, V2 and V3 of all our subjects (bootstrap comparison). This modification was consistent with a contraction of the maps. We hypothesize that our results reflects an adaptation of early visual areas to the perceived size of the stimulus, which becomes smaller as the vergence angle increases (Leibowitz & Moore, 1966).

[This work was supported by a Marie Curie IIF grant (Real-Depth: PIF-GA-2011-298386) and a Fyssen grant accorded to Benoit Cottureau. This work was also supported by an ANR grant (OPTIVISION: ANR-12-BSV4-0005-01) accorded to the ECO-3D team in CerCo.]

◆ **Functional connectivity of face and scene selective regions**

31 L Garrido<sup>1</sup>, A J Holmes<sup>2</sup>, K Nakayama<sup>3</sup> (<sup>1</sup>Psychology, Brunel University, United Kingdom; <sup>2</sup>Psychology, Yale University, United States of America; <sup>3</sup>Psychology, Harvard University, United States of America; e-mail: garridolucia@gmail.com)

fMRI has revealed cortical regions that consistently respond more to faces than to other objects (Kanwisher et al., 1997), and regions that respond more to scenes than to other objects (Epstein et al., 1998). But face and scene processing not only depend on computations implemented in these selective regions, but also in their interactions with each other and with the rest of the brain. Here, we used resting state fMRI to investigate the functional connectivity of face and scene selective regions. We tested 39 participants and used functional localizers to identify six face-selective and six scene-selective regions. We extracted low-frequency spontaneous fluctuations in BOLD signal from each of these selective regions and correlated those signals with each other and with the rest of the brain. We observed higher correlations within face-selective regions and within scene-selective regions than across face- and scene-selective regions. Correlations within face-selective regions were more right-lateralized than correlations within scene-selective regions. We will also show the whole-brain connectivity patterns for each of the selective regions. The description of consistent and reliable correlations of face and scene selective regions in this relatively large sample contributes to defining the functional organization of the systems that process faces and scenes.

[This research was supported by a NIH grant awarded to Ken Nakayama (5ROI1EY013602-07) and a NIMH grant awarded to Avram J. Holmes (K01MH099232).]

◆ **Temporal integration in rapidly presented natural scenes**

32 J Drewes, D Melcher (CIMeC, Trento University, Italy; e-mail: mail@jandrewes.de)

Humans are capable of extracting content information from newly presented visual scenes at high speed, yet the nature of the underlying mechanism is still unclear. We attempted to study the duration over which information in the visual system can be integrated into a meaningful percept, using an RSVP paradigm. A stream of "neutral" images (containing neither vehicles nor animals) were presented centrally at 20ms/image at fixed image contrast of 50%. Embedded in this image stream were one or two presentations of one target image randomly selected from two target categories (vehicles and animals). Subjects were asked to decide the target image category. Target contrast was adjusted by QUEST to achieve 57% correct detection ratio. In trials with two presentations, the ISI was varied systematically from 0 to 600ms. Generally, longer ISIs led to reduced detection performance, consistent with a temporal integration window for object category discrimination. When separating trials by target type, the "animal"

Tuesday

trials exhibited a significant oscillatory component at approx. 5Hz ( $p < 0.05$ , Bonferroni-corrected). Our results show indications of recurrent processing in visual perception, suggesting that alternating optimal and non-optimal time periods exist during which stimulus repetition can improve recognition performance to a varying amount.

[The research was supported by a European Research Council (ERC) grant (grant agreement no. 313658)]

◆ **Disentangling effects of percepts and stimuli in Fraser-like displays: an explorative EEG study**

33 X Yun<sup>1,2,3</sup>, S J Hazenberg<sup>1</sup>, R H A H Jacobs<sup>1</sup>, J Qiu<sup>2,3</sup>, R van Lier<sup>1</sup> (<sup>1</sup>Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, The Netherlands; <sup>2</sup>School of Psychology, Southwest University, China; <sup>3</sup>Key Laboratory of Cognition and Personality, Ministry of Education, China; e-mail: x.yun@donders.ru.nl)

We studied neural correlates accompanying the Fraser spiral illusion. The Fraser spiral illusion consists of twisted cords superimposed on a patchwork background arranged in concentric circles, which is typically perceived as a single spiral. We tested four displays: the Fraser spiral illusion and three variants derived from it by orthogonally combining local and global properties. The global shape of the cords comprised either concentric circles or a single spiral. The local black-and-white cords were either parallel or twisted. The displays with twisted cords successfully induced illusory percepts, i.e. circles looked like spirals (the Fraser spiral illusion) and spirals looked like circles (the reversed Fraser spiral illusion). Using EEG, we compared the event-related potentials in a Stimuli (Circle, Spiral) x Percepts (Circle, Spiral) design. A significant main effect of Stimuli was found at the posterior scalp in the early component (P220-280) and a significant main effect of Percepts was found over the anterior scalp in the later component (P350-450). For both components, the amplitude was higher for the spiral than for the circle, suggesting that higher amplitude reflects higher complexity, both at the stimulus level and at the perceptual level.

## POSTERS: ATTENTION II

◆ **Devaluation of distractors limited to evaluations after incorrect target localization**

34 R H A H Jacobs, Y Güçlütürk, R van Lier (Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, The Netherlands; e-mail: r.jacobs@donders.ru.nl)

Distractors in localization tasks are subsequently rated as less cheerful than target items and novel items (Raymond et al., 2003). We hypothesized that knowledge of the target and distractor categories in itself would suffice to bring about this distractor devaluation effect. We replicated the distractor devaluation paradigm with some modifications. Participants saw squares filled with geometric figures to the left and right of fixation, and had to indicate at which side target geometric figures (circles, hexagons, or triangles) were presented. Subsequently, the target or the distractor or a novel item was presented for evaluation of liking on a Likert scale. In addition, participants indicated their liking of items from target, distractor, and novel categories before the localization task, but after specification of the target. We found no differences between evaluations of targets and distractors, whether before or after the localization task. However, we found that distractors were evaluated more favourably after successful than after erroneous localization of the target. These results suggest that task performance is a critical mediator of stimulus re-evaluation, while a stimulus' status in itself seems to have no effects. We are currently investigating whether awareness of errors and invested effort can explain the observed effects.

◆ **Motion orients attention**

35 K E Burnett, I Arend, A Henik (Department of Psychology, Ben-Gurion University of the Negev, Israel; e-mail: k.e.burnett@hotmail.co.uk)

Does motion orient attention? We designed a conflict cue containing direction information from both shape and motion, by presenting a group of left- or right-pointing arrows that translated left or right. We used the cue in a Posner cueing paradigm with a simple detection task. In two separate groups of participants, either arrow direction or motion direction predicted the location of the target with 80% reliability. The irrelevant dimension was equally likely to be congruent or incongruent with the relevant dimension, and therefore was nonpredictive of the location of the target. Both relevant cue dimensions produced a validity effect, and, importantly, reaction time was influenced by irrelevant dimension congruity. The profile of the cueing effects was different for the two dimensions: When the motion was the relevant dimension, the congruity effect produced by the arrow was similar across SOAs.

In contrast, when the arrow was the relevant dimension, the congruity effect was different across SOAs, suggesting that motion processing has a different timecourse to arrow processing. Nevertheless, motion direction produced cueing effects as both an irrelevant and relevant dimension, suggesting that motion can orient attention both automatically and with volition. This finding has theoretical implications for automaticity and attentional orienting.

◆ **Effects of visual-spatial and semantic attributes on attentional orienting in response to environmental cues.**

36 A J Lambert, A Greenwood, N Ryckman (School of Psychology, University of Auckland, New Zealand; e-mail: a.lambert@auckland.ac.nz)

Are shifts of attention in response to environmental cues driven by visual-spatial features of cue stimuli, or by their semantic properties? Contrary to a prediction of the spatial correspondence hypothesis, in Experiment 1 attention movements in response to centrally presented number cues were unaffected by the visual-spatial feature of left-right asymmetry. Experiment Two disconfirmed a second prediction, derived from neurocognitive considerations, that number cues would elicit stronger spatial effects than letter cues. In Experiment 3, when cues were presented briefly (for 66ms) orienting behaviour was driven primarily by visual-spatial features, and not by cue meaning; but when cues were shown for a longer period (300ms), orienting was driven primarily by cue meaning, and not by visual-spatial properties. These results, together with earlier findings, are interpreted in terms of two key theoretical proposals: (1) When cues for attention are presented under stimulus conditions that favour encoding by the dorsal visual stream, rapid shifts of attention, based on non-semantic, visual-spatial properties of the cue are elicited, (2) When cues for spatial attention are presented under stimulus conditions that favour encoding by the ventral stream, relatively slow shifts of spatial attention, based on semantic encoding of the cue, are elicited.

◆ **Continuous measures of time and space for inhibition of return**

37 J MacInnes (Psychology, Higher School of Economics, Russian Federation; e-mail: jmacinnes@hse.ru)

Attention is drawn automatically to peripheral onsets, and responses to subsequent probes at the attended location are facilitated for a short time after the onset. This early facilitation, however, becomes a slowing of responses at the attended locations in what has been termed Inhibition of return (IOR). The temporal and spatial properties of IOR have been well studied, but these typically treat time and space as median splits or discrete bins. In this study, we test the temporal and spatial properties of IOR as continuous variables and demonstrate Linear Mixed Effect models as an appropriate way to measure the results. A number of classic IOR results are replicated using this method, including the spatial gradient of IOR, the reference frame of IOR and the time course of IOR with manual and saccadic responses.

◆ **Task-irrelevant attentional fluctuation enhances detection of gradual change**

38 S Nishina (Honda Research Institute Japan, Japan; e-mail: nishina@jp.honda-ri.com)

A gradual change in a scene is often unnoticed when the change is sufficiently slow (Simons et al., 2000). This type of change blindness is thought to be due to the observer's failure to direct attention to the changing object. In this study, we examined how detection performance of gradually changing color could be affected by task-irrelevant flickering stimuli presented in the same experimental display. The task was to answer in which of four regions a color-changing target exists as quickly as possible. Although adding distracting objects would generally impair the task performance, the result was the opposite when spatial distribution of the task-irrelevant stimuli and temporal frequency of the flicker were appropriately selected. We show that the relationship between observed improvement and the spatio-temporal properties of the task-irrelevant stimuli was well modeled by a stochastic resonance model.

◆ **Detecting multiple changes in visual scenes: Perceptual and semantic prioritisations**

39 S Spotorno<sup>1,2</sup>, A McKechnie<sup>1</sup>, B W Tatler<sup>1</sup> (<sup>1</sup>School of Psychology, University of Dundee, United Kingdom; <sup>2</sup>Institut de Neurosciences de la Timone, CNRS & Aix-Marseilles University, France; e-mail: sara.spotorno@univ-amu.fr)

The change detection paradigm has been used in previous research to examine how we extract and represent different types of information from our visual surroundings. We investigated how perceptual salience and semantic informativeness of objects influence selection for two competing objects within the same scene. We used a flicker task with two changes by addition per scene, one highly consistent

Tuesday

(diagnostic) and the other inconsistent with the semantic context (gist) of the scene. Moreover, each change was of either low or high perceptual salience. We found that when the two changes differed in salience, the most salient one was more likely to be detected first, independently of its semantic content. When both changes had low salience, the diagnostic one was detected earlier than the inconsistent one. When both changes were highly salient, they had the same probability of being detected first, even if first detections were faster for inconsistent changes than for diagnostic changes. These results suggest that perceptual and semantic properties interact in determining prioritisation, with visual distinctiveness being a preferential source of selection between competing objects. When attention cannot be driven to the objects by salience, high consistency with gist facilitates object selection and representation.

◆ **Does set-size contribute to masking in Object Substitution Masking?**

40 S Camp, M Pilling (Psychology, Oxford Brookes University, United Kingdom; e-mail: sarah.camp-2012@brookes.ac.uk)

Object substitution masking (OSM) is a phenomenon in which a target is rendered imperceptible by four surrounding dots which trail the target's offset. OSM has been traditionally assumed to be attention dependent. Di Lollo et al. (2000) reported that set-size (the number of distractors presented with the target) interacted with the effect of the duration of the trailing mask. Argyropoulos et al. (2012), by contrast, found OSM occurred independently of set-size when ceiling effects are avoided and appropriate response-bias independent measures applied. We revisit the question of set-size effects in OSM using digits (rather than Landolt Cs or circles with a vertical bar as in DiLollo et al., Argyropoulos et al.) as stimuli. Experiment 1 required observers to detect the presence/absence of a digit at the mask location. Experiment 2 required observers to identify the digit at that location. Both experiments showed a significant increase in OSM associated with set-size. This seems to suggest that attention is an important factor in OSM when digits are used. We suggest the importance of attention in this case relates to the overlearned nature of digits as stimuli which makes them more likely to accentuate the masking produced by the four dots.

## POSTERS: PERCEPTION AND ACTION II

◆ **Speed estimation during driving**

41 K R Gegenfurtner<sup>1</sup>, A C Schütz<sup>1</sup>, J Billino<sup>1</sup>, D Polin<sup>2</sup>, P Bodrogi<sup>2</sup>, T Q Khanh<sup>2</sup> (<sup>1</sup>Psychology, Giessen University, Germany; <sup>2</sup>Lighting Technology, TU Darmstadt, Germany; e-mail: gegenfurtner@uni-giessen.de)

Speed estimation errors are one of the major sources of traffic accidents. We therefore investigated speed estimation when driving cars or when passively judging the speed of the own or other vehicles. We performed three experiments at a former airport runway under controlled driving and lighting conditions. Participants had to estimate the speed of a car as a passenger, drive at a certain speed, or estimate the speed of an oncoming car while driving. A total of 9 participants took part in the experiment, driving either during the day, at dusk, or at night. Speeds varied between 30 and 90 km/h. In line with earlier results, we found that passengers underestimated their own speed by about 20% and drivers went over the desired speed by roughly the same amount. There were stable individual differences between different participants, and a stronger underestimation of speed as a passenger went along with a higher speed as a driver ( $\rho=0.93$ ). Interestingly, the underestimation of perceived speed extended to oncoming cars (25%). All of these effects were independent of lighting conditions. These effects lead to potentially fatal situations where drivers go faster than they think, while the speed of oncoming traffic is underestimated. [Supported by DFG grant Ge 879/10]

◆ **Coordination of eye-head movements during a jump with half turn**

42 Y Sato<sup>1</sup>, S Torii<sup>2</sup>, M Sasaki<sup>3</sup> (<sup>1</sup>College of Commerce, Nihon University, Japan; <sup>2</sup>College of Arts and Sciences, University of Tokyo, Japan; <sup>3</sup>Faculty of Liberal Arts, Hirosaki Gakuin University, Japan; e-mail: sato.yusuke@nihon-u.ac.jp)

Gymnasts use visual information during aerial maneuvers, but how they use vision to perform a jump with a turn is still unclear. This study's aim was to clarify the coordination of horizontal eye-head movements in gymnasts during a jump with half turn. 8 participants were male skilled gymnasts. They performed a jump with half turn (180°), during which the line of sight was determined by combining information about eye and head movements. Two patterns of eye-head coordination were identified. In both the patterns, the head rotated in the direction of body rotation from pre-takeoff to landing. In one pattern, compensatory eye movement in the direction opposite that of the head movement developed

before takeoff, after which the eyes rotated in the direction of head movement and compensatory eye movement developed again between immediately before and after landing. In the other pattern, additional compensatory eye movement developed during the flight phase. In this eye movement, the line of sight remained fixed. These results show that gymnasts fix their line of sight by eye-head coordination, regardless of the coordination patterns. Thus, gymnasts use visual information by fixing their line of sight to control their performance during a jump with half turn.

◆ **Training perceptual skills in soccer: Effects of a longitudinal protocol on predictive abilities of skilled goalkeepers**

43

M Murgia<sup>1,2</sup>, F Sors<sup>2</sup>, A F Muroi<sup>2</sup>, S Pertoldi<sup>2</sup>, M Guicciardi<sup>1</sup>, T Agostini<sup>2</sup> (<sup>1</sup>Department of Pedagogy, Psychology, Philosophy, University of Cagliari, Italy; <sup>2</sup>Department of Life Sciences, University of Trieste, Trieste; e-mail: maumurgia@tiscali.it)

Perceptual skills are fundamental in the interaction between kickers and goalkeepers in soccer. In particular, goalkeepers need to perceive the kickers' movements in order to predict the direction of the penalties. Previous studies suggest that non-athletes and novice players can benefit from perceptual training in soccer, but nobody reported effective results with skilled goalkeepers. We developed an home-training based on temporal occluded movies, and our aim was to test whether skilled soccer goalkeepers can benefit from it. We recruited a sample of goalkeepers playing in the academies of professional and semi-professional Italian teams. Participants were randomly assigned to one of three groups: Experimental, placebo and control. All of them were tested at the beginning of the experiment and after eight weeks. The test consisted in the presentation of temporal occluded videos of penalties recorded from the goalkeeper perspective, and participants were required to predict the direction of penalty kicks. A 2x3 ANOVA analysis revealed a significant interaction, and a set of t-test analyses revealed a significant improvement between pre-test and post-test only for the experimental group. This outcome indicates that even skilled soccer goalkeepers can benefit from perceptual trainings, and suggest the efficacy of the adopted protocol.

◆ **Adaptation to motor-visual temporal lag is independent of reduction of attentional resources**

44

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Prolonged exposure to fixed temporal lag between observer's keypress and visual feedback recalibrates motor-visual temporal relationship, and consequently shifts the point of subjective simultaneity (PSS) in subsequent temporal order judgments between keypress and visual flash (Stetson et al., 2006). In order to examine how observer's attention to the temporal lag during adaptation contributes the motor-visual temporal recalibration, we limited observer's attention by the use of the dual-task paradigm. During the adaptation phase, the observers repeatedly pressed a key accompanied by a visual feedback with 0 ms or 200 ms fixed temporal lag. During this phase, we presented pairs of circles with the same or different sizes around a fixation point nine times with random timing. As the dual-task, the observers were required to count frequency of the pairs of circles with different sizes. We prepared three conditions with various difficulty of the dual-task by changing the difference in the size of circles. In order to measure the PSS, in the test phase, the observers conducted temporal order judgment between keypress and visual flash with various temporal lags. Obtained results suggest that prolonged exposure to motor-visual temporal lag sufficiently recalibrates perception of temporal order even with reduced attentional resources.

◆ **The effect of obstacle baseline displacement on traversal behaviour in running humans**

45

K Daniels, J Burn (Department of Mechanical Engineering, University of Bristol, UK; e-mail: k.daniels@bristol.ac.uk)

Raised obstacles in the path of locomotion can cause loss of balance and injury if not anticipated. Information about the horizontal location and height of an obstacle must be obtained using vision in advance of arrival at the obstacle if it is to be traversed successfully. It is not fully understood which properties of the obstacle are used to obtain this information. Here we investigated whether the presence and location of an intersection of the base of the obstacle with the ground (the baseline) was used by human subjects to control foot kinematics when traversing a raised obstacle. Subjects ran along a track and leaped over an obstacle consisting only of an elevated horizontal rod and an identical rod, the baseline, at ground level. Baseline position was varied along the direction of travel to alter the geometry



Tuesday

of the obstacle without changing the mechanical requirements for traversal. We showed that the position of the baseline, when present, affected the horizontal but not the vertical trajectory of the feet when leaping over the obstacle. This suggests that a baseline contributes to the visual judgement of obstacle location.

[EPSRC DTA]

◆ **Identification of self-produced movement based on positional information**

46 H Umemura (Health Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), Japan; e-mail: h.umemura@aist.go.jp)

Comparing a planned state of self-body and the perceived state is essential to motor learning and/or to attribute agency. Little is known, however, about the characteristic of the ability for the comparison. In this study, I investigated how correctly the brain can detect the difference of the current position of self-hand in motion and displaced one. Because I was concerned on the ability of the identification without using the temporal-delay of the initiation of one's action, I required participants to rotate a turntable, and trimmed displays of the movement were used as stimuli. Participants sequentially observed the movement with no-delay and several levels of delays during rotation, and chose the display of current movement. Sensitivity to identify self-movement was not declined without seeing the initiation of action when they moved their hand with a moderate speed. However, even if participants moved their hand slowly, the same amount of positional difference was required for the identification. While, participants frequently confused their current movement with the movement of being one lap behind. Numerical estimation of response rate considering this confusion indicates that the spatial range for detecting the difference would be symmetrical for preceded and followed positions.

[Supported by JSPS KAKENHI Grant Number 24500335. ]

## POSTERS: EYE MOVEMENTS II

◆ **Microsaccades are monocular and might compensate for foveal non-uniformity during discrimination**

47 J Gautier<sup>1</sup>, M I Hairol<sup>1,2</sup>, J Siderov<sup>1</sup>, S J Waugh<sup>1</sup> (<sup>1</sup>Anglia Vision Research, Department of Vision and Hearing Sciences, Anglia Ruskin University, United Kingdom; <sup>2</sup>Program Optometri & Sains Penglihatan, Universiti Kebangsaan Malaysia, Malaysia; e-mail: josselin.gautier@anglia.ac.uk)

A long path in the study of microsaccades has led to new proposals about their purpose, size (<12-20 arcmin or <0.5-2 deg), and potential role/s in human vision. Recently, it was suggested that genuine (<12 arcmin) microsaccades serve to re-center gaze to the preferred locus of foveal fixation, at least for spatial discrimination tasks performed monocularly. Using a C (8 arcmin gap) and an orientation discrimination task, performance across the psychometric function for 5 randomly presented contrast levels was measured. Eye movements were recorded during judgments to 2s presentations using an EyeLink1000 eyetracker. Microsaccades are mainly (80%) if not exclusively, monocular, considering their amplitudes are within the foveal area (6 to 12 arcmin). Their occurrence is 60% more likely to appear in the dominant eye. Binocular "micro"saccades have orientation and occurrence rates that appear correlated with psychophysical performance level in agreement with literature. The pattern of monocular microsaccades is consistent with a purpose of finding the preferred intra-foveal locus of fixation (keeping on average within 10 arcmin from centre). Conversely, binocular saccades are saccades, directing the foveae to the object of interest. Besides differences in size, distinction between microsaccades and saccades appears to be fundamentally functional.

[Supported, in part, by a grant from the Evelyn Trust, Cambridge]

◆ **Local and global factors in orientation perception and gaze allocation**

48 N B Bocheva, S Stefanov, M Stefanova (Sensory Neurobiology, Institute of Neurobiology, Bulgaria; e-mail: nadya@percept.bas.bg)

We studied the perceived orientation of line patterns when the overall shape and the orientational flow provide conflicting information. The stimuli were line patterns with mean orientation of the line segments of 60 or 120 deg. The orientation of each individual line segment was perturbed with noise taken from uniform distribution with different range. The observation time was either restricted to 1.65 s or unlimited. The observer's task was to indicate whether the patterns appeared tilted to the left or to the right. The gaze allocation during the task performance was recorded in order to find whether the pattern of eye movements differ depending on the stimulus complexity and the perceived pattern orientation. The results suggest that for restricted observation time, the perceived orientation is dominated by the

orientation of the overall shape and the eye movements are grouped mostly along the elongation axis of the patterns. For unlimited observation time the perceived orientation is determined mostly by the direction of the orientational flow. The number of saccades, but not their duration correlates with the noise level. The results imply that the pattern of eye movements reflects the relative weight of the local and global factors in perceptual decisions.

◆ **Assessing symmetry of scan patterns in multiple object tracking**

49 F Dechterenko<sup>1,2</sup>, J Lukavsky<sup>2</sup> (<sup>1</sup>Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic; <sup>2</sup>Institute of Psychology, Academy of Sciences of the Czech Republic, Czech Republic; e-mail: filip.dechterenko@gmail.com)

We are often interested in consistency of scan patterns during repeated presentations of trials (e.g. in Multiple Object Tracking, MOT). We could effectively mask repetition, if we could use trials flipped around x or y axis. In our study, we have measured eye movements of 31 participants in MOT task. Each participant saw 5 different MOT trajectories repeatedly over 6 blocks. In each block, each trajectory was presented twice - once in the original condition and once flipped around y axis. Previously, we have shown that the flipped trajectories evoke similar, but slightly different scan patterns (Dechterenko & Lukavsky, 2013). Here, we evaluated the similarity of scan patterns using three distinct methods (direct group comparison, pairwise comparison and group pairwise comparison). The third method was developed for comparing group of trajectories and were thorough fully tested on artificial data. The current results confirmed there is a significant drop-off in consistency when using symmetrical trials instead of identical trials. However it is still possible to use flipping to mask the repetition due to the strong correlation ( $r=0.84$ ) between groups of trajectories consisting only of identical trials and groups of trajectories consisting from trials and their flipped variant.

[This work was supported by student grant GA UK No. 68413]

◆ **Saccade trajectories: Differential sensitivity of generation and correction processes to stimulus salience**

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This experiment investigated the processes underlying the generation and online correction of saccade trajectories. Earlier studies suggest that saccade trajectories are the result of the interaction of at least two processes. A quicker process influences initial direction by a delayed, coarse inhibition of oculomotor space surrounding non-selected stimuli. A slower 'online' corrective process makes finer trajectory changes during the saccade. The experiment involved a target-distractor saccade task (see McSorley, Haggard, & Walker, 2006), but with the modification that the luminance salience of the distractor was varied at two levels. At low salience, the distractor was of equal luminance to the target. At high salience, it was more luminous. As a measure of initial generation processes, the angular deviation of the saccade towards the distractor was measured at 10ms after saccade onset. Angular deviation of saccade landing point served to measure the outcome of later corrective processes. The results showed a significant interaction of latency with distractor salience when considering initial deviation, but not when considering landing position deviation. This suggests that quick initial generation processes are more sensitive to stimulus salience, and highlights the importance of gathering separate measures of initial and final deviation in studies of saccade trajectory.

[Luke Tudge is supported by the Berlin School of Mind and Brain PhD scholarship.]

◆ **Saccade-related responses in the human superior colliculus: Preparatory activity and laterality**

51 M Furlan, A T Smith, R Walker (Department of Psychology, Royal Holloway University of London, TW20 0EX UK, United Kingdom; e-mail: Michele.Furlan@rhul.ac.uk)

In recent years a small number of studies have started to apply functional imaging techniques to study visual responses in the human superior colliculus (SC) but very few have investigated its oculomotor functions. Here we applied a combination of univariate (GLM) and multivariate (MVPA) analysis (a) to demonstrate neural activity associated with saccade-target selection and (b) to try to decode the representations of leftward and rightward saccade-related activity. We used 3T fMRI to record the BOLD response in the SC while participants were either preparing or executing saccadic eye movements. Our results showed that executing a saccade and, most importantly, preparing a saccade produced an increase in the SC hemodynamic activity. Preparatory activity was observed in both contralateral and ipsilateral

Tuesday

SC and MVPA analysis was unable to distinguish two different patterns for preparation of leftward and rightward saccades. This study provides the first evidence of pre-saccadic preparatory activity recorded in human SC using fMRI.

◆ **Position and direction inputs when making saccades to moving targets**

52 D I Braun (Dept. of Experimental Psychology, Justus-Liebig-University Giessen, Germany;  
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Both, the smooth pursuit and the saccadic eye movement system receive information about stimulus position, movement direction and velocity. We investigated the trade-off between position and direction in programming of initial saccades to moving stimuli. Initially a single Gaussian blob appeared 5 deg eccentric either horizontal, +15 or -15 degrees vertical. After a step towards the center, it moved at 20 deg/s randomly in one of three directions either horizontally or 15 degrees up- or downwards. Our interest concerned conditions of reversed step and ramp directions, like an upward step followed by downward ramp motion. Targets were defined by high or low luminance contrast or isoluminant color. Observers typically made initial saccades towards the center and then followed the target by smooth pursuit. We found that fast saccades with latencies around 150 ms were directed towards the position where the target was about 100 ms before the saccade. Saccades with longer latencies around 200 ms took into account the duration of saccade planning, execution as well as ramp movement and landed close to the moving target. Relative weights of position and motion direction changed for different stimulus conditions, with isoluminant color stimuli leading to higher weights for position.

## POSTERS: COLOUR AND ILLUMINATION II

◆ **Perception of saturation in natural scenes**

53 F Schiller, K R Gegenfurtner (Department of Psychology, Justus-Liebig-Universität Gießen ,  
Germany; e-mail: florian.schiller@psychol.uni-giessen.de)

We wanted to explore whether 6 common colorimetric measures can be successfully used to predict the perception of saturation when human observers view natural scenes. 8 participants were asked to choose the most saturated pixel in 80 calibrated color images from the McGill database. All saturation measures we investigated were able to predict the choices quite well, with small advantages for measures based on CIELUV and DKL color spaces. The chosen pixels corresponded to the top 15% of saturated pixels according to these measures. To investigate the contributions of color versus spatial features, we repeated the experiment using grayscale images. Participants were asked to choose the pixel that would be the most saturated if the image was in color. The saturation of the chosen pixels was still above that of randomly chosen pixels. Participants' choices were more salient than randomly chosen pixels and could not be predicted well on the basis of luminance alone. We conclude that simple colorimetric measures work quite well to predict saturation in natural scenes. Saliency, as evoked by the spatial structure of the scenes, may make a small but significant contribution.

◆ **Stereoscopic three-dimensional depth quality assessment in different colour arrangements**

54 S Kao (Department of Digital Arts, University of Malta, Malta;  
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An immersive stereoscopic three-dimensional (S3D) viewing experience is constructed on a considerate scene design of the content. Colour is a remarkable factor that influences human depth perception. Previous works in colour and depth perception have shown that long-wavelength colours appear closer to viewers when competing with short-wavelength colours. This research explores colour and stereoscopic depth perception under a polarised projection viewing condition. The effect of colour on stereoscopic depth perception is examined from a stereoscopic depth quality viewpoint. It considers the way in which depth perception is influenced by different decisions of hue and identifies the quality of stereoscopic depth perception in different colour arrangements, which can provide a guidance during colouring decisions for S3D imaging. In particular, different levels of hue are tested on foreground and background colour objects in computer-generated scenes. A polarised projection system is built for stereoscopic viewing and the image stimuli are designed and rendered in industry-standard 3D application package. A depth quality assessment based on ITU-R Recommendation is then performed to evaluate different colour arrangements in stereoscopic contents. The results indicate that hue is affective in stereoscopic depth perception. However, the discriminations of depth perception are equally efficient between the long-wavelength and short-wavelength trials.

◆ **Same same, but different: similarity explains both chromatic discrimination and colour categorisation**

55

S J Cropper, D R Little, K Mullins (Melbourne School of Psychological Sciences, University of Melbourne, Australia; e-mail: scropper@unimelb.edu.au)

Generally, it has been assumed that the task of stimulus discrimination differs from that of categorisation; exemplar-based theories (Nosofsky, 1986) challenge this assumption. We have recently shown that both the discrimination and categorisation of cardinal colours may be explained by the same underlying similarity judgement (Cropper, Kvansakul & Little, 2013). This result was predicated on an elliptical deformation of the cardinal colour plane into a perceptually equal space. In the work presented here we test the validity of this transformation by measuring similarity directly. Seven observers were required to judge, on a scale of 1-8, the degree of similarity between 441 pairs (21 colours) of scaled, equiluminant cardinal colour patches. The paradigm and stimulus structure was exactly the same as used for the previous discrimination and categorisation measurements; only the observer judgement changed. The data were analysed using multi-dimensional scaling to give a psychological similarity space for each subject. When expressed in this way, the data were best-fit with an elliptical solution, supporting the transformation made to model the original discrimination and categorisation data. This empirically strengthens our conclusion that discrimination and categorisation are both founded upon stimulus similarity and are coherently explained within the same theoretical framework.

◆ **Colorfulness-adaptation influenced by spatial frequency components and scene recognition of natural images**

56

Y Mizokami, S Sakaibara, H Yaguchi (Graduate School of Advanced Integration Science, Chiba University, Japan; e-mail: mizokami@faculty.chiba-u.jp)

We previously showed that colorfulness-adaptation was stronger in natural images than unnatural images, suggesting the influence of naturalness. However, it was not clear what kind of information was critical. Here, we investigate whether the effect of colorfulness-adaptation is associated with the spatial frequency components and/or the scene recognition of natural images. We examined how the colorfulness impression of a test image changed following to adaptation images with high or low saturation. We prepared a natural image and modified images: shuffled, low-pass filtered and high-pass filtered images with spatial frequency component different from the original, and phase-scrambled images with spatial frequency component similar to the original, for both adaptation and test images. Observers evaluated whether a test image was colorful or faded. They also evaluated the scene recognition of each image. Results showed that the colorfulness-adaptation was the strongest for the combination of natural (original) adaptation and natural test images. However, either the spatial frequency components or the recognition of images alone did not explain the strength of the adaptation effect, suggesting both factors would influence to the adaptation. This implies that mechanisms at the multiple levels of visual processing contribute to colorfulness-adaptation.

[Supported by JSPS KAKENHI Grant Number 24760036.]

◆ **Luminance distribution influence of surrounding colors on estimating illuminant color in a scene**

57

K Uchikawa, K Fukuda (Information Processing, Tokyo Institute of Technology, Japan; e-mail: uchikawa@ip.titech.ac.jp)

Illuminant color needs to be estimated in a scene to achieve color constancy. We previously showed that luminance balance of surrounding colors was an effective cue for estimating the illuminant, and proposed a hypothesis, in which the visual system chose the optimal-color surface best fit to surrounding colors under the illuminant (Uchikawa et al., J.O.S.A.A, 2012). The peak of the optimal-color surface corresponds the illuminant color. In the present study, to verify our hypothesis, we used different luminance distributions (convex, concave and flat) of surrounding colors, expressed in the luminance, redness and blueness of MacLeod-Boynton color space under three different simulated illuminants, 3000K, 6500K and 20000K. The surrounding field consisted of 60 colors, some of which were selected from optimal colors. The mean luminance of surrounding colors was equal among different distributions. Each color element subtended 2-deg. The observer adjusted both luminance and chromaticities of the center test field so that it appeared as the full white surface under the test illuminant. The results showed that chromaticities of the illuminant were estimated independently from luminance distributions

Tuesday

of surrounding colors for all illuminants, but the luminance of the test field was dependent on them, supporting our optimal-color surface hypothesis.

[This study is supported by JSPS KAKENHI 22135004 and 25245065.]

◆ **Colour impacts recognition of affective meaning in emoticons**

58 P Chassy, G V Paramei (Psychology, Liverpool Hope University, United Kingdom; e-mail: parameg@hope.ac.uk)

Emoticons for conveying emotional states in computer-mediated communications are conventionally coloured yellow. However, because emotions are associated with certain colours (Suk & Irtel, 2010), it is conceivable that congruency facilitates emotion recognition. We used emoticons conveying positive (ecstatic, happy, surprised and mischievous) or negative emotions (anger, annoyance, worry, contempt); their colour varied between grey, red, green and blue. Emoticons were presented in colour-counterbalanced blocks of 16 trials (8 emoticons; each with valence-congruent or incongruent flankers). Participants (N = 59; M = 23±5.5 years) were instructed to identify as quickly as possible whether the target emoticon conveyed a positive or negative emotion by pressing 'up' or 'down' arrow keys respectively. Colour was found to have a significant effect on identification times ( $F(3,174) = 2.11$ ,  $p = 0.05$ , directional), with fastest responses to grey emoticons. Valence of the target emoticon also influenced identification times ( $F(1,58) = 31.61$ ,  $p < 0.01$ ): positive emotions were identified faster ( $M_P = 0.89 \pm 0.26s$ ) than negative ( $M_N = 0.94 \pm 0.32s$ ). Similarly, positive flankers exceeded negative in their distraction impact on emotion identification times ( $M_P = 0.95 \pm 0.30s$  vs.  $M_N = 0.89 \pm 0.29s$ ),  $F(1,58) = 12.32$ ,  $p < 0.01$ . The results suggest an effect of colour on recognition of emoticon affective meaning. The finding has implications for optimisation of computer-mediated communication.

[The authors thank Claire Goley for help with data collection.]

**POSTERS: CLINICAL II**

◆ **Psychophysics of two experimental video-based interventions for phantom limb pain in unilateral and bilateral amputees**

59 D H Peterzell<sup>1,2,3,4</sup> (<sup>1</sup>Psychology, Naropa University, USA; <sup>2</sup>Psychology, UC San Diego, USA; <sup>3</sup>Psychology, Fielding Graduate University, USA; <sup>4</sup>Psychology, JFK University, USA; e-mail: davidpeterzell@mac.com)

It is widely reported by Ramachandran and colleagues that simple mirror reflections can cause phantom sensations in normal observers and reduce phantom limb pain in amputees. Two visual conditions were created that intensify these effects, and sometimes reduce phantom pain when the simple mirror is ineffective. The first (video feedback, Peterzell, 2012) uses a laptop video movie of another (intact) person's limb movement (with timed periodic movement). The second (phantom pulse, Peterzell, 2010, 2011) uses a real-time video image of the observer that flickers between a normal image and a mirror-reversed image at rates varying from 0.5 to 2 cycles/sec (with an 0.2-sec delay). Pain reduction was measured using the Trinity Amputation and Prosthetic Experience Scale (TAPES), Short Form McGill Pain Questionnaire (SF-MPQ) and Descriptor Differential Scale (DDS). For both conditions, new data from amputees support the finding that movement of one limb causes phantom sensations in the opposite limb, followed by seemingly permanent pain reduction in some amputees. Moreover when normal observers view their movements in these ways, they often report paresthesias, with optimal stimulation occurring in most individuals at 1-2 Hz. Thus psychophysical results imply that neural mechanisms underlying mirror therapy for phantom limb pain are temporarily tuned.

◆ **Visuomotor timing and sense of agency in a phantom limb: a case study**

60 S Imaizumi<sup>1</sup>, T Asai<sup>2</sup>, N Kanayama<sup>3</sup>, M Kawamura<sup>4</sup>, S Koyama<sup>1,4,5</sup> (<sup>1</sup>Graduate School of Engineering, Chiba University, Japan; <sup>2</sup>NTT Communication Science Laboratories, NTT Corporation, Japan; <sup>3</sup>Institute of Biomedical and Health Sciences, Hiroshima University, Japan; <sup>4</sup>School of Medicine, Showa University, Japan; <sup>5</sup>School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore; e-mail: skoyama@faculty.chiba-u.jp)

Some amputees report having experienced a phantom limb, sensing voluntary movement in their amputated limb when viewing mirrored images of their intact limb superimposed onto the phantom. Although delayed visual feedback to an action can reduce sense of agency (Asai & Tanno, 2007), its effect on phantom motor sensation (i.e., sense of agency in the phantom limb) has not been elucidated. We examined the effect of delayed visual feedback on phantom motor sensation in a male upper-limb amputee. In the experiment, he viewed mirrored video images of his intact right hand clasping and

unclasping in a flat monitor placed in front of his left arm, and rated the intensity of phantom motor sensation. There were three delay conditions (0, 250, and 500 ms). Results showed that phantom motor sensation decreased when the image was delayed by 250 and 500 ms. However, when we instructed him to adjust the phase of phantom movement to that of the image with a 500-ms delay, phantom motor sensation increased. Furthermore, the intensity of phantom motor sensation was positively correlated with electromyographic activity on his stump. These results suggest that delayed visual feedback reduces phantom motor sensation, which is modulated by top-down effects.

[This work was supported by Grant-in-Aid for JSPS Fellows (25-943) to Shu Imaizumi from Japan Society for the Promotion of Science.]

◆ **Perceptual learning improves vision in patients with macular degeneration**

61 G Contemori<sup>1</sup>, M Maniglia<sup>2</sup>, C Casco<sup>1</sup> (<sup>1</sup>Department of General Psychology, University of Padova, Italy; <sup>2</sup>Centre de Recherche Cerveau & Cognition (CerCo) Toulouse, CNRS France, (France); e-mail: giulio.contemori@studenti.unipd.it)

Macular degeneration (MD) leads to de-afferented input to the foveal cortex, resulting in a loss of central vision, contrast sensitivity and visual acuity (VA). The question of whether perceptual learning (PL) can improve peripheral vision is of great clinical interest. PL stimuli consist of a configuration of a low contrast Gabor patch flanked by two collinear high contrast Gabors presented monocularly in the parafovea. We measured contrast-detection thresholds using a Yes/No forced choice task (three MD, three controls, allowing for no feedback) and/or a temporal-2AFC task (two MD and three controls). Both tasks produce a significant increase in contrast sensitivity in trained targets; depending on target-to-flanker separation only in temporal-2AFC tasks. Furthermore, in both tasks PL has been shown to improve VA. However, only the subjects performing the 2AFC task showed reduced crowding and improved contrast sensitivity to untrained spatial frequencies. Although PL is more effective in temporal-2AFC tasks, the effect is also present in Yes/No tasks, suggesting that PL reflects sensory enhancement rather improvement in decision mechanisms. Most importantly, a follow-up of one patient showed that a PL effect was retained for 8 months, suggesting that the effects resulted from neuroplastic changes in the visual cortex.

◆ **Age related changes in perceived display brightness**

62 G Ikaunieks, I Krastina, R Truksa, G Krumina (Department of Optometry and Vision Science, University of Latvia, Latvia; e-mail: gatisik@lu.lv)

Perceived brightness of display luminance usually changes with age. Older subjects have increased level of retinal straylight which causes disability glare. Another important factor is retinal illumination. It decreases with age due to absorption of the lens and due to a reduction in pupil size. The aim is to assess preferred level of display luminance for young and older subjects when different contrast stimuli are showed and to find out main optical factors which could affect these results. 18 young subjects age of 20 to 24 years and 10 older subjects age of 55 to 69 years participated in this research. Task was using method of adjustment to find out the acceptable level of display luminance when reading low (20%) and high (>90%) Weber contrast text. Pupil size was determined in each condition. Measurements were done in dark room. Results showed that with high contrast stimuli older subjects chose lower ( $p < 0.05$ ), but with low contrast stimuli subjects chose the same level of background luminance as young group. Results were not correlated with pupil size. We can conclude that influence of different optical factors on preferred level of background luminance for older subjects depend on stimulus contrast.

[Supported by ESF project No.2013/0021/1DP/1.1.1.2.0/13/APIA/VIAA/001]

## POSTERS: MULTISENSORY PROCESSING II

◆ **The role of physical exploration in the preference of spatial perspective in absence of vision**

63 I Santoro, F Sors, G Angelon, M De Tommaso, T Agostini (Department of Life Sciences, University of Trieste, Italy; e-mail: ila.santo@virgilio.it)

Visual experience is a crucial factor for the development of spatial representation ability, as it provides global and immediate information. However, also people with visual impairment could adequately build up a mental representation of space, based on integration of multisensory cues, such as tactile or idiothetic information. Several research, providing participants with a verbal description of a space, have highlighted differences in the preferred perspective – egocentric or allocentric - of spatial representations for sighted and visually impaired people. Our study aimed to test the perspective of spatial representation, after the physical exploration of space, in order to provide participants with idiothetic information.

Tuesday

Moreover, in this way we avoid the influence of verbal description, which anchors participants to a single orientation. We tested both visually impaired people and blind-folded sighted, asking them to explore autonomously a room having several objects inside, and then to perform a Sentence Verification Task. Each sentence was verbally presented both in an egocentric and in an allocentric version. We measured both response time and accuracy. Data show differences in response time with egocentric and allocentric sentences for sighted and visually impaired participants, suggesting that personal visual experience could modulate the preference for spatial perspective.

◆ **Emotion recognition: Just how similar are voices and faces?**

64 L K Kuhn, L Garrido, T N Wydell (Psychology, Brunel University, United Kingdom;  
e-mail: lisa.kuhn@brunel.ac.uk)

Objectives: We aimed to investigate how similar the recognition of the six basic emotions across two independent modalities, -visual (faces) and auditory (voices) is. In particular, this study investigated whether happiness (Becker et al., 2011) or anger (Damjanovic et al., 2013) superiority effects are predominantly a feature of visual emotion recognition or whether they are also observable within the auditory domain. Methods: 49 English adults (18 male, 31 female, aged 18-61, M = 30.8) rated Ekman faces (Ekman, 1976) as well as non-verbal vocalisations (Belin, Fillion-Bilodeau & Gosselin, 2008) for perceived emotion intensity. Results: Faces received higher intensity ratings than voices, especially for happiness, fear and surprise. Happy and surprise stimuli received highest intensity ratings and anger received the lowest intensity ratings in both modalities. The same pattern was observable for reaction times. Additionally, confusion matrices of the six basic emotions are highly correlated across the two independent modalities. Conclusion: The happiness superiority observed both within facial emotion recognition and vocal emotion recognition, combined with the highly similar confusion matrices across modalities, suggests that modality independent mechanisms are crucial for emotion recognition.

[This study has been funded by the ESRC studentship to the first author.]

◆ **The effects of head and retinal-image orientations on apparent depth of light-and-shade pictures**

65 A Higashiyama, T Yamazaki (Psychology, Ritsumeikan University, Japan;  
e-mail: achan@lt.ritsumei.ac.jp)

It is well documented that the pictures that are painted with light and shade emphasize their apparent depth. This description presupposes that an upright observer views the normal pictures and the light of the pictures comes from above. If the pictures are viewed upside down, we would obtain a totally different perception regarding depth. What does happen when the pictures are viewed on the ceiling or on the floor at the feet? The head orientation then changes while the retinal image orientation remains the same as when the upright observer views the normal pictures. If the visual system allows for the gravity that is perceived through the proprioceptive system, the pictures on the ceiling are more likely to appear convex than the pictures on the floor. But, if the retinal-image orientation is exclusively critical, apparent depth would not change independently of head orientation. In two experiments, we presented seven light-and-shade pictures in different orientations and the observers judged whether each picture appeared convex or concave while looking at it forward, upward, or downward. We found that retinal-image orientation was consistently effective for all pictures and head orientation was effective only for limited pictures.

◆ **The role of spatial and temporal information in passage estimation of looming stimuli**

66 R M Silva<sup>1,2</sup>, S Mouta<sup>1,3</sup>, J Lamas<sup>1,3</sup>, J A Santos<sup>2,3,4</sup> (<sup>1</sup>INESC-TEC, INESC-Porto, Portugal;  
<sup>2</sup>Psychology, University of Minho, Portugal; <sup>3</sup>Centro de Computação Gráfica, Portugal; <sup>4</sup>Centro Algoritmi, University of Minho, Portugal; e-mail: mariana.macedo.silva@gmail.com)

Estimating the time remaining for certain objects to approach us in specific points in space is part of our daily routines. Extracting spatiotemporal information in order to respond to looming objects has been widely studied in the visual modality. Moreover, several studies tested the effect of visual stimuli's occlusion in performance. However, modality may affect the role of different perceptual cues. Our goal is to understand the role of auditory and visual modalities in the perception of looming events. We found that participants were quite accurate in estimating the time remaining for an auditory looming stimulus to pass or contact them. Interestingly, we found a change in the perceptual strategy with higher uncertainty on the task. In a time-to-passage task, with a 50% stimulus' occlusion, the final distance of the stimuli was more informative for the judgment than temporal variables. We are especially interested in understanding the cues that most contribute to participants' performance on both visual and auditory

modalities. We aimed to understand if continuous or intermittent information influence the accuracy and precision of passage's judgment. This way, we would control whether variations on spatial and/or temporal information has an impact in the estimation of time remaining for passage.

[Supported by Fundação Bial (Grant 77/12) and Fundação para a Ciência e Tecnologia - EXPL/MHC-PCN/0162/2013, SFRH/BPD/ 63393/2009; FCOMP-01-0124-FEDER-022674 and PESt-C/CTM/U10264/2011; FCOMP-01-0124-FEDER-037281 and PESt-C/EEI/LA0014/2013. This work was financed by FEDER grants through the Operational Competitiveness Program – COMPETE]

◆ **May the Force be with you: Anisotropy of perceived effort and different body orientations**

67 L M Jovanović, O M Tošković (Laboratory for experimental psychology, Faculty of Philosophy, University of Belgrade, Serbia; e-mail: ljubica.jovanovic.90@gmail.com)

Previous research showed that perception of effort invested in movement is anisotropic: effort is perceived as greater if movement opposes the direction of gravity than movement performed opposite direction. Aim of two present experiments was to examine whether this effect can be attributed to on site gravity integration in effort perception, internal model of space (based on gravity integration) or muscles constitution. In first experiment 12 participants, lying on their left side, estimated invested effort presented on one direction and reproduced it on the other. Instrument was dynamometer, by whose extension standards of 2, 4 and 6kg were presented to subjects on two directions: subjective vertical (movement in the line with the body) and subjective horizontal (movement orthogonal to the body). Movement on subjective horizontal was perceived as more difficult than the one on subjective vertical. In the second experiment, twelve people had the same task, but they were lying on their back while performing movements. In this condition, movement in direction of subjective vertical was perceived as more difficult. These findings suggest that when perceiving effort in different directions system adjusts internal model of space (based on gravity integration) according to current gravity direction.

## POSTERS: SENSORY DEVELOPMENT AND AGING II

◆ **Audio-visual interactions in face and voice perception in older adults**

68 C Maguinnc, F N Newell (School of Psychology and Institute of Neuroscience, Trinity College Dublin, Ireland; e-mail: maguinnc@tcd.ie)

Although studies show that dynamic facial information can enhance speech perception, recent evidence suggests that audio-visual (AV) integration is also relevant for person recognition. For example, speaker recognition is enhanced when the voice is accompanied by its corresponding facial identity and voice information can also enhance face recognition. These findings suggest that identity information is shared across the senses, yet little is known about whether ageing affects AV integration in person recognition. To that end, in separate experiments, younger and older adults learned a bimodal stimulus comprising of a voice accompanied by a static image or a time synchronised video of the corresponding facial identity. Following a short delay, in a 2IFC, participants matched the voice or face with the learned identity. Matching voices contained learned or novel speech content whereas matching faces displayed a learned or novel pose. While we found older adults' speaker matching performance was poorer than younger adults', performance improved when a dynamic rather than static face accompanied the voice. In parallel, face matching was worse when a static than dynamic face accompanied the voice. Our results suggest that cross-modal spatiotemporal cues likely mediate face and voice interactions and that these cues remain accessible with ageing.

[Funded by The Innovation Academy, Trinity College Dublin]

◆ **Face perception across the life-span**

69 B Meinhardt-Injac (Department of Psychology, Johannes Gutenberg University Mainz, Germany; e-mail: meinharb@uni-mainz.de)

Perception of faces and watches has been studied in children (8-10; 11-13, 14-15 years), young adults (20-30 years) and older adults (65-82 years) in a contextual congruency paradigm (Meinhardt-Injac, et al., 2011; Meinhardt-Injac, 2013). In the current study, selective attention to parts of stimuli is required (i.e., internal features –eyes, eyebrows, nose, mouth in faces/ clock face in watches), while the unattended context (i.e., hair, head- and face- outline in faces/ clock-case in watches) may be either congruent or incongruent with the expected identity judgment. The data revealed lower performance in children and older adults compared to young adults, irrespectively of the stimuli class (faces/ watches). In addition, there was a face-specific impairment in the performance of older adults and children, where face matching was less accurate than object matching. Holistic effects (i.e., context effect and orientation



Tuesday

effect) were clearly restricted to faces at any age tested, but particularly strong in older adults. The nature of the mechanisms underlying visual perception in childhood, adulthood and late adulthood is discussed with respect to the face-specific perceptual development theory.

◆ **Early childhood tuning for facial expression signal and intensity**

70 H Rodger, R Caldara (Psychology, University of Fribourg, Switzerland;  
e-mail: helen.rodger@unifr.ch)

Behavioural studies of facial expression recognition during development have applied various methods to establish by which age different expressions can be recognized. Unique recognition trajectories have been found for the basic emotional expressions; however the diverse methods have not investigated the ontogenesis of all of the expressions together under the same paradigm, from early childhood to adulthood. To clarify this issue and quantify visual information use for recognition of the 6 basic emotional expressions from early childhood up to adulthood, we implemented a novel psychophysical approach. Using the QUEST threshold seeking algorithm we correlated (1) the quantity of signal necessary to recognise an emotional expression normalized for contrast and luminance, and (2) the expression intensity (using neutral-expression image morphs) necessary for each observer to recognise the 6 basic emotions. Both measures revealed that fear and happiness were the most difficult and easiest expressions to recognise across development. As predicted, recognition thresholds for both measures improved with age; however the correlation between signal and intensity remained stable from age 5. Our data show that there is an early tuning for diverse information use to achieve expression recognition. This tuning is refined throughout development but not fundamentally shifted.

◆ **Testing two theories of size constancy development in childhood**

71 C E Granrud<sup>1</sup>, M Kavšek<sup>2</sup> (<sup>1</sup>School of Psychological Sciences, University of Northern Colorado, USA; <sup>2</sup>Department of Psychology, Unit of Developmental and Educational Psychology, University of Bonn, Germany; e-mail: carl.granrud@unco.edu)

The ability to estimate a distant object's size improves during childhood. According to the perceptual learning theory, this change results from increasing sensitivity to visual cues. In contrast, the metacognitive theory proposes that this change results from the development of strategy use. We tested these theories in several experiments. Participants viewed standard discs at near (6.1 m) and far (61 m) distances, and chose from a set of nearby discs one that matched the standard. Self-reported strategy use increased between 5 and 11 years of age. Nevertheless, children who reported that they deliberately inflated their size estimates to compensate for the effects of distance (i.e., strategy users) made accurate size estimates or overestimated size at the far distance regardless of age. Those who reported no strategy use (strategy nonusers) consistently underestimated size at the far distance. Strategy users' and nonusers' size estimates did not differ at the near distance, indicating that these groups did not differ in motivation, task proficiency, or sensitivity to visual cues. Contrary to predictions from the perceptual learning theory, monocular vs. binocular viewing had no effects on children's size estimates. Overall, our findings support the metacognitive theory and conflict with the perceptual learning theory.

## POSTERS: VISUAL SEARCH

◆ **Independent effects of perceptual set-size and VWM load on target discriminability in visual search**

72 D J K Barrett (School of Psychology, College of Biological and Medical Science, University of Leicester, United Kingdom.; e-mail: djkb1@le.ac.uk)

Simultaneous search for two targets is often slower and less accurate than independent searches for the same two targets. Within the SDT framework, this can be attributed to the division of attentional resources across multiple stimulus sets during search (Palmer, Ames & Lindsey, 1993). The current study used one or two cues to elicit single- and dual-target searches for orientation-defined targets in a "yes-no" response task. In Experiment 1, a method of constant stimuli was used to manipulate target-distractor similarity ( $\pm 0$  to  $30^\circ$ ) in displays with a set-size of one. The results revealed comparable sensitivity ( $d'$ ) and response bias (Crit.) on single- and dual-target searches. In Experiment 2,  $d'$  and Crit. were compared on single- and dual-target searches at set-sizes of 1, 2 and 4. The results revealed a decrease in  $d'$  as set-size increased, which approximated the inverse square root predicted by SDT models of search. A significant decrease in  $d'$  that was independent of set-size was also observed on dual- compared to single-target searches. The results reveal independent effects of set-size and visual working memory (VWM) load on target discriminability during search.

◆ **Ocular contrast speeds up an inefficient search for a T among L's which appear in non-uniform depth**

73

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An eye-of-origin singleton, e.g., a bar shown to the left eye among identical bars shown to the right eye, captures attention whilst nevertheless not being distinctive (Zhaoping, 2008). For instance, observers in an easy visual search task (say for a uniquely oriented target bar against a background of uniformly oriented bars) can be significantly distracted by a non-target bar which is such a singleton. This concept has been generalized to the case that a bar is shown to both eyes (at a depth defined by its disparity), but with respective contrasts  $C_L$  and  $C_R$  for left and right eyes. The ocularity of the bar is defined as  $(C_L - C_R)/(C_L + C_R)$ ; if it is sufficiently unique, i.e., has sufficient ocular contrast from other elements in the display, then it can still be salient and attract attention (Zhaoping, 2010), albeit less powerfully than a pure eye-of-origin singleton. Here, we extend this to the search for a letter T among letter L's displayed at non-uniform depths; search is faster for a target T with a sufficient ocular contrast from background L's. These observations support the proposal that V1 creates a bottom-up saliency map (Li, 2002).

[Supported by The Gatsby Charitable Foundation]

◆ **Pupil size reflects memory load only for fixated targets**

74

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Pupil size is known to be sensitive to memory load. Items outside the focus of attention can increase memory load; is pupil size sensitive to these items as well? While recording eye movement and pupil size, we presented, first, a display containing 3, 4 or 5 targets among distractors. Both occurred in various orientations. In a subsequent display, in half of the cases the orientation of one of the targets was changed. Participants reported whether a change had occurred. When trials with correct responses were grouped according to the number of targets fixated (irrespective of the number of targets presented), pupil size at the first (search) stage of the task increased linearly with the number of targets. No such increase was observed for the number of targets present per se (i.e. irrespectively of whether they were fixated). Pupil size, therefore, is sensitive only to memory for targets that are fixated; not to memory for ones scanned peripherally.

◆ **Positional priming of pop-out is nested in visuospatial context**

75

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The present study investigated facilitatory and inhibitory positional priming using a variant of Maljkovic and Nakayama's (1996) priming of pop-out task. The search items were arranged as Z- or T-configurations (Garner & Clement, 1963) and varied across trials. These conditions made it possible to assess positional priming of target and distractor locations on consecutive trials of repetitions vs. changes of item configurations. Three inter-trial transitions were present: configuration-repetition, configuration-change, and category-change. An object category was defined as a set of unique geometrical elements, sharing features that are perceptually distinct from elements of other categories (Z vs. T category). A configuration, by contrast, was defined by a particular element in a given item category ("└" in the Z-category or "┘" in the T-category). Target facilitation was dependent on the repetition of the exact item configuration, while the inhibitory effect was coarser and influenced by the repetitions vs. changes of the item's visuospatial category. These findings show that single items are buffered in visual short-term priming memory by means of configural rather than absolute, i.e., location-based representations. They further show that target location facilitation and distractor location inhibition represent distinct memory phenomena.

◆ **Search strategies in simulated hemianopia**

76

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Damage to visual brain areas typically leads to a loss of sensitivity in a portion of visual field, referred to as hemianopia. During search, patients with hemianopia tend to direct eye movements toward the intact portion of visual field. This is thought of as a sub-optimal search strategy because it causes a larger proportion of the search array to fall within the damaged field, so rehabilitation programs often

Tuesday

train patients to make large eye movements into their damaged field. But this strategy may also be sub-optimal, depending on where and what kind of information is present in both the damaged and intact field. We examined eye movements in healthy controls during search for an emotional face when information from one half of the search display was degraded or removed, contingent on gaze position. The majority of participants saccade towards the intact field first and then saccade into the “damaged” field. This strategy is associated with longer search times. However, more, and larger, saccades are executed into a field when no information is available in it relative to when low-spatial frequency or search item location information is available. The results are discussed in the context of what constitutes optimal search behaviour.

[Supported by the ESRC and James S McDonnell Foundation]

◆ **Haptic search for change with blind people**

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Haptic perception of two-dimensional images—recognised easily by sight but not by touch—makes heavy demands on our working memory. During active exploration, we need to store not only the latest local sensory information, but also integrate this with kinaesthetic information of hand and finger locations to generate a coherent percept. We tested the active search process and working memory storage of tactile exploration as measured in a tactile change detection task. We previously reported a series of experiments demonstrating considerably longer search times and slower process speeds per item during tactile than visual exploration to detect change. This indicated an extremely small estimated tactile memory held during search and potentially little or no cross-position integration in two-dimensional tactile perception. Here, we tested possible contributions of past visual and tactile experiences, in the early, congenitally and adventitiously blind populations. Their serial search process and small estimated working memory capacity were quite similar to normal participants', confirming our previous findings on limited tactile information integration across hand movements. These results suggest that information capacity at the higher level is similar across blind and sighted populations. Cognitive differences, if any, may be attributed to hand movements or information sampling strategies. [Supported by COI-T & JST.]

◆ **Intuitive cost optimization: trade-off between acquisition and memorization in comparative visual search**

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In view of optimizing task performance, the application of body movements (enabling acquisition) and visual working memory (enabling memorization) must be balanced based on their occurring costs and the task constraints resulting in a trade-off between acquisition and memorization strategies. For changing costs (memorization as well as acquisition), it could be shown that this trade-off was adapted adequately in a robust and time cost-optimized manner. Now, we present continuing results concerning trade-off adaptations in a simplified version of a comparative visual search paradigm where costs for acquisition as well as memorization can be manipulated easily. In order to control time available for actions, a mask (covering always one stimulus array) must be shifted between the two search-arrays by using the mouse buttons. Here, costs for acquisition were manipulated by changing the time subjects had to wait before the mask moved and new information of the other array could be perceived. Additionally, the costs for memorization were manipulated by using stimuli with varying complexity regarding perception as well as memorization. The overall results show a robust, significant, but differing degree in trade-off adaptation depending on the manipulated task constraints (costs) and the individual subjects.

◆ **Testing load theory of attention: ignoring irrelevant distractor**

79 M Milisavljević, V Gvozdrenović (Laboratory of Experimental Psychology, University of Belgrade, Serbia; e-mail: milisavljevicm@gmail.com)

Load theory of attention suggests that insufficient capacity for processing prevents subjects from perceiving irrelevant distractor in high perceptual load tasks (LaVie et al, 2004). The aim of our research was to test proposed theory in visual search task, since in their researches authors used choice response tasks. Participants were asked to search for oblique line among horizontal or vertical ones, while ignoring irrelevant distractor. Independent variables were target presence, task difficulty (depending on

angle of rotation of target), distractor (there could be no distractor, or it could be oriented in the same direction as target, or in opposite direction) and set size. Dependent variable was reaction time. Only target-present sets were analyzed. Significant effects of factors task difficulty ( $F(1,11)=118.05$ ,  $p=.000$ ) and distractor ( $F(2,22)=17.436$ ,  $p<.01$ ) were obtained, as well as significant interaction of task difficulty and distractor ( $F(2,22)=17.281$ ,  $p<.01$ ). Analysis showed that in simple tasks there was no effect of irrelevant distractors, while in difficult tasks reaction times were shortest when there was no irrelevant distractor, and longest when distractor was rotated in opposite direction than target. Obtained results suggest that irrelevant distractor disturbs performance only in high perceptual load task, which does not support assumptions of load theory.

[Research supported by Ministry of Education and Science, Grant No.179033 ]

◆ **Target knowledge in visual search does not always improve performance**

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Influential models assume that target features are used to preferentially select individual items with these features during visual search. We tested this guidance-by-feature assumption in four experiments by informing participants about either: the target colour, its orientation, its size or its motion. Participants searched for T amongst L's. The target feature was shared either by all search items (100% eligibility) or only half of the search items (50% eligibility). If features indeed guide search, reaction times (RTs) should improve for both absent and present trials when eligibility falls to 50%, since there are fewer potential targets. Colour knowledge improved RTs on both present and absent trials. Motion knowledge improved RTs only on absent trials. For orientation knowledge, RTs actually became worse on absent trials. Size knowledge effects were target-dependent. Small targets yielded RT improvements on absent and present trials. Big targets yielded no improvement whatsoever. This pattern of results argues against simple guidance-by-feature accounts. It is more consistent with models where summary statistics pooled across several items are used to decide on target presence. Colour can be used to exclude items from pooling, but orientation and motion cannot. Moreover, increased orientation heterogeneity reduces the diagnostic value of the summary statistics.

[This work was supported by a grant from the Leverhulme Trust (F/00 181/T)]

◆ **A direct contribution of peripheral vision to preview facilitation in visual search**

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Preview of a real-world scene facilitates the visual search of a target object through that scene (preview facilitation). It has been suggested that a single snapshot may be sufficient to improve visual search by binding target object to scene location. However, it remains unclear which information of the visual field is extracted during this snapshot. Here, we investigated the importance of visual information gathered by central and peripheral vision for preview facilitation. Seventeen subjects were involved in a visual search task with brief (200 ms) preview snapshots. The scenes were complex real world images (180°x55°) and the snapshots showed only a circular portion of those scenes (0°-30° diameter) centered on the target objects. We observed a rapid reduction of visual search time, similar to an exponential decay, as the snapshots' size increased. Crucially, the addition of peripheral information (20, 30°) in the snapshots reduced the visual search time compared to conditions with central information only (2, 5, 10°). Consequently, even during a very brief exposure to complex visual scenes, peripheral information is extracted and stored to facilitate subsequent visual search. These results demonstrate a direct contribution of peripheral vision to preview facilitation in visual search.

◆ **Winter is coming: How humans forage in a temporally structured environment**

82 D Fougne<sup>1,2</sup>, J Zhang<sup>2</sup>, S M Cormiea<sup>1</sup>, X Gong<sup>3</sup>, G A Alvarez<sup>1</sup>, J M Wolfe<sup>2,4</sup> (<sup>1</sup>Psychology, Harvard University, USA; <sup>2</sup>Surgery, Brigham & Womens Hospital, USA; <sup>3</sup>Psychology, Wheaton College, USA; <sup>4</sup>Ophthalmology & Radiation, Harvard Medical School, USA; e-mail: darylfougne@gmail.com)

Much is known about visual search for single targets, but relatively little about how participants "forage" for multiple targets in multiple displays. In foraging tasks, one important question is how long participants will search before moving to the next display. Optimal foraging theories suggest that

Tuesday

observers leave when intake drops below the average rate. This theory is typically tested in random or uniform environments. However, the real world has temporal structure (e.g. seasons) that could influence foraging behavior. Does it matter if winter is coming and the next trial will be reliably worse than the last? In our task, participants were given displays comprised of 64 items mixing targets (Ts) and distractors (Ls). There were 0-10 targets per display. The number of targets per trial was either structured—rising and falling systematically—or random. Participants were asked to collect targets as fast as possible, and could move to the next trial at any time. In the structured condition, observers searched displays for longer when quality was falling compared to rising ( $p < .005$ ) showing that foraging behavior is affected by temporal context. These results demonstrate that foraging theories in visual search need to consider richer models of observers' representations of the world.

◆ **Repeated visual search: How good is the memory across searches?**

83 M Höfler<sup>1</sup>, I D Gilchrist<sup>2</sup>, C Körner<sup>1</sup> (<sup>1</sup>Department of Psychology, University of Graz, Austria; <sup>2</sup>School of Experimental Psychology, University of Bristol, United Kingdom; e-mail: ma.hoefler@uni-graz.at)

If the same display is searched consecutively twice for different letter targets, the target of the second search is found faster if it was inspected recently during the first search (Höfler, Gilchrist, & Körner, 2014). However, such memory for recently inspected items may not be perfect since participants need on average four fixations to find the second target. To delineate this memory imprecision in greater detail, we analysed the eye movements of participants who performed a repeated visual search task. The results showed that the second target was found immediately (within one or two fixations) in about 40 percent of the trials when it was inspected most recently during the first search; this indicates an almost perfect memory for such cases. This percentage decreased however with decreasing target recency and approached a baseline (reflecting memory-less search) for less recent items. The results also suggest that the impact of memory may be weakened by a bottom-up driven oculomotor behaviour in the second search: Participants fixated items located „on-the-way“ between the starting point of the search and the target. Together, these results imply that the memory representations involved in repeated search are to some extent imprecise and vulnerable to bottom-up factors.

◆ **How colour signals benefit visual search**

84 J D Hickey, J L Barbur, M Rodriguez-Carmona (Optometry and Vision Science, City University London, United Kingdom; e-mail: joseph.hickey.1@city.ac.uk)

When a stimulus of interest is amongst many distractors, the visual search (VS) time needed to find the stimulus is affected in different ways by the spatial, chromatic or temporal properties that differentiate the stimulus from distractors. Large colour signals can often shorten VS times by transforming what is essentially a serial into a parallel mode of visual processing. Small colour signals are less effective, largely because red / green chromatic sensitivity decreases rapidly with eccentricity, but this is less so when yellow / blue colours are involved. When the subject's task is to locate spatial features such as the gap orientation in a Landolt ring stimulus, the luminance contrast of the stimulus becomes an important parameter in determining VS times. In normal trichromats, the addition of other features such as colour changes the 'effective contrast' of the stimulus and also enlarges the spatial extent of visual processing within each glimpse which leads to shorter VS times. A number of findings that illustrate how the polarity of luminance contrast and the strength of red-green and yellow-blue colour signals interact and how these in turn affect VS times will be presented together with unexpected findings in subjects with congenital, red-green deficiency.

## POSTERS: VISUAL MEMORY

◆ **Independent effects of resolution and set size on recognition memory for unfamiliar faces**

85 T O Onwuegbusi, H D Flowe, D J K Barrett (Psychology, University of Leicester, United Kingdom; e-mail: too5@le.ac.uk)

Visual working memory (VWM) is a limited-capacity resource for the temporary storage of visual information (Cowan, 2001). Selective visual attention can protect VWM capacity by filtering relevant from irrelevant information during encoding or maintenance (Griffin & Nobre, 2003). The current study was designed to investigate the consequences of attentional selection on the accuracy of recognition for unfamiliar faces. We used a Change Detection task to measure  $d'$  for cued and uncued faces in displays of 1, 2 and 4 faces, in a free-view (Experiment 1) and single-fixation (Experiment 2) displays. In both experiments, recall accuracy was greater for cued than uncued faces. Recognition accuracy was

also higher in free-view compared to single fixation displays and declined as a function of set size. This suggests the acquisition of high spatial frequency information during saccadic sampling improves recognition memory. Importantly, this advantage appears to be independent of the decrease in accuracy associated with set size, indicating that increasing the resolution of memoranda in VWM does not dilute resources in the same way as increasing the number of objects to remember.

◆ **The influence of dimensional attention on perceptual comparisons of features**

86 M Pilling (Psychology, Oxford Brookes University, UK; e-mail: mpilling@brookes.ac.uk)

Two experiments investigate if and how dimensional attention influences perceptual comparisons of features. Observers viewed two consecutive multi-item stimulus displays separated by a 600 ms ISI. In Experiment 1 observers reported on feature changes, reporting whether any item's feature changed across the two displays. On 'yes' trials a change could occur either to the colour or shape of one display item; on 'no' trials all item features remained the same. In Experiment 2 observers reported on feature identity, reporting whether any item's feature was the same across the displays (on 'yes' trials one feature of one item was the same across the two displays - all others changed; on 'no' trials all features on all items changed). Observers were given verbal cues which indicated the feature dimension of the change (Experiment 1) or identity (Experiment 2). The cue (80% valid on 'yes' trials) was given prior to the sample display, during the ISI, or during the test display. For both experiments valid cues were more effective than invalid cues only when presented prior to the sample display. This suggests that dimensional attention influences perceptual comparisons only to the extent that it permits selective encoding of the relevant features into VSTM.

◆ **Individual differences in masking sensitivity correlate with neural individuation abilities**

87 V Mazza, S Pagano (Center for Mind/Brain Sciences, University of Trento, Italy; e-mail: veronica.mazza@unitn.it)

Many studies indicate that the visual system can implicitly process a single stimulus under conditions of low visibility. However, it remains unknown whether this ability can extend to multiple stimuli and whether differences in early perceptual abilities can modulate the variability in masking sensitivity. We conducted two ERP/EEG experiments to evaluate these aspects. Participants enumerated a variable number (1, 2, 3) of target elements among homogenous distracters. Either one (Experiment 1, n=20) or all targets (Experiment 2, n=18) were masked through object substitution. Results showed that an ERP measure of selective individuation, the N2pc component, was modulated by target numerosity in both masked and unmasked trials, suggesting that multiple object individuation can operate in conditions of limited visibility. However, this effect was present only for participants with low masking effects, who overall showed more pronounced N2pc modulations as a function of target numerosity. Finally, Time/Frequency results revealed that early binding mechanisms, as reflected by gamma synchronization, were augmented in participants with low sensitivity to masking. The results indicate that individual variation in early perceptual functions is strongly associated with susceptibility to masking. In particular, more efficient binding and individuation mechanisms might prevent the visual system from being prone to masking.

◆ **Relationship of spatial memory to spatial and temporal aspects of multiple object tracking**

88 C J Howard, D Guest (Psychology, Nottingham Trent University, UK; e-mail: Christina.Howard@ntu.ac.uk)

There is a debate around the role of serial processes in multiple object tracking (MOT), with some suggesting that spatial information is updated serially (e.g. Oksama & Hyona, 2008). Spatial memory is necessary for serial component models. We therefore investigated the relationship between spatial memory performance and MOT. In the spatial memory task, participants viewed complex patterns and then made same-different judgements after a filler task. In the MOT task, participants tracked the locations of four discs amongst four distractors. At the end of each trial, participants were queried to report the final location of one of the targets. Memory performance, particularly under high load, was related to spatial precision in MOT. It was also related to temporal lags exhibited in responses. These lags, previously reported in MOT (e.g. Howard, Masom & Holcombe, 2011), indicate that responses are more similar to the recent past states of the target than its final state. Further, memory performance was also related to a task requiring perception of fine timescales, namely a flicker phase simultaneity judgement. These results suggest that spatial memory may be supporting performance in MOT and this is consistent with serial component models of tracking.

Tuesday

◆ **Remembering pictures and people: a familiarity-based dissociation**

89 R G M Armann, A M Burton (School of Psychology, University of Aberdeen, United Kingdom; e-mail: r.armann@abdn.ac.uk)

There are key differences between familiar and unfamiliar face processing which are often overlooked. Perception of unfamiliar faces seems to be more picture-specific, and less abstractive, than perception of familiar faces. Here we explored recognition memory for faces: in an initial stage, participants were shown images, and asked to remember the people they contained. In a recognition test, one group was asked to indicate whether they had seen the same image as in phase 1, whereas a second group were asked to indicate whether they had seen the same person. As expected, recognition was poorer for unfamiliar than familiar faces. However, this was driven mainly by a failure to recognise novel pictures of unfamiliar faces. When identical pictures were shown at learning and test, performance for unfamiliar faces was high. In general, performance for familiar faces was high except in one case: when viewers were presented with a new picture of a familiar person, and asked to indicate whether they had seen this particular image, they performed poorly. These results support the notion that recognition of unfamiliar faces is image-bound, whereas recognition of familiar faces is more abstract, relying on representations which do not retain visual details of a specific encounter.

◆ **Impact of feature-reward associations on iconic and working memory**

90 E Infanti, C M Hickey, M Turatto (Center for Mind/Brain Sciences (CIMEC), University of Trento, Italy; e-mail: infanti.elisa@unitn.it)

Reward plays a fundamental role in human behavior. A growing number of studies have shown that stimuli associated with reward become salient and attract attention. The aim of the present study was to extend these results into the investigation of iconic and visual working memory (VWM). In two experiments we asked participants to perform a visual search task where different colors of the target stimuli were paired with high or low reward. We then tested whether the pre-established feature-reward association affected performance on a subsequent memory task in which no external reward was provided. In this test phase participants viewed arrays of 8 objects, one of which had unique color that could match the color associated with reward during visual search. A probe appeared at varying intervals after stimulus offset to identify the to-be-reported item. Our results suggest that reward biases the encoding of visual information such that items characterized by a reward-associated feature interfere with mnemonic representations of other items in the test display. These results extend current knowledge regarding the influence of reward on early cognitive processes, suggesting that feature-reward associations automatically interact with the encoding and storage of visual information.

◆ **Visual short-term memory for surface reflectance properties across variations in illumination**

91 H Tsuda, J Saiki (Graduate School of Human and Environmental Studies, Kyoto University, Japan; e-mail: saiki@cv.jinkan.kyoto-u.ac.jp)

Retaining material properties such as surface reflectance in memory is considered a difficult task because the image presented by a material dramatically varies depending on the conditions of illumination so that we cannot simply match the raw image to a stored representation. Since studies of visual short-term memory have almost exclusively used a simple matching between study and test, very little is known about how people retain image properties across variations in illumination. To address this issue, we measured the precision of visual short-term memory for material surface reflectance properties by using feature matching tasks. Participants were presented with the image of a sphere and after the 1000ms retention interval, they adjusted the matching feature (specular reflectance or roughness) of the probe sphere. By using perceptual matching task as baseline, we assessed memory cost (drop of matching accuracy relative to baseline) under two illumination conditions (identical or different). Memory cost was relatively small under conditions where illumination was different between study and test compared to when illumination was identical. This suggests that under variations in illumination where image-based matching is prevented, people can still effectively extract and retain the surface reflectance properties. [This work was supported by Grant-in-Aid for Scientific Research on Innovative Areas "Shitsukan" (No. 25135719) from MEXT, Japan.]

◆ **How the change in location of an additional reference point affects spatial learning**

92 K Ohtsu (Graduate School of Education, Waseda University, Japan;  
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We previously reported that the layout of objects serving as spatial reference points affects spatial learning. In this previous work, participants explored a virtual circular room under one of two conditions: (1) square array condition where four objects were displayed in a square (like dots on dice) or (2) central node array condition where an additional object was added to the center. After a learning trial, participants judged the direction of targets from several imaginary positions in the virtual room. The results indicated that performance was better in the central node array than the square array. Therefore, in the present study using the same experimental procedures, we examined whether the introduction of an additional object produced an effect because it was centrally positioned or not. The results indicated that performance in the distorted central node array condition where an object was added to the interior of the array, but not in the center was better than in the central node array and worse than in the square array. These findings suggest that an additional reference point has an effect, even when it is not located at the center.

◆ **Pictorial detail provide conceptual hooks allowing for massive pictorial long-term memory**

93 K K Evans, A Baddeley (Psychology, University of York, United Kingdom;  
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Humans have an astonishing ability to remember with high fidelity previously viewed scenes with robust memory for visual detail. What affords them this massive pictorial long-term memory? We tested scene memory using a standard massive memory paradigm under intentional and incidental encoding with 100 exemplars from a heterogeneous (real complex scenes) and a homogenous (doors) image set and examined if aesthetic valence affects memorability of scenes. Observers unaware of the memory test performed at the same level as observers intentionally memorizing the heterogeneous image set ( $d' = 1.85$  for both groups) with memorability of images correlated across the two conditions ( $p < 0.01$ ). A similar result was found using a more constrained set, pictures of doors. However when the door pictures were made less discriminable by removing incidental detail, instruction to remember led to better performance ( $d' = .90$  intentional,  $d' = .68$  incidental). Perceived pleasantness of scenes had no effect on memory performance in either of the conditions with pleasantness rating increasing with familiarity ( $p < 0.02$ ). High fidelity encoding into pictorial long-term memory does not require any intent until there is not enough detail to provide conceptual hooks. The memorability of images is intrinsic to the images, reproducible under any encoding condition and independent from their aesthetic valence.

◆ **Sensory memory: a lingering memory trace from the time when perception was formed**

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As visual information is always incomplete, our brain accumulates sensory evidence over time to achieve an accurate representation of the world. We now show that this initial accumulation leaves a lingering memory trace, able to bias the perception of subsequent displays. Specifically, we suggest that this lingering sensory evidence manifests itself as a sensory memory: a facilitatory history effect observed in multi-stable perception. To demonstrate this, we employed an intermittently presented ambiguously rotating, asymmetric shape ("structure-from-motion") and systematically varied its orientation when the display resumed after being interrupted. Surprisingly, we found that it is not the most recently perceived states (near the end of the presentation interval) that are favored by the content of sensory memory. Instead, sensory memory favors the earliest perceived state, revealing a memory trace from the time at which perception was initially resolved. Our results demonstrate that sensory memory offers an opportunity to investigate the process of perceptual construction post hoc. It is potentially revealing about the time-course of perceptual inference, allowing us to characterize the representations involved in constructing perception, and predicting neural correlates of the accumulation of sensory evidence.

◆ **Perceptual groups do not improve spatial memory in a localisation task**

95 H H Haladjian (School of Social Sciences & Psychology, University of Western Sydney, Australia;  
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This study aimed to determine if "chunking" strategies are used to increase the capacity and accuracy of visual information processing into spatial memory. We tested subjects on a localisation task where we manipulated: 1) the total number of discs (3–9) on briefly-presented masked stimulus displays, and



Tuesday

2) the number of clusters these discs formed (one or two). Furthermore, in the two-cluster condition, the clusters could be presented simultaneously or sequentially (where one cluster of discs appeared on either the left or right side of the display, followed by the second cluster on the alternate side). The results indicate better performance for one-cluster displays for both enumeration accuracy (the number of responses placed on the screen) and for localisation accuracy (how spatially accurate these responses were). There was no overall benefit from viewing two-cluster displays, but spatial accuracy was higher for the first cluster presented in the sequential condition. Otherwise, the simultaneous presentation of clustered discs produced better recall than sequential, for both enumeration and localisation accuracy. Such results support theories of an early parallel selection mechanism that encodes limited (but global) spatial information into short-term memory, without any strategic use of grouping to increase capacity or localisation accuracy.

◆ **Memory for images of faces and objects**

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We both assert in the literature, and assume in the wider world, that humans are particularly good at recognising faces. While this may be the case for familiar faces, a variety of tasks have shown that this is simply not the case for unfamiliar faces. Looking specifically at memory, good performance has been shown for faces when small numbers of images are used, however recent research has demonstrated that long-term visual memory capacity for objects is very good even for vast numbers of images. In the current study, we compare memory for specific images of faces and objects, and show that memory for objects is better than for faces. Familiar faces are remembered better than unfamiliar faces, but not as well as objects. Where previous studies seemed to show an advantage for faces over objects in memory tasks, the requirement to remember a specific image appears to reverse this effect.

[This project was supported by an ESRC Professorial Fellowship awarded to Mike Burton.]

## POSTERS: BIOLOGICAL MOTION

◆ **Actions and Eye Movements: Can biological motion cues trigger overt orienting of attention?**

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Perceiving the direction of others' movement is a crucial skill for survival. In two eye tracking studies we investigated the effect of biological motion on the cueing of spatial attention. From recordings of eye movements we determined how observing actions performed by point light figures, toward either the screen left or right, affected the direction of first fixation as participants attempted to locate a target stimulus. In Experiment 1 participants matched the action performed by a point-light figure to one of two objects presented to either side of fixation. In Experiment 2, participants matched centrally presented action words to the same laterally presented pictures of objects as in Experiment 1, but preceding the appearance of the object pictures either a point-light action or a moving Gabor patch were shown. The results of both experiments show that for both biological motion and Gabor patches, first fixations are more likely to be made to the object that is located in the direction of action/motion, regardless of whether this is toward a target or distractor. These findings will be discussed in relation to previous biological motion studies and attentional cueing.

◆ **The informative content of optical flow features of biological motion**

98 A Sciutti<sup>1</sup>, N Noceti<sup>2</sup>, F Rea<sup>1</sup>, F Odone<sup>2</sup>, A Verri<sup>2</sup>, G Sandini<sup>1</sup> (<sup>1</sup>Robotics, Brain and Cognitive Sciences Department, Istituto Italiano di Tecnologia, Italy; <sup>2</sup>Department of Computer Science, Bioengineering, Robotics and System Engineering, University of Genova, Italy; e-mail: alessandra.sciutti@iit.it)

A natural predisposition towards biological motion, i.e. motion produced by a living being, is shown in human neonates since the earliest stage of the development. An innate ability allows them to perceive the presence of other humans moving in their social space, even with the limited visual information available at birth. In this work we show that a perspective invariant visual feature, computed from optical flow, could be used to explain this ability and we test this hypothesis through action observation and using a humanoid robot engaged in a human-robot cooperative task. To assess the validity of our idea we record videos of non-biological motions (e.g., bouncing ball, pendulum) and biological motion (e.g., human actions, as lifting and transporting objects) and we show that it is possible to classify movements

in a scene as biological or not just on the basis of dynamic features computed from optic flow. Moreover, we demonstrate that it is possible to extract subtle action properties (e.g., the weight of the object lifted) from these features. The derived model is then implemented on a humanoid robot, to test the validity of our assumptions in real human-robot interactive scenarios.

◆ **A matter of perspective: action recognition depends on stimulus orientation in the periphery**

99 L Fademrecht, I Bühlhoff, S de la Rosa (Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Germany; e-mail: laura.fademrecht@tuebingen.mpg.de)

Recognizing actions of others in the periphery is required for fast and appropriate reactions to events in our environment (e.g. seeing kids running towards the street when driving). Previous results show that action recognition is surprisingly accurate even in far periphery ( $\leq 60^\circ$  visual angle (VA)) when actions were directed towards the observer (front view). The front view of a person is considered to be critical for social cognitive processes (Schillbach et al., 2013). To what degree does the orientation of the observed action (front vs. profile view) influence the identification of the action and the recognition of the action's valence across the horizontal visual field? Participants saw life-size stick figure avatars that carried out one of six motion-captured actions (greeting actions: handshake, hugging, waving and aggressive actions: slapping, punching and kicking). The avatar was shown on a large screen display at different positions up to  $75^\circ$  VA. Participants either assessed the emotional valence of the action or identified the action either as 'greeting' or as 'attack'. Orientation had no significant effect on accuracy. Reaction times were significantly faster for profile than for front views ( $p=0.003$ ) for both tasks, which is surprising in light of recent suggestions (Schillbach et al. 2013).

◆ **Does action recognition depend more on the meaning or motion of different actions?**

100 D Chang<sup>1,2</sup>, H H Bühlhoff<sup>1</sup>, S de la Rosa<sup>1</sup> (<sup>1</sup>Dept. of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Germany; <sup>2</sup>Graduate School of Neural & Behavioural Sciences, International Max Planck Research School, University of Tübingen, Germany; e-mail: dong-seon.chang@tuebingen.mpg.de)

How does the brain discriminate between different actions? Action recognition has been an active field of research for long time, still little is known about how the representations of different actions in the brain are related to each other. We wanted to find out whether different actions were ordered according to their semantic meaning or kinematic motion by employing a novel visual action adaptation paradigm. A total of 24 participants rated four different social actions in terms of their perceived differences in either semantic meaning or kinematic motion. Then, the specific perceptual bias for each action was determined by measuring the size of the action adaptation aftereffect in each participant. Finally, the meaning and motion ratings were used to predict the measured adaptation aftereffect for each action using linear regression. Semantic meaning and the interaction of meaning and motion significantly predicted the adaptation aftereffects, but kinematic motion alone was not a significant predictor. These results imply that differences between distinct actions are rather encoded in terms of their meaning than motion in the brain. The current experimental paradigm could be a useful method for further mapping the relationship between different actions in the human brain.

◆ **Isolating cues to sex and quantifying their relative influence on perception**

101 G A Hacker, R van der Zwan, A Brooks (Health & Human Sciences, Southern Cross University, Australia; e-mail: graeme.hacker@scu.edu.au)

The neural processes mediating sex perceptions – the ability to discriminate female from male humans by human observers - have not yet clearly been described. There is a growing body of evidence suggesting female and males are not handled in the same way by sex processing mechanisms. In particular, there seems to be a perceptual bias in sex perceptions such that sexually ambiguous figures are more often perceived as being male than female. The aim of the experiments reported here was to explore that bias using binocular rivalry. Using models derived from the sex continuum developed by Troje (2008), red and green point-light walkers of the same and opposite sexes were presented to observers who had to report the colour of the walker that predominated in the visual scene. Total dominance durations were recorded. Our data show that maleness tends to predominate even during binocular rivalry. There are observer sex differences too: Male walkers predominated more for female observers. These data are consistent with the existence of a male bias and suggest a role for unconscious attentional mechanisms.

Tuesday

◆ **Perception of biological motion depends on lighting-from-above prior**

102 L A Fedorov<sup>1</sup>, J Vangeneugden<sup>2,3</sup>, M A Giese<sup>1</sup> (<sup>1</sup>Department of Cognitive Neurology, University Clinic Tübingen, Germany; <sup>2</sup>University of Leuven, Department of Neurosciences, Belgium; <sup>3</sup>The Netherlands Institute for Neuroscience, Levelt Research Group for Molecular Visual Plasticity, Netherlands; e-mail: martin.giese@uni-tuebingen.de)

Most research on biological motion perception has focused on the influences of 2D motion and form cues, and sometimes also of binocular disparity, while the influence of shading has been largely neglected. The perception of 3D static shapes from 2D images is strongly influenced by a lighting-from-above prior (Brewster, 1847; Ramachandran, 1988). We observed that for biological motion stimuli with perceptually ambiguous walking direction (Vanrie et al. 2004) the illumination direction can radically alter the perceived walking direction of walkers that consist of volumetric moving elements at the joints. **METHOD:** We replaced the dots of a walker by volumetric elements that are rendered with different positions of the illuminating light source. We studied the dependence of the perceived walking direction on the position of this light source. **RESULTS/DISCUSSION:** We found a radical change of the perceived walking direction (corresponding to a rotation by 180 deg) between lighting from above and lighting from below, while the physical structure of the walker remained exactly identical. This illusion demonstrates that biological motion perception is also substantially influenced by shading cues, where the processing of these cues is dependent on a lighting-from-above prior.

[Acknowledgements: FP7-PEOPLE-2011-ITN(Marie Curie): ABC PITN-GA-011-290011, AMARSi-EC FP7-ICT-248311; DFG GI 305/4-1, DFG GZ: KA 1258/15-1; BMBF, FKZ: 01GQ1002A, HBP FP7-ICT-2013-FET-F/ 604102; Koroibot FP7-ICT-2013-10/ 611909.]

◆ **Adaptation aftereffects for biological motion**

103 S C Biehl, T Vaitkus, K S Pilz (School of Psychology, University of Aberdeen, United Kingdom; e-mail: s.biehl@abdn.ac.uk)

In a series of different experiments, Theusner and colleagues (2011) found biological motion adaptation to the global form but not the local motion of point-light walkers. In their experiments, participants adapted for 20 seconds to leftwards or rightwards facing point-light walkers and experienced oppositely directed aftereffects for subsequently presented ambiguous test stimuli. In this study, we replicated these findings using a within-subjects design and much shorter adaptation times. In three separate blocks, participants adapted to point-light walkers containing global form and local motion information (classic), primarily local motion information (scrambled), and primarily global form information (random position). After an adaptation period of 10 seconds to the respective point-light walker, an ambiguous test stimulus appeared and participants had to indicate the facing direction of the test stimulus. Our results show adaptation effects for classic and for random position point-light walkers but not for scrambled walkers. This suggests a dissociation of biological adaptation effects induced by form and by motion information. Our results replicate previous findings and show that adaptation aftereffects can be induced using much shorter adaptation periods. We are currently investigating optimal adaptation duration for biological motion by reducing adaptation times even further.

[This research is funded by a BBSRC New Investigator Grant to Dr. Karin Pilz.]

◆ **Modulation of crowding of biological motion by action congruency**

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Identification and discrimination of peripheral stimuli surrounded by flankers are often difficult (crowding). Our previous study showed that crowding occurred for walking direction discrimination of biological motion stimuli. In the present study, we examined whether action congruency between target and flankers would modulate the crowding effect of biological motion stimuli. Each biological motion stimulus was one of directional actions (e.g., walking, throwing a wastepaper, etc.) and rotated one of five direction around the vertical axis. In the peripheral visual field, observers discriminated the direction of action of the flanked target stimulus while ignoring the two flankers. The crowding effect was stronger when the flankers were in the same action as and different direction from the target. That is, congruent actions enhanced the crowding effect in the direction discrimination task. In the subsequent experiment, observers identified the actions of target stimuli. The congruency in action direction did not influence the crowding effect for the action identification task. Thus, the same actions caused more crowding for action direction but the same directions did not affect crowding for action identification.

These results suggest that the process for direction discrimination of biological motion is partly different from that for action identification of biological motion.

[This work was supported by JSPS KAKENHI Grant-in-Aid for Young Scientists (B) Grant Number 25730099.]

◆ **Simulation of walking re-shapes extrapersonal space categorization**

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Recent results suggest that the perception of extrapersonal space might be filtered not only by our own motion potentialities but also by the motor potentialities of others. The aim of the present study was to investigate whether the simulation of a walking action shapes our extrapersonal space perception. In three experiments we took advantage of biological motion displays as primes for a distance judgment task. In Exp 1, participants were presented with a point-light walker or a scrambled motion, and judged the location ("Near" or "Far") of a target with a human body or an inanimate object as reference frames (RFs). In Exp 2, participants were primed with point-light walkers of different speeds: a runner, a normal and a slow walker. Finally, in Exp 3 we displayed a sitting down or a standing up point-light motion before the presentation of a target-oriented or a non target-oriented human body as RF. Results show a reduced perceived distance when the human body RF was primed with a point-light walker (Exp 1). Furthermore, we found an additional reduction of the perceived distance when priming with a runner (Exp 2). Finally, Exp. 3 shows the necessity of inferring the intention to cover the distance as a precondition for priming effects of the point-light walker.

## POSTERS: APPLICATIONS

◆ **Figure skaters eye movements as indices of vection: VR study**

106 A I Kovalev, G Y A Menshikova, O A Klimova (Psychology, Lomonosov Moscow State University, Russia; e-mail: artem.kovalev.msu@mail.ru)

Illusory self-motion (vection) describes the sensation of ego-motion in the absence of physical movement. It is suggested that the illusion is caused by the sensory conflict between visual and vestibular systems which manifested in discomfort (nausea) and changes of eye movements. Here we developed a method of quantitative evaluation of vestibular function disturbances based on eye movement characteristics. The study involved 15 well prepared (figure skaters) and 15 poorly prepared (not athletes) to vestibular loads participants. The vection illusion was initiated with the help of CAVE virtual reality system. To evaluate the vestibular dysfunctions eye movement characteristics during the vection illusion experience were analyzed. In addition the SSQ test was performed to evaluate the strength of discomfort. Results showed that the vection illusion experience caused an optokinetic nystagmus which was more pronounced in well prepared than in poorly prepared participants. The scanpaths were also different for both groups: more blinks and fixations were revealed for athletes. Average values of saccade amplitudes were also significantly fewer for athletes. Total scores obtained by the SSQ questionnaire were consistent with the eye movements. The changes of eye movement characteristics may be considered as a compensatory mechanism to reduce the sensory conflict.

[Supported by RFBR grant № 12-07-00146 and № 13-07-00834.]

◆ **Higher resolution stimulus facilitates depth perception even when the resolution difference is undetectable.**

107 Y Tsushima (Three-Dimensional Image Research Division, NHK Science and Technology Research Labs, Japan; e-mail: tsushima@strlstaff.strl.nhk.or.jp)

Today, we are faced with high-quality virtual worlds of a completely new nature. For instance, we have digital displays consisting of high enough resolution that we cannot distinguish them from the real image. However, little is known about how such high-quality representations contribute to the sense of realness, especially to depth perception. Here, we examined the relationship between stimulus resolution and depth perception while manipulating the stimulus resolution of luminance-contrast (shading) for a Gabor patch and several composite images. In these experiments, two different resolution stimuli were presented on a display, participants were asked to report which stimulus had more depth (Depth Task) or had higher resolution (Resolution Task). The results showed that higher resolution stimuli facilitate depth perception even when the resolution difference is undetectable. This finding is against the

Tuesday

traditional view that visual input is processed continuously in a bottom-up cascade of cortical regions that analyse increasingly complex information such as depth information. In addition, it indicates that there are two types of perceptual information, consciously available and unavailable information. These results might provide us with not only new insights into the neural mechanisms of depth perception but also suggest an advantage of using extremely high resolution displays.

◆ **The effect of video game experience in earlier childhood on fatigue with a portable 3D game machine**

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We have reported the effects of playing a video game with glassless 3D viewing on a portable game machine of Nintendo 3DS at ECVP (Takaoka & Ashida, 2012), suggesting that 3D viewing is more tiring and is not fully appreciated as a fun experience. Here, we analysed how susceptibility to fatigue is related to participants' experiences in playing games in their childhood. Participants played a video game (Mario Card 7, Nintendo, Japan) with glassless 3D or 2D viewing, and were asked to report fatigue using a visual analogue scale (VAS) and to fill out other questionnaires as we used before. They were also asked when they first played a video game. On average, they first played games at the age of 6.5 years; we divided the participants into early and late groups at this averaged starting age. After 3D play, the total VAS score was significantly higher for the late group than for the early group, while it was lower after 2D play with no difference between the two groups. Despite the limitation of memory-based survey and possible confounds of other factors, it is suggested that early game experiences, even in 2D, may affect adaptability to 3D viewing.

[Supported by JSPS Grant-in-Aid for challenging Exploratory Research #24653187.]

◆ **Which tone-mapping is the best? A comparative study of tone-mapping perceived quality**

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High-dynamic-range (HDR) imaging refers to the methods designed to increase the brightness dynamic range present in standard digital imaging techniques. This increase is achieved by taking the same picture under different exposure values and mapping the intensity levels into a single image by way of a tone-mapping operator (TMO). Currently, there is no agreement on how to evaluate the quality of different TMOs. In this work we psychophysically evaluate 15 different TMOs obtaining rankings based on the perceived properties of the resulting tone-mapped images. We performed two different experiments on a CRT calibrated display using 10 subjects: (1) a study of the internal relationships between grey-levels and (2) a pairwise comparison of the resulting 15 tone-mapped images. In (1) observers internally matched the grey-levels to a reference inside the tone-mapped images and in the real scene. In (2) observers performed a pairwise comparison of the tone-mapped images alongside the real scene. We obtained two rankings of the TMOs according their performance. In (1) the best algorithm was ICAM by J.Kuang et al (2007) and in (2) the best algorithm was a TMO by Krawczyk et al (2005). Our results also show no correlation between these two rankings.

[CAP and XO are supported by grant TIN2010-21771-C02-01 from the Spanish Ministry of Science.]

◆ **The Effects of Image Padding in Saliency Algorithms**

110 N M W Frosst<sup>1,2,3</sup>, C Wloka<sup>1,2</sup>, J Tsotsos<sup>1,2</sup> (<sup>1</sup> Dept. of Electrical Engineering and Computer Science, York University, Canada; <sup>2</sup>Centre for Vision Research, York University, Canada; <sup>3</sup>Department of Computer Science, University of Toronto, Canada; e-mail: nfrosst@cse.yorku.ca)

Gaussian Smoothing is a popular post-processing step applied to saliency algorithms to improve salient region identification. Frequently, the best performance is achieved with very large smoothing kernels (often with standard deviation on the order of a hundred pixels). When performing any image convolution one must implement some rule to handle the edge pixels for when part of the kernel extends beyond the boundary of the image. This issue is most commonly addressed through some form of image padding: extending the number of pixels in an image such that all the required input pixels for the kernel are defined. With such large smoothing kernels being used to improve saliency algorithm performance, the type of padding which is implemented can have a significant effect on performance. Despite this potential impact, smoothing parameters and methodology beyond magnitude of the Gaussian standard deviation are almost never reported or defined. To address this we evaluate five popular saliency algorithms with five different padding styles to examine the performance effects different padding methods introduce.

Based on our results, we find that the padding method does indeed affect performance, and that we achieve maximum area under the curve scores by padding the image with zeros.

◆ **Assessment of human-likeness and naturalness of interceptive arm reaching movement accomplished by a humanoid robot**

111

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The generation of believable human-like movements is a key problem of humanoid robotics. A central biologically-inspired approach for the solution of the underlying high-dimensional control problems relies on learned low-dimensional dynamic movement primitives. METHOD: Three different control algorithms, based on different definitions of dynamic movement primitives, were trained with human motion-capture data from a double-step reaching task. The algorithms were applied to control an accurate physical model of the humanoid robot COMAN (developed at the Istituto Italiano di Tecnologia). The generated movements were then used to animate a corresponding robot avatar model. In addition, the original human movements were retargeted to the same avatar model. Participants rated the 'human-likeness', the 'naturalness', and reported observed 'artifacts'. RESULTS: Interestingly, participants rated not the human but the most smooth trajectories as most 'natural' and most 'human-like'. This points to a non-veridical perception of human-likeness, which might be based rather on low-level properties of the observed motion than on the reproduction of details of complex human trajectories.

[This research was supported by: AMARSi- EC FP7-ICT-248311; Koroibot FP7-ICT-2013-10/ 611909; DFG GI 305/4-1, DFG GZ: KA 1258/15-1; BMBF, FKZ: 01GQ1002A, FP7-PEOPLE-2011-ITN(Marie Curie): ABC PITN-GA-011-290011, HBP FP7-ICT-2013-FET-F/ 604102.]

◆ **Coefficient estimation for cellular texture generation based on visual perception**

112 X Cai, J Liu, L Qi, J Dong (Computer Science and Technology, Ocean University of China, China; e-mail: dongjunyu@ouc.edu.cn)

Cellular models can generate textured surfaces of various appearance using combination of different basis functions. We focused on linear combinations of  $n$  basis functions ( $C1F1+C2F2+C3F3$  for various values of  $Cn$ ) (Worley & Steven, 1996) and expected to find combination coefficients to generate textures whose perceptual features are in accordance with human's perception. Sixty-one cellular texture samples were generated using a cellular model and a folding cellular model, which were used in two psychophysical experiments: free-grouping and rating (Rao A.R & Lohse G., 1996). The similarity matrix derived from free-grouping experiment was used to construct a three-dimensional perceptual texture space by Isometric feature mapping. Each dimension in this space is related to a combination of a set of 12 perceptual features obtained from the rating experiment. We trained four support vector machine regression models for mapping the combinational features to the coefficients of the basis functions. The average of squared correlation values based on performing twenty regressions for predicting  $C1$ ,  $C2$ ,  $C3$  and  $n\_folds$  were :  $0.867\pm 0.010$ ,  $0.645\pm 0.019$ ,  $0.995\pm 0.001$ ,  $0.938\pm 0.060$ . The regression models can predict appropriate values for the combination coefficients of the basis functions to generate textures that are in accordance with given perceptual features.

[This work was supported by grants from National Natural Science Foundation of China (Project No.61271405) and the Ph.D.Program Foundation of Ministry of Education of China (20120132110018) and Qingdao Science and Technology Plan Projects (12-1-4-1-(8)-jch).]

## POSTERS: OBJECT RECOGNITION AND CATEGORIZATION

◆ **The importance of where you look: A study of the role of eye movements in object recognition**

113

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How important is where we look when we are tasked to recognise an object, and to what extent does viewing the image locations fixated during the learning of that object lead to a behavioural advantage? A previous study by the authors, examining the role of eye movements in object recognition demonstrated that the spatial pattern of eye movement, made during the learning of a novel object, are remarkably similar to those made by participants as they later attempt to recognise the object. What is less clear is whether re-fixating the same locations conveys any advantage for the object recognition process. Here

Tuesday

we present data from a gaze contingent object recognition paradigm where objects to be recognised are presented such that the participants are constrained to look only at specific image locations that could be either (i) a region that was, or (ii) was not previously fixated during the preceding learning phase. The results demonstrate a significant behavioural advantage when participants view previously fixated image regions compared to viewing image regions that were not previously fixated during the learning phase. These results suggest a functional role of eye movements to extract high resolution information from image features in the recognition process.

◆ **Looking at planar views during active object visual learning: moments of stability**

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The planar bias in active object learning is a well-documented viewpoint selection preference: in adults, and infants, the proportion spent looking at planar views – viewpoints where flat surfaces are shown perpendicular to the viewer – deviates strongly from random selection. One hypothesis of the planar bias' functional role is that dynamic viewing around them is more informative – movements around planar views reveal more of the objects' structure; this hypothesis predicts more exploratory behaviours, for instance measurable in higher angular velocities of the main axis of elongation. We asked adults to manipulate 3D objects on a computer, using a mouse, for twenty seconds each, and recorded the object's 3D orientation and eye fixations (60Hz). We computed, per contiguous frames of dwell activity, inside a bin of the object's viewing sphere: duration, proportion of time with object not moving, mean angular velocity of the main axis, and number of saccades. Results show that counter to the initial prediction, viewing periods around planar views are more stable: duration is higher, time not moving is higher, main axis speed is lower, and there are more saccades. Put together, these findings suggest focused attention to planar views and learning of a static view.

[This research was funded by Fundação para a Ciência e Tecnologia (FCT) with Portuguese Government funds under the project PTDC/PSI-PCO/121494/2010 “Visual Object Recognition and Children's Self-Generated Object Views: Developmental Changes in Active Viewing“ and under the project Scope: PEst-OE/EEI/UI0319/2014. AFP was also supported by a Marie Curie International Incoming Fellowship PIFI-GA-2011-301155.]

◆ **Scene priming and location priming in scene-object consistency effects**

115 N Heise, U Ansorge (Faculty of Psychology, Universität Wien, Austria; e-mail: nils.heise@univie.ac.at)

Object recognition within scenes is better for semantically consistent objects as compared to inconsistent ones (for example: Biederman, Mezzanotte, & Rabinovitz, 1982): This might be due to the fact that visual search is more efficient for consistent objects as they occupy expected places. If solely visual search is responsible for consistency effects, they might be weaker (1) with repeated object locations, and (2) with repeated scene backgrounds. In Experiments 1 and 2, locations of objects were varied within a scene to a different degree (one, two, or four possible locations), and consistency effects were studied as a function of progressive numbers of repetitions of the backgrounds. Because repeating locations and backgrounds could facilitate visual search for objects, these repetitions might alter the consistency effects by lowering of location uncertainty. We a significant consistency effect, but there is no clear support for a modulation of location priming or scene priming on consistency effects. On the other hand our data indicates that the consistency effect might be strongly depended on the eccentricity of the target objects.

◆ **Model for the categorization of bottled soft drinks using their silhouette**

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In our daily life, we use our senses to acquire information about the objects that surrounds us. However, the information processing that allows the recognition and consecutive classification into categories of those objects remains unclear. In this study, we analyzed quantitatively and tested experimentally the visual properties of bottles silhouettes responsible for categorization in soft drinks. First, we took pictures of all personal bottles of soft drinks available in the local market. Then, we extracted the silhouette and analyzed its physical characteristics using a cluster analysis. The silhouette image analysis revealed the physical characteristics that separate the categories according to the real market.

To evaluate if these parameters correlate with the consumer's perceived categories, we conducted a psychophysical experiment where subjects chose the category of a randomly presented bottle silhouette image. The experimental results support the hypothesis that the width of the lid and the shape of the bottle are important visual factors for categorization. Furthermore, we present metrics for assessing the categorization which enable direct correlation with physical attributes of the bottles silhouettes. These findings permit implementation of guidelines for new bottle designs that capitalize on existing categorization rules based on consumer visual perception.

◆ **Facilitation of object categorization in multiple objects stimuli**

117 A Šoliūnas, A Pleskačiauskas, A Daktariūnas, O Gurčiniienė (Department of Neurobiology and biophysics, Vilnius University, Lithuania; e-mail: alvydas.soliunas@gf.vu.lt)

Visual system recognizes objects in real world in context of environment and other objects. There are many studies that demonstrate facilitating context effect on object recognition in scenes. In a series of experiments, we tested the hypothesis that objects can facilitate categorization of each other in a situation when several isolated objects are presented simultaneously and the low spatial frequencies could be responsible for this facilitation effect. Stimuli were various 2D pictures of man-made objects of eleven categories. One, two, or three objects of one, two or three categories were presented simultaneously for 100 ms and the subjects were required to perform the same-different categorization task or the category present-absent identification task. Objects were presented unaltered or filtered out of low or high spatial frequencies. We found that the response time depend more on the number of categories than on the number of objects. This finding suggests that the category features could be analyzed in parallel. Experiments did not confirm the hypothesis that such effect was determined by low spatial frequencies of stimuli. Some performance differences in the same-different and present-absent categorization tasks let us assume that physical similarity of stimuli play more important role in the first task.

◆ **Rapid gist perception of meaningful real-life scenes: exploring individual and gender-specific differences in multiple categorization tasks**

118 S Vanmarcke, J Wagemans (Laboratory of Experimental Psychology, KU Leuven, Belgium; e-mail: steven.vanmarcke@ppw.kuleuven.be)

Rapid gist perception can be assessed in multiple ways. In the ultra-fast categorization paradigm developed by Simon Thorpe and colleagues (1996), participants get a clear categorization goal in advance and succeed at detecting the object (animal) almost perfectly. Since this pioneering work, follow-up studies consistently reported population-level reaction time differences in performance on different categorization tasks explained by a superordinate advantage (animal versus dog), perceptual similarity (animals versus vehicles) and object category size (natural versus animal versus dog). In this study, we replicated and extended these separate findings by using an explorative test battery of different categorization tasks (varying in presentation time, task demands and stimuli) and focusing on individual differences based on gender, IQ, and questionnaires (e.g., BRIEF, SRS, EQ, SQ). Within this structured framework, we find subtle, yet consistent gender differences in the performance of healthy adults (women faster than men). Given the combined expectations of the Weak Central Coherence theory (WCC) on slowed rapid gist perception and the dimensional, gender-sensitive expectations of the extreme male brain (EMB) theory, stronger deficits are expected when testing people with ASD on the same test battery.

## POSTERS: SPATIAL VISION

◆ **Illusory rotation of translating wheels: Kinematics override surface cues**

119 D Souto, R Islam (School of Psychology, College of Medicine, Biological Sciences and Psychology, University of Leicester, United Kingdom; e-mail: ds572@le.ac.uk)

Gibson's ecological optics stressed the importance of ground surface affordances for locomotion. Here we ask whether ground surface properties are important for estimating object motion. This was tested by using a motion illusion in which a translating flickering wheel is perceived to rotate, suggesting that friction with the ground is inferred. Observers reported the direction of rotation of a wheel translating back-and-forth horizontally for 20 s trials. If perceived rotation reflect friction, we expect to see a higher rate of judgements congruent with the direction of the friction force for wheels presented on less slippery-looking surfaces. Wheels were shown over 'concrete', 'mirror' and 'water' virtual surfaces or over a grey uniform background. Surprisingly, surface type had little influence on congruent responses, even compared with the uniform background condition. Image inversion had also a weak effect on



Tuesday

judgements. However, the position along the trajectory had a strong effect, with judgements going from chance level (50% congruent) to a high proportion of congruent responses from the beginning to the end of the trajectory, before the wheel changes direction. We conclude that physical context is important in disambiguating motion, but kinematics override static cues.

◆ **Mapping near acuity using a 2D psychometric tracking algorithm**

120 S P Heinrich, C Reichel, M Bach (Eye Center, Albert-Ludwigs-Universität Freiburg, Germany; e-mail: sven.heinrich@uniklinik-freiburg.de)

Visual acuity at short distances is primarily determined by the accommodation of the eye. It is typically measured at a single distance with a near-acuity chart. Alternatively, accommodation ability is assessed by asking subjects to report when an approaching visual target starts to appear blurred. Both methods fail to provide a full account of acuity as a function of distance, which would be represented by an isoprobability line for correct optotype identification in a 2D space spanned by optotype size and distance. We developed an algorithm that, together with a movable microdisplay, allows for efficient mapping of acuity over a nearly continuous range of distances, using two staircase strategies in repeatedly alternating runs. One strategy targets an above-threshold probability of correct optotype identification, with the optotype size being adjusted. The other staircase strategy targets a below-threshold probability of correct identification, with the optotype distance being adjusted. This results in a zig-zag trajectory bracketing the threshold isoprobability line. The approach proved feasible in groups of normal, presbyopic, and pseudophakic subjects. Generally, subjects completed the measurement procedure without problems, and meaningful threshold curves were obtained, allowing for an individual comparison to theoretically predicted performance and characterization of presbyopic vision and intraocular lenses.

[Supported by the DFG.]

◆ **Gender differences in orientation sensitivity: behavioral data and event-related potentials (ERPs).**

121 N Y U Gerasimenko<sup>1</sup>, A V Slavutskaya<sup>1</sup>, M A Krylova<sup>2</sup>, I V Izyurov<sup>2</sup>, E S Mikhailova<sup>1</sup>  
(<sup>1</sup>Department of Sensory Physiology, IHNA & NP RAS, Russian Federation; <sup>2</sup>Department of Physics, Moscow State University, Russian Federation; e-mail: nataliagerasimenko@gmail.com)

Determination of line orientation is a basic image processing stage. The aim of present study was to investigate the neural mechanism of orientation sensitivity to cardinal and oblique lines, as well as gender difference in line identification. 41 subjects (21 males) were to identify the orientation of cardinal (horizontal and vertical) and oblique (45° and 135°) lines. It was found that the cardinal orientations were defined faster than the oblique ones, and the females showed the lower accuracy for oblique orientations in comparison with males. The P1 component (50–130 ms) at parietal areas and the N1 component (100–190 ms) at occipital areas were found to be larger for oblique orientations than for cardinal ones. The males showed larger P1 and N1 amplitudes, and the effects of orientations were more pronounced in males. Our results indicated the important role of parietal cortex in early detection of line orientation and the role of the occipital areas in performing the subsequent steps of visual processing. These findings may suggest a feedback from higher parietal visual areas to occipital ones in processing of line orientation. Also, we can assume that gender differences in spatial abilities related with different brain mechanisms of orientation processing.

[Supported by the grants of RFBR 14-04-00706 and RFH 12-36-01291.]

◆ **The effects of eccentricity and separation on positional localization bias**

122 Z Hussain, B S Webb, P V McGraw (Psychology, University of Nottingham, United Kingdom; e-mail: zahra.hussain@nottingham.ac.uk)

Previous work has shown that outside one degree of fixation, positional accuracy depends on the ratio of stimulus separation to eccentricity. Here, we examined the effects of this ratio on bias. The task was free localization comprising dual bisection and alignment of stimuli positioned on an isoeccentric arc. Stimuli were viewed peripherally at 32 locations (4 eccentricities x 8 axes), and judgements were made in the diagonal, horizontal and vertical direction relative to the reference, yielding three separation/eccentricity ratios (0.78, 1.85, 2.00). Absolute error (accuracy), and signed error (bias) in Cartesian and polar coordinates were measured. Results: The ratio of separation to eccentricity influenced both accuracy and bias, with stronger effects on bias, particularly on the bisection judgement. Stimulus separation determined the sign and magnitude of bias, with eccentricity affecting bias only at large separations. The combined spatial map revealed a pattern of bias in which responses at large absolute separations were pushed toward the map centre and those at small separations were pushed away. Polar angle bias

resembled reference repulsion effects and varied with separation. The results suggest that positional accuracy and bias covary with the separation/eccentricity ratio, with an increasing interdependence at large ratios.

[The Leverhulme Trust]

◆ **Psychophysical scaling of contrast sensitivity in three different spatial frequencies**

123 M F Costa<sup>1,2</sup>, S M C F Moreira<sup>1</sup> (<sup>1</sup>Psicologia Experimental, Universidade de São Paulo, Brasil; <sup>2</sup>Nucleo de Neurociências e Comportamento, Universidade de São Paulo, Brasil; e-mail: costamf@usp.br)

Contrast Sensitivity (CS) is the fundamental measurement regarding the basis of the spatial vision. A typical CS function shows a band-pass shape with higher sensitivity around 2cpd. Our purpose is to study the suprathreshold contrast perception measuring the subjective scaling in different spatial frequencies. Ten subjects with mean age of 27yrs (SD= 5.3) performed the psychophysical scaling of contrast sensitivity in three spatial frequencies: 0.4, 1.6 and 4.8 cpd. We used a Magnitude Estimation procedure in which the modulus had a contrast of 45% and received an arbitrary value of 50. The task was to compare the CS of a second grating and associate a respective number considering their impression of higher, lower or equal contrast perceived. Our results show the exponents of the Steven's Power Law of 0.86, 0.48 and 0.66 for 0.4, 1.6 and 4.8 cpd, respectively. We conclude that the suprathreshold contrasts perception are similar despite the spatial frequency, since the exponent obtained for the spatial frequency with highest sensitivity had the smaller exponent. We interpreted these results as a compressive effect of the contrast perception to balance our impression in all spatial frequencies.

[FAPESP #04049-4, CNPq #404603/2013-0]

## POSTERS: RIVALRY

◆ **Ambiguous figures perception under binocular and monocular viewing conditions**

124 V A Maksimova, D N Podvigina (Physiology of Sensory Systems , Pavlov Institute of Physiology, Russian Federation; e-mail: vera.maksimova.rgpu@yandex.ru)

We have continued studying temporal characteristics of perception of the ambiguous images with two types of monocular depth cues – perspective and shading (Podvigina, 2013, Perception 42 ECVF Abstract Supplement). The aim of the present work is to compare temporal characteristics of monocular and binocular perception of the two images - Necker lattice and lines of shadowed circles. Each image was presented five times for one minute (five minutes overall). We've found out that the mean number of reversals during both monocular and binocular viewing of the two images is the same. The reversal rate of both images viewed monocularly didn't change significantly over all five trials, whereas during binocular viewing it had a tendency to grow up from the first to the last trial. This result may suggest that in binocular viewing condition there's a slight mismatch between the two types of cues that we use together to perceive 3D shape – binocular (stereo disparity) and monocular (shading or perspective). This mismatch is corrected with the adapting visual system over time during the experiment. In monocular viewing condition there's no any contradiction as the system uses only one type of cues and thus operates steady.

◆ **Dominance preservation in binocular rivalry**

125 M Persike, G Meinhardt (Statistical Methods, Johannes Gutenberg University Mainz, Germany; e-mail: persike@uni-mainz.de)

One of the long-standing questions in binocular rivalry is whether rivalry occurs between eyes or between stimuli. Research has converged on the notion that a multitude of stimulus properties determine if a physical exchange of rivaling stimuli is consciously perceived or not. Most of these stimulus properties considered so far have been of low-level nature such as luminance contrast, spatial frequency, or flicker frequency. In a series of experiments with stimuli of varying complexity we find that semantic content strongly modulates what rivals during binocular rivalry. While a physical swap of stimuli between eyes is immediately perceived when the dominant percept lacks meaningful semantic content, the swap goes largely unnoticed when the dominant percept has object-like semantic qualities. We thus conclude that both the capture and the preservation of perceptual dominance is at least partly governed by high-level cognitive control.

Tuesday

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◆ **The scope and limits of numerical priming under continuous flash suppression**

126 G Hesselmann<sup>1</sup>, P Sterzer<sup>1</sup>, A Knops<sup>2</sup> (<sup>1</sup>Visual Perception Lab, Charité Universitätsmedizin Berlin - Campus Mitte, Germany; <sup>2</sup>Department of Psychology, Humboldt-Universität zu Berlin, Germany; e-mail: g.hesselmann@gmail.com)

Continuous flash suppression (CFS) is a powerful variant of binocular rivalry that allows to deterministically control the perceptual dominance of visual stimuli. By presenting high-contrast dynamic mask images to one eye, CFS disrupts conscious perception of target images presented to the other eye for up to seconds, and reduces neuronal responses already at the level of primary visual cortex. Whether and to what degree target information can escape suppression by CFS and mediate unconscious high-level priming effects, is a matter of ongoing research and debate. Here, we investigated the scope and limits of numerical priming under CFS using non-symbolic primes and targets (arrays of Gabor patches). Specifically, we asked a) whether previously observed unconscious priming effects in subitizing range (1-3) generalize to large numerosities, and b) whether the numerical target-prime distance modulates the priming effect. We observed that invisible primes influenced response times (RT) to targets in the small, but not in the large numerosity range. The effect of target-prime distance depended on the choice of a baseline to which the target RTs were compared. We discuss our findings with respect to recent studies that reported opposing numerosity priming effects under CFS (Bahrami et al., 2010; Sklar et al., 2012).

**WEDNESDAY****INVITED TALK: RANK PRIZE LECTURE**◆ **Vision and eye movements**

K R Gegenfurtner (Psychology, Giessen University, Germany;  
e-mail: Karl.R.Gegenfurtner@psychol.uni-giessen.de)

The existence of a central fovea, the small retinal region with high analytical performance, is arguably the most prominent design feature of the primate visual system. This centralization goes along with the corresponding capability to move the eyes to reposition the fovea continuously. Past research on perception was mainly concerned with foveal vision while the eyes were stationary. Research on the role of eye movements in visual perception emphasized their negative aspects, for example the active suppression of vision before and during the execution of saccades. But is the only benefit of our precise eye movement system to provide high acuity of small regions at the cost of retinal blur during their execution? In my talk I will compare human visual perception with and without eye movements to emphasize different aspects and functions of eye movements. I will argue that our visual system has evolved to optimize the interaction between perception and the active sampling of information. For orientation and interaction in our environment we tend to make repeated fixations within a single object or, when the object moves, we track it for extended periods of time. When our eyes are fixating a stationary target, we can perceive and later memorize even complex natural images at presentation durations of only 100 ms. This is about a third of a typical fixation duration. Our motion system is able to obtain an excellent estimate of the speed and direction of moving objects within a similar time frame. What is then the added benefit of moving our eyes? Recently we have shown that lightness judgments are significantly determined by where on an object we fixate (Toscani, Valsecchi & Gegenfurtner, 2013a, b). When we look at regions that are darker due to illumination effects, the whole uniformly colored object appears darker, and vice versa for brighter regions. Under free viewing conditions, fixations are not chosen randomly. Observers prefer those points that are maximally informative about the object's lightness. For pursuit eye movements, we have shown that our sensitivity to visual stimuli is dynamically adjusted when pursuit is initiated. As a consequence of these adjustments, colored stimuli are actually seen better during pursuit than during fixation (Schütz, Braun, Kerzel & Gegenfurtner, 2008) and small changes in the speed and direction of the object are more easily detected (Braun, Schütz & Gegenfurtner, 2010), enabling a better tracking of moving objects. Pursuit itself increases our ability to predict the future path of motion (Spering, Schütz, Braun & Gegenfurtner, 2011), lending empirical support to the widespread belief that in sports it's a good idea to keep your eyes on the ball. These results demonstrate that the movements of our eyes and visual information uptake are intricately intertwined. The two processes interact to enable an optimal vision of the world, one that we cannot fully grasp while fixating a small spot on a display.

**SYMPOSIUM: AMODAL COMPLETION: MICHOTTE'S LEGACY AND NEW DIRECTIONS FIFTY YEARS AFTER 'LES COMPLÉMENTS AMODAUX'**◆ **Amodal completion: Michotte's legacy and new directions fifty years after 'Les compléments amodaux'**

R van Lier<sup>1</sup>, V Ekroll<sup>2</sup> (<sup>1</sup>Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, The Netherlands; <sup>2</sup>Laboratory of Experimental Psychology, University of Leuven, Belgium; e-mail: R.vanlier@donders.ru.nl)

Exactly fifty years ago Albert Michotte famously coined the term "amodal completion", which refers to the perceived completeness of partly occluded shapes. Whereas modal completion refers to processes within a given modality of perception (e.g. vision), the term amodal completion alludes to processes outside that modality. This stance can be defended with regard to the first-person phenomenology; while the visual nature of modal percepts is obvious, we do not see amodally completed shapes in the literal sense. That is, an observer may have a very definite impression of the occluded parts of a shape, but the phenomenological presence clearly differs from modally completed properties. At the level of brain processes, however, it would be a rather hazardous enterprise to label one type of filling-in as perception and the other as cognition. Nobody knows where in the brain perception stops and cognition starts, and it may even be questioned whether a clear line can be drawn at all! (e.g. because

Wednesday

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of neural cross-wiring and feedback connections). Nevertheless, exactly this 'grey zone' makes amodal completion a particularly interesting domain of research. This symposium intends to demonstrate that amodal completion provides a unique opportunity for investigating interactions between stimulus-driven and knowledge-driven processing streams.

◆ **Michotte's work on amodal completion: A brief historical and conceptual introduction**

J Wagemans (Laboratory of Experimental Psychology, University of Leuven, Belgium;  
e-mail: johan.wagemans@psy.kuleuven.be)

Fifty years ago, Albert Michotte and two collaborators published "Les compléments amodaux des structures perceptives" (Michotte, Thinès & Crabbé, 1964). This short monograph is one of the landmark publications of the Gestalt literature after the second world-war. This brief introduction to the symposium will provide some historical background to the theme of amodal completion and this monograph in particular. Michotte coined the term "amodal completion" to refer to the perceived completeness of partly occluded shapes and to emphasize that we do not see amodally completed shapes in the literal sense. An observer may have a very definite impression of the occluded parts of a shape but the phenomenal presence clearly differs from modally completed properties. Hence, this tradition strongly relies on first-person phenomenology, although Michotte and his associates also performed careful parametric manipulations (i.e., experimental phenomenology). Michotte's work on amodal completion will be situated in the context of his other research (e.g., the tunnel effect, a case of dynamic occlusion; causality perception, another case on the fringes between perception and cognition), and of the theoretical frameworks and experimental approaches at that time.

◆ **Amodal completion: A conceptual playground between perception and cognition**

R van Lier (Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, The Netherlands; e-mail: R.vanlier@donders.ru.nl)

Michotte and colleagues published a seminal paper, now fifty years ago, in which the term 'amodal completion' was introduced. This term is widely used in the literature, but is also rather puzzling. What does it mean for a 'perceptual' interpretation to be amodal – outside the modality of perception? The phenomenon of amodal completion raises fundamental questions regarding the perception-cognition distinction. I will discuss research on amodal completion that investigated the influence of, lower level, figural aspects (like collinearity or symmetry) and research that points to higher level influences (like familiarity or learning). I will also discuss the notion that amodal completion is an inextricable part of object perception, developed at relatively early stages after birth. Amodal completion appears intimately related to prediction and stability. It deals with questions like: 'what is a likely retinal stimulation when I move my head a little bit' or 'can I easily grasp that object' (placing large parts of my hand at the unseen side)? All in all, amodal completion appears to be a particularly fruitful playground for research on the interface between perception and cognition. It is a classic, Gestalt-like problem that has survived years of research, perhaps because it is still largely unsolved.

◆ **When amodal completion fails**

W Gerbino (Department of Life Sciences - Psychology Unit, University of Trieste, Italy;  
e-mail: gerbino@units.it)

The very name of our symposium topic is challenging. It soon became the (almost) universally accepted translation of "Les compléments amodaux" despite the fact that "amodal complements" – with the emphasis on phenomena, rather than processes – would have been much more in agreement with the content of the original paper by Michotte, Thinès and Crabbé. However, consider the hypothesis that all amodal complements actually are the result of the amodal completion of possibly incomplete (when considered in isolation) input elements, perceived as modal parts. Then, failures of amodal completion might tell us something important, just like failures of constancy tell us something on constancy. I will discuss a neglected perceptual phenomenon in detail and show why it can be considered a surprising and macroscopic failure of amodal completion, to be contrasted with its many positive manifestations. I will also recommend symposium participants to keep in mind that amodal complements, being phenomena, will survive our possible loss of faith in the hypothetical process of amodal completion.

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◆ **Michotte magic: Amodal perception and the art of conjuring**

V Ekroll (Laboratory of Experimental Psychology, University of Leuven, Belgium;  
e-mail: vebjorn.ekroll@ppw.kuleuven.be)

The research on amodal perception inspired by Michotte has contributed significantly to our present understanding of visual perception. Here, I show how it also provides an excellent framework for explaining the surprising potency and robustness of many magic tricks. Conversely, I also argue that studying people's reactions to magic tricks involving hidden objects may point to the existence of hitherto unknown kinds of amodal perception playing a role even in cases involving total occlusion. As already pointed out by Michotte, an important feature of amodal perception that sets it apart from imagery and cognition is its cognitive impenetrability. This is why amodal perception works in the magician's favor: The cognitive impenetrability of the perceptual illusion makes it exceedingly difficult to debunk the trick. Another well-known feature of amodal perception is the distinct and compelling impressions of contour or shape pertaining to the occluded parts of an object. As shown by van Lier (1999), however, the latter is not a general feature of amodal perceptual representations—they may also be fuzzy and visually indeterminate. In the case of total occlusion, I suggest that the extremely indeterminate perceptual representations constrain our thinking about what may be hidden behind the occluder.

◆ **Perceptual interactions between two kinds of amodal completion in the perception of occlusion**

B Gillam (School of Psychology, University of New South Wales, Australia;  
e-mail: b.gillam@unsw.edu.au)

There are two kinds of occlusion indicators when multiple objects are cut off in a linear fashion. "Para" factors cooperate to support occlusion from information on one side of the occluding surface. These include factors promoting amodal completion for each inducer, such as interruptions to its symmetry/regularity. It is difficult to determine if para factors are perceptual or cognitive. "Trans" factors support occlusion by allowing amodal completion of inducers across an occluder, which requires that they be relatable. Using subjective contour strength as an index of perceived occlusion, we showed that having para inducers on both sides of a potential occluding surface increased subjective contour strength. However trans factors enhanced perceived occlusion surprisingly little except when the gap size was small. The size effect is unlikely to be top-down since subjective contours were also consistently weaker for small gaps. A purely perceptual interaction between two kinds of amodal completion can explain these effects. Assume that para factors are more significant in generating perceived occlusion than trans factors. At small gaps, trans relations tend to dominate, generally diminishing the salience of para factors thus reducing subjective contour strength. This is partially compensated however when amodal completion across the gap is present.

◆ **Consistency criteria for successful interpolation of partly-occluded contours**

M Singh<sup>1,2</sup> (<sup>1</sup>Department of Psychology, Rutgers University, USA; <sup>2</sup>Rutgers Center for Cognitive Science, Rutgers University, USA; e-mail: manish.singh@rutgers.edu)

Studies of amodal completion often rely on subjective estimates of "completion strength" or, indirectly, on performance on other tasks believed to depend on amodal completion. A more direct approach is to rely on observers' ability to actually interpolate a contour in the region of occlusion. One might expect that, as geometric conditions become less favorable, interpolation settings will simply become less precise. While precision is certainly important, we argue that a more relevant criterion is self-consistency—whether interpolation settings are consistent with a single, stable, smooth contour. Note, however, that no pattern of results could violate consistency if one obtains settings at a single location, or obtains only positional settings at multiple locations. I will discuss consistency criteria for successful interpolation (developed jointly with J. Fulvio and L. Maloney). These criteria require obtaining paired settings of position and orientation at multiple locations within the occlusion region. We find that, for certain partly-occluded contours, observers' interpolation settings are not consistent with any smooth contour. The results allow us to operationalize, in formal terms, the notion of "completion strength." They also have interesting implications for the isomorphism hypothesis—the idea that perception in some sense "mirrors" properties of objects in the world.

Wednesday

◆ **Dynamic neural mechanisms suggested by the different kinds of perceptual organization in modal and amodal completion**

N Kogo (Laboratory of Experimental Psychology, University of Leuven, Belgium;  
e-mail: naoki.kogo@ppw.kuleuven.be)

Recent research has revealed a complex flow of information through the feedforward and feedback pathways in the hierarchy of the visual cortex. However, knowledge of how the multi-level interactions work together to establish a coherent perception is still incomplete. For example, the context-sensitivity of illusory surface formation suggests that the detection of global configurations plays a fundamental role. We have suggested that the neurons that are active at the location of illusory contours belong to the class of cells sensitive to border-ownership (“BO cells”) and that context-sensitive feedback mechanisms activate BO cells at the locations of illusory contours which constitutes the visualization of illusory contours. What happens, then, in amodal completion? According to the above hypothesis, the invisibility of completed contours characteristic of amodal completion may correspond to lack of the activation of BO cells. It is possible that higher-level neural activities represent both modally and amodally completed surfaces. However, while the shape of a modally completed surface is articulated with the dynamic development of border-ownership signals completing the gaps, the shape of amodally completed surfaces remain uncertain and may be represented only in terms of likelihood.

**SYMPOSIUM: MEASURING VISUAL AWARENESS - APPROACHES, APPLICATIONS, RECOMMENDATIONS**

◆ **Measuring visual awareness - approaches, applications, recommendations**

G Hesselmann, M Rothkirch (Visual Perception Laboratory, Department of Psychiatry & Psychotherapy, Charité-Universitätsmedizin Berlin, Germany; e-mail: g.hesselmann@gmail.com)

One of the scientific approaches developed to investigate perceptual awareness consists in making an exhaustive inventory of the processes that proceed non-consciously, in order to isolate, by contrast, those that are exclusively restricted to conscious perception. In the visual domain, in particular, a wide range of paradigms have been designed to render a stimulus invisible, sometimes dubbed “psychophysical magic” (e.g., backward masking, crowding, binocular rivalry). It is self-evident, however, that before one can claim “invisibility” of a stimulus, the fundamental question of what behavioral report or physiological signal classifies as a valid measure of visual awareness needs to be answered. Although the controversy on the optimal measure has been a long standing one (Eriksen 1960; Holender 1986), a renewed debate seems timely and important. On the one hand, new measures of visual awareness such as post-decision wagering have been introduced, which might (or might not) turn out to be superior to established measures. On the other hand, new visual paradigms such as continuous flash suppression have been developed, which might (or might not) require more rigorous measures to assess observers’ awareness. Ultimately, given the increasingly large inter-study variability of awareness measures and visual paradigms, guidelines or recommendations should be formulated.

◆ **The challenge of measuring visual consciousness**

M Overgaard<sup>1,2</sup> (<sup>1</sup>Institute of Clinical Medicine, Aarhus University, Denmark; <sup>2</sup>Department of Psychology and Communication, Aalborg University, Denmark;  
e-mail: morten.overgaard@hammel.rm.dk)

Having an adequate measure of consciousness is obviously crucial for consciousness research per se. Overall, two general kinds of measures of have been applied: Objective measures (e.g. forced-choice discriminations) and subjective measures. Whereas consensus is forming that objective measures are only relevant when accompanied by or validated by a subjective measure, there is currently much confusion what various subjective methods actually measure, not least if they all measure consciousness and if so in the same way. Current findings lead to an attempted overview of different measures relate to different concepts of consciousness.

[European Research Council]

◆ **Putting high-level findings in breaking continuous flash suppression in perspective**

P Moors (Laboratory of Experimental Psychology, KU Leuven, Belgium;  
e-mail: pieter.moors@ppw.kuleuven.be)

Breaking continuous flash suppression (b-CFS) has proven to be a popular method to measure unconscious (visual) processing. Some studies using b-CFS have provided evidence for high-level processing of suppressed stimuli, contrary to findings obtained using classical binocular rivalry

paradigms. In this talk, I will present two b-CFS studies. In the first study, we replicated the finding that a Kanizsa square configuration breaks suppression faster than a random configuration, but that this is presumably due to low-level differences in the configurations rather than the extraction of the illusory surface during suppression. In a second b-CFS study, we investigated whether word stimuli are processed up to the semantic level during suppression. We failed to obtain any evidence that word stimuli broke suppression differentially from pseudo- or non-word stimuli. These findings can be explained from the perspective that suppression through CFS might act at a level too low in the visual cortex for these processes to unwind. The implications for the usefulness of CFS as a method to study unconscious visual processing in general will be discussed.

◆ **Modeling of conscious and unconscious visual emotion perception with a signal detection theory approach**

R Szczepanowski (Faculty in Wroclaw, University of Social Sciences and Humanities, Poland;  
e-mail: rszczepanowski@swps.edu.pl)

For the last decades experimental psychology has attempted to address questions whether visual emotion perception occurs without consciousness. More recent lines of research on emotion perception use a signal detection theory approach to tackle this scientific problem. According to this statistical framework one can 'objectively' measure whether participants are aware of detecting emotional stimuli under a forced choice condition. In this fashion, behavioral choices exhibited in the perception task were equated with our intuition of conscious behavior. Unfortunately, this reasoning suffers from oversimplification if we admit that we have no access to the stimulus and our ability to discriminate the presence or absence of the emotional stimulus depends on our brain's activity. Nevertheless, during the presentation it will be shown that signal-detection models can successfully capture conscious perception if one embraces subjective knowledge-based components into characteristic of affective discrimination predicted by the hierarchical signal-detection model and the Krantz's threshold model. The author will provide modeling evidence from masking experiments with confidence ratings indicating that both models can be applied not only to simple facial affect discrimination, but they also have capability in predicting conscious emotion perception as a product of the dynamic interplay between cognitive and affective processes.

◆ **Enforcing double dissociations between measures of priming and awareness**

T Schmidt (Center for Cognitive Science, University of Kaiserslautern, Germany;  
e-mail: thomas.schmidt@sowi.uni-kl.de)

Unconscious perception can be demonstrated by establishing an experimental manipulation that leads to opposite effects in an indirect measure of visual perception and a direct measure of visual awareness. Such a double dissociation (e.g., between priming and identification of a masked prime) rules out that both effects are controlled by only a single source of conscious information. Importantly, it requires none of the restrictive assumptions needed for demonstrating that a masked prime is "invisible" (Schmidt & Vorberg, 2006). Here a psychophysical procedure is demonstrated that enforces double dissociations between masked priming and prime visibility by experimentally inducing qualitatively different time-courses of visual masking. Participants respond to visual targets preceded by masked primes, and the intensity of the mask is systematically coupled to the prime-target SOA so that prime visibility either increases or decreases with SOA. A double dissociation is produced when motor priming effects keep increasing with SOA no matter whether prime visibility increases or decreases. Such "enforced double dissociations" between priming and awareness are demonstrated for response priming and Eriksen paradigms. The technique can sometimes produce double dissociations in fields where this was previously not possible.

◆ **Don't trust your subjects – a case for objectifying subjective experience in rivalry**

W Einhäuser (Neurophysics, Philipps-University Marburg, Germany;  
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Visual awareness is frequently measured by rivalry paradigms. Typically, observers must continuously monitor their perceptual experience and report changes therein, and analysis solely relies on such report. I will review recent evidence that casts doubt on this approach: 1) The duration of perceptual dominance depends on the action required for report. 2) Comparing observers' report to objective measures of current perceptual dominance (e.g., the direction of the optokinetic nystagmus for rivalry between stimuli moving in distinct directions or pupil size for rivalry between stimuli of distinct luminance) reveals that observers fail to report short periods of dominance and that button-press data conceals the gradual nature of awareness. 3) Contrasting alternations in awareness to corresponding stimulus changes typically



Wednesday

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shows activations in frontoparietal networks. When observers are not required to report their perceptual state, however, only parietal activations prevail. This suggests that frontal activation in rivalry is related to introspection rather than to transitions in awareness. 4) Objective measures without volitional control allow testing the effect of reward on awareness with tasks for which deliberate non-veridical report is strategically optimal (i.e., they prevent “cheating”). These findings make a strong case that objective measures should complement subjective report when assessing visual awareness.

[Supported by the German Research Foundation (DFG) grant EI 852/3.]

## TALKS: MULTISENSORY PROCESSING

### ◆ **Rapid temporal recalibration is unique to audiovisual stimuli: no effects for audiotactile or visuotactile stimuli**

D Alais, E Orchard-Mills, E van der Burg (School of Psychology, University of Sydney, Australia; e-mail: david.alais@sydney.edu.au)

Recently, Van der Burg, Alais and Cass (2013) showed audiovisual temporal recalibration occurs very rapidly, requiring only a single, brief asynchronous trial. Does such rapid recalibration also occur between audiotactile and visuotactile stimuli? In separate audiovisual, audiotactile and visuotactile experiments (using same participants, design, and task) we replicated rapid audiovisual recalibration but found no recalibration whatsoever for audiotactile and visuotactile. This shows that rapid recalibration is a uniquely audiovisual phenomenon. In addition, given previous findings of recalibration for all combinations following prolonged adaptation, it suggests that audiovisual recalibration occurs at two different timescales (fast and slow) but audiotactile and visuotactile recalibration only occurs at slow timescales. A second experiment used the same task but all three modality pairings were presented in a randomized order so that they were unpredictable. We confirmed that only audiovisual stimuli exhibit rapid recalibration but we also found a degree of transfer between pairings: any pairing showed a recalibration effect on the current trial if the preceding trial contained an audiovisual stimulus. These results again show that recalibration is uniquely an audiovisual phenomenon, and that it occurs whether trials are blocked and predictable or randomised and unpredictable.

### ◆ **Audio-visual temporal recalibration is driven by decisional processes**

D H Arnold<sup>1</sup>, B Keane<sup>1</sup>, K Yarrow<sup>2</sup> (<sup>1</sup>Psychology, The University of Queensland, Australia; <sup>2</sup>Psychology, City University London, United Kingdom; e-mail: d.arnold@psy.uq.edu.au)

“Time is an illusion. Lunch time doubly so” (Adams, 1979). A malleable sense of time is not unique to the bacchanal, but commonplace, resulting in striking, and some subtle, illusions. Audio-visual temporal recalibration (TR) is an example of the latter. After prolonged exposure to an audio-visual asynchrony, subsequent tests can seem more synchronous than they did previously. The underlying cause(s) is unclear. One suggestion is that TR reflects changes in processing speed. This seems unlikely as one can induce oppositely signed TRs simultaneously. Another suggestion is that TR results from multiple channels tuned to different temporal offsets, with adaptation to asynchrony causing systematic changes in channel responsiveness and encoded timing. A third explanation is that TR reflects changes in decisional criteria. Consistent with this last, we show that TR is strongly influenced by task demands. TR was approximately halved by asking people if sounds preceded or lagged visual events, or if timing was indeterminable, as opposed to simply asking if signals were synchronous or asynchronous. We believe the former task encouraged participants to adopt more rigorous and stable criteria, highlighting the importance of these processes over changes in the responsiveness of hypothetical channels, for which no firm evidence exists.

[Australian Research Council - Future Fellowship]

### ◆ **Seeing and feeling size: a cross-modal discrimination experiment**

A M L Kappers, S E M Jansen, W M Bergmann Tiest (Human Movement Sciences, Move Research Institute, Netherlands; e-mail: a.m.l.kappers@vu.nl)

How does the size of an object that you can only see compare to that of an object you can only feel? To answer this question we have conducted an experiment where participants verbally reported which of the following they perceived as being larger: a visually presented object that could not be touched or a haptically presented object that could not be seen. Haptic exploration was either unrestricted or the object was presented on a stand, thereby removing mass information. Participants were tested in a 2 (exploration) × 2 (shape) within-subject design where each block consisted of a single condition. Within each block, 4 staircases of 20 trials were presented interleaved. Stimuli ranging in size between 2-10

cm<sup>3</sup> and 6-14 cm<sup>3</sup> were tested against reference volumes of 6 and 10 cm<sup>3</sup>, respectively (both haptically and visually). The perceptual bias results from subtracting the reference volume from the point of subjective equality. Data from 12 participants show that they are consistent in their judgments within a block. However, it seems that substantial variances arise between blocks and between participants but independent of shape or exploration type. These results suggest that judgment is recalibrated at the start of each block.

◆ **Size, distance, her anisotropy and her lover – independence of perceived size and distance**

O M Tošković (Laboratory for Experimental Psychology, Faculty of Philosophy, University of Belgrade, Serbia; e-mail: otoskovi@f.bg.ac.rs)

According to Size-distance invariance hypothesis perceived distance is related to perceived size. We showed that perceived distance is anisotropic since vertical distances are perceived as longer than horizontal. Size-distance invariance hypothesis would claim that this anisotropy must imply perceived size anisotropy, as well. We performed four experiments in which 57 (14+13+16+14) participants matched distances or sizes of dim light stimuli, in a dark room, on three directions (0, 45 and 90 degrees). In two experiments participants were sitting upright (vestibular and proprioceptive information change), while in other two they were lying on the left side of the body (proprioceptive information change). For distance matches in both situations, when participants are sitting upright and lying on the side, results show significant effects of stimuli distance, viewing direction and their interaction. In both positions participants tend to perceive vertical distances as longer. For size matches, in both positions of participants, results show only significant effect of stimuli distance, meaning that there are no differences in perceived sizes of stimuli on various viewing directions. Results show that although perceived distance is anisotropic, perceived size is isotropic. These findings contradict to Size-distance invariance hypothesis and suggest relative independence of perceived size and distance.

[This research was supported by Ministry of education and science of Republic of Serbia, project number ON179033.]

◆ **Effects of color and visual texture on drink perception**

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Color and visual texture of food affect people's taste perception. However, the influence of color and visual texture of a drink on flavor perception has not been studied quantitatively. We developed an Augmented Reality system that was capable of changing the color and visual texture of drinks in real time. We conducted experiments designed to investigate how the color and/or visual texture of drinks influences taste and flavor perception. Participants viewed a video of a drink (orange juice, coffee or cola) presented in a cup placed in front of them with a head mounted display. We changed the color and/or the visual texture of the drink. The participants reported before and after tasting the drink on the expected and perceived flavor. The results showed that people's perception of drink can be modulated by changing the visual texture of the visual image. For example, the visual texture of milk enhanced the flavor of milk in a coffee, and saturated color of orange juice increases the perceived density of the juice. In addition, the effects of visual texture on flavor perception were highly consistent across participants, suggesting that such visual effects can be used for changing the flavor of drinks.

[This work was supported by JSPS KAKENHI Grant Number 25135715.]

◆ **Music-color associations in synesthetes and non-synesthetes: the mediating role of emotion**

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Are synesthetic experiences caused by direct connections between sensory domains or are they mediated by other associations? We approached this question by investigating whether the strong evidence of emotional mediation in music-to-color associations of non-synesthetes (Palmer et al., 2013) is also evident in matched timbre-color synesthetes choosing among the same 37 colors while listening to the same musical stimuli (dozens of musical excerpts, plus lower-level instrumental timbres and chords). As before, non-synesthetes showed systematic patterns of cross-modal associations between musical features (e.g., tempo, major/minor mode) and four dimensions of color appearance (light/dark, blue/yellow, red/green, saturated/unsaturated). These associations were mediated by emotions (e.g., happy/sad, agitated/calm, angry/not-angry, strong/weak, active/passive) as indicated by high correlations between emotional ratings of the music and corresponding emotional ratings of the colors they associated

Wednesday

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with that music (e.g.,  $r=.95$  for happiness/sadness). Sixteen timbre-color synesthetes showed color choices similar to non-synesthetes ( $r=.64$ ) and evidence of emotional mediation in most dimensions, but systematically weaker. Some emotional effects present for non-synesthetes were entirely absent for synesthetes (e.g., pure note-rate effects on every emotional dimension). Emotions thus play a surprisingly powerful role in the experiences of timbre-color synesthetes, but their absence in certain cases suggests qualitative differences from analogous non-synesthetic associations.

[This work was supported by the National Science Foundation (Grant Nos. BCS-1059088 and BCS-0745820) to the first author.]

## TALKS: LEARNING

### ◆ Individual differences in perceptual learning: structural and functional brain correlates

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We report that pre-existing individual differences in the cortical thickness of brain areas involved in a perceptual learning task predict subsequent perceptual learning rate. Motion-sensitive area MT+ and posterior parietal cortex (PPC), an area involved in attention and decision-making, were functionally identified as central to a motion-discrimination task: individual differences in the amplitude difference in blood oxygen level-dependent (BOLD) activity during task performance between pre-training and post-training in those areas predicted individuals' learning rate. We then computed the pre-training cortical thicknesses of MT+ and PPC, measured by anatomical magnetic resonance imaging (MRI), and found that they significantly predicted perceptual learning rate. Participants with thicker cortex in MT+ and PPC before training learned faster than those with thinner cortex in those areas. Taken together, pre-training cortical thickness and functional activity changes in MT and PPC accounted for about half of the overall variance in learning rate across participants.

[BMBF "Brain Plasticity and Perceptual Learning".]

### ◆ Search history influences choosing and liking: bias towards target is provided by distractor repetition while liking is decreased after distractor-to-target switch

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Visual search performance benefits from repetition of targets and distractors and suffers when they are switched. Priming effects of repeated visual search also extend to free choice: observers are more likely to choose targets repeatedly presented in preceding search trials than equally exposed distractors (Brascamp, Blake, Kristjánsson, 2011). Previous exposure also influences liking ratings of search items: targets receive more positive rating, and distractors – less positive (Goolsby et al., 2009). Here, we bridge the gap between these research fields by comparing the effects of repetitions and switches on reaction times, choice biases, and liking in a color singleton search task. The results show that choice biases and liking are differentially sensitive to repetition benefits and switch costs. Choices were biased towards search targets when distractors were repeated. Novel distractors or distractor-to-target switches eliminated this bias. In contrast, liking effects were sensitive only to the distractor-to-target switch, in which case there was a decreased liking of the distractor that became a target. Finally, RTs were sensitive to repetition benefits; switch costs were present but not significant. The findings suggest that choice biases reflect distractor inhibition while liking reflects the conflict resulting from its disinhibition.

[The study was supported in parts by the Russian Fund for Humanities project #12-36-01294 and a research grant from Saint-Petersburg State University 8.38.207.2014 (AC).]

### ◆ Perceptual learning with only one stimulus

L Grzeczowski<sup>1</sup>, E M Tartaglia<sup>2</sup>, F W Mast<sup>3</sup>, M H Herzog<sup>1</sup> (<sup>1</sup>Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; <sup>2</sup>Departments of Statistics and Neurobiology, University of Chicago, USA; <sup>3</sup>Department of Psychology, University of Bern, Switzerland; e-mail: lukasz.grzeczowski@gmail.com)

Perceptual learning is learning to see. For example in a bisection task, three parallel lines are presented with the central line slightly offset towards the right or the left outer line. Participants indicate the offset direction. Training gradually improves performance. Models of perceptual learning explain learning

by synaptic changes determined by the learning algorithm and the stimulus presentation. In these models, learning cannot occur when the very same stimulus is presented in all training trials. Here we show that, surprisingly, humans can improve performance in such "impossible" conditions. We trained observers with a line bisection task where the central line was always exactly in the middle for all 4160 training trials. Participants were not told about the "zero offset" and were instructed to indicate the offset direction as in a normal bisection task. Surprisingly, performance improved with gains similar to "normal" bisection experiments where both the left and right offset are presented. These results cannot be explained by most of current models of perceptual learning and reproduce previous studies in the auditory domain (Amitay, Irwin & Moore 2006). We suggest that perceptual learning occurs by mental imagery in accordance with previous results (Tartaglia, Bamert, Mast & Herzog, 2009, 2012).

◆ **Improvement of visual acuity and contrast sensitivity in non-corrected mild myopia with combined contrast detection training and transcranial random noise stimulation (tRNS)**

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Perceptual learning has shown to produce an improvement of visual functions such as an increase of visual acuity and contrast sensitivity both in participants with amblyopia and refractive defects such as myopia or presbyopia. Additionally, transcranial random noise stimulation (tRNS) has proven to be efficacious in accelerating neural plasticity and boosting perceptual learning in healthy participants. This study investigated whether a short behavioural training using a contrast detection task, combined with online tRNS, was more effective than the training plus sham stimulation in improving visual functions in participants with mild myopia. A battery of tests measuring visual functions was administered prior to (pre-test) and following the training (post-test). Eight training sessions on a contrast detection task using individualized cut off spatial frequencies (combined or not with tRNS) were administered. The experimental group reached a larger improvement, respect to the control group, in both visual acuity (mean improvement of 1.4 LogMAR) and contrast sensitivity (at intermediate spatial frequencies). These results suggest that neuromodulatory techniques can boost perceptual learning and its generalization to non-trained visual functions, strongly reducing the duration of trainings needed to improve sight in people with non-corrected refractive defects.

◆ **Oculomotor sequence learning, automation and interruption**

M J Stainer<sup>1</sup>, R H S Carpenter<sup>2</sup>, P Brotchie<sup>3</sup>, A J Anderson<sup>1</sup> (<sup>1</sup>Optometry and Vision Sciences, University of Melbourne, Australia; <sup>2</sup>Gonville and Caius College, University of Cambridge, UK; <sup>3</sup>Radiology, University of Melbourne, Australia; e-mail: mstainer@unimelb.edu.au)

Many of our day-to-day activities can be thought of as chains of shorter sequential actions. Accordingly, we appear to automate many habitual parts of our daily routine to free up processes for other tasks. While this can be advantageous, there are also times where our routine is unexpectedly interrupted. We conducted two experiments to examine how sequence interruption affects response latencies in a simple, short oculomotor sequence that is quickly learnt and automated, and across the learning of a complex, long sequence. Typically the short sequence was completely learnt by the second presentation, and interruptions made after this were equally disruptive. However, in long sequences, learning was significantly slower (exponential time constant:  $t(5) = 9.57$ ,  $p < 0.001$ ), and accordingly a graded increase in the disruptive effect ( $\beta = 11.66$ ,  $SE = 2.99$ ,  $t = 3.9$ ) of interruptions at different levels of learning completeness was observed. Our results are consistent with a gradual change in sequence representation as sequences are learnt, with later representation schemes being least resilient to interruptions. The timecourse of this representation change appears to mirror that of sequence learning itself. Our sequence interruption paradigm may be a useful tool for researchers studying aspects of behavioural automation.

◆ **Binocular suppression transfers to the contralateral eye**

M Vergeer, J Wagemans, R van Ee (Laboratory of Experimental Psychology, KU Leuven, Belgium; e-mail: mark.vergeer@ppw.kuleuven.be)

In perceptual learning, performance on a visible trained stimulus typically improves as the result of training. Here we show that training on suppressing a stimulus can have a detrimental effect on perceptual learning. Throughout training, an oriented grating presented to one eye was constantly suppressed by a high-contrast expanding bull's eye presented to the other eye. To keep observers attentive, they performed a contrast discrimination task on the bull's eye while unaware of the suppressed grating. Pre- and posttest detection performance were measured for target gratings with the suppression-trained

Wednesday

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orientation and for gratings with the orthogonal orientation in both the trained and untrained eye. These targets competed with a low-contrast expanding bull's eye presented to the opposite eye. Overall, performance showed a stronger improvement compared to pre-training baseline for gratings presented to the eye that was dominant during training (where the bull's eye was presented), indicating eye-based learning. Interestingly, there was an additional stimulus-based effect, where improvement was significantly stronger for orthogonal orientations, compared to the trained, suppressed orientation. This suggests that observers can train to suppress a specific stimulus. The stimulus effect also occurred for the untrained eye. Such interocular transfer challenges purely monocular accounts of binocular suppression.

## TALKS: FACE PERCEPTION

### ◆ Individual variation in the perception and recognition of faces

K Lander<sup>1</sup>, S Poyarekar<sup>1</sup>, J Davis<sup>2</sup> (<sup>1</sup>School of Psychological Sciences, University of Manchester, UK; <sup>2</sup>Psychology and Counselling Department, University of Greenwich, UK; e-mail: karen.lander@manchester.ac.uk)

Relatively little research has looked at individual differences in face recognition ability. However, Megreya and Burton (2006) showed large individual differences in unfamiliar face matching and found moderate correlations between face matching and various components of visual short-term memory, cognitive style and perceptual speed tasks. Li et al. (2010) found that extroverts who have better social skills performed better in a face recognition memory task compared with introverts. Finally, Burton et al. (1999) found that expert police officers were no better at identifying people from CCTV footage compared with other unfamiliar participants. In this talk, we describe a number of experiments, conducted with police officers and non-police officers looking at the effect of expertise and individual differences on a number of face perception and recognition tasks. Results suggest that fingerprint experts and facial image comparison experts perform significantly better than controls on a CCTV face array task. We also discuss the range of performance across an undergraduate student population on both face recognition and face matching tasks.

### ◆ Combined TMS / fMRI reveals dissociable cortical pathways for dynamic and static faces

D D Pitcher<sup>1</sup>, B Duchaine<sup>2</sup>, V Walsh<sup>3</sup> (<sup>1</sup>Laboratory of Brain and Cognition, NIMH, U.S.; <sup>2</sup>Psychology, Dartmouth University, U.S.A.; <sup>3</sup>Psychology, University College London, U.K.; e-mail: david.pitcher@nih.gov)

Faces contain structural information, for identifying individuals, as well as changeable information, that conveys emotion. Neuroimaging studies reveal brain regions that exhibit preferential responses to invariant or changeable facial aspects but the functional connections between these regions are unknown. We addressed this issue by causally disrupting two face-selective regions with thetburst TMS and measuring the effects of this disruption in local and remote face-selective regions with fMRI. Participants were scanned, over two sessions, while viewing dynamic or static faces and objects. During these sessions, TBS was delivered over the occipital face area (OFA) or posterior superior temporal sulcus (pSTS). Disruption of the OFA reduced the neural response to both static and dynamic faces in the OFA and in the downstream face-selective region in the fusiform gyrus. In contrast, the response to dynamic and static faces was doubly dissociated in the pSTS. Namely, disruption of the OFA reduced the response to static but not dynamic faces, while disruption of the pSTS itself, reduced the response to dynamic but not static faces. These results suggest that dynamic and static facial aspects are processed via dissociable cortical pathways that begin in early visual cortex, a conclusion inconsistent with current models of face perception.

### ◆ Effects of inversion and contrast-reversal on objective face detection thresholds identified by sweep steady-state visual evoked potentials

J Liu-Shuang<sup>1</sup>, J M Ales<sup>2</sup>, B Rossion<sup>1</sup>, A Norcia<sup>3</sup> (<sup>1</sup>Psychology, University of Louvain, Belgium; <sup>2</sup>Psychology, University of St-Andrews, Scotland; <sup>3</sup>Psychology, Stanford University, USA; e-mail: joan.liu@uclouvain.be)

Human observers can rapidly detect face stimuli in natural scenes. Recently, we determined a perceptual threshold for face detection by parametrically varying the visibility of a face stimulus with phase-scrambling, while alternating it with fully scrambled face stimuli (3 Hz alternation, 6 images/second) (Ales et al., 2012). As the face gradually emerged over the course of a trial, periodic EEG responses at 3 Hz appeared at  $\approx 35\%$  phase coherence over right occipito-temporal channels. Here we evaluated the specificity of this response to face structure rather than general shape perception by presenting sweep

sequences containing faces that varied in orientation (upright vs. inverted) and contrast polarity (positive vs. negative). These two manipulations preserve low-level visual information but greatly and specifically affect face perception. Robust 3Hz responses emerged abruptly on occipito-temporal electrodes at  $\approx 35\%$  phase coherence for upright faces, replicating previous results. Importantly, this threshold was delayed ( $\approx 45\text{-}50\%$  coherence) and the overall amplitude of the response was reduced ( $50\text{-}75\%$  magnitude of the response) for inverted and negative polarity faces. These findings indicate that the 3Hz response reflects face-specific processes and can thus be used as an objective index of face detection in the human brain.

◆ **Reconstructing Emotions in Motion in Prosopagnosia Reveals Separate Representations for Identity and Emotion**

A Richoz<sup>1</sup>, R E Jack<sup>2</sup>, O G B Garrod<sup>2</sup>, P G Schyns<sup>2</sup>, R Caldara<sup>1</sup> (<sup>1</sup>Department of Psychology, University of Fribourg, Switzerland; <sup>2</sup>Institute of Neuroscience and Psychology, University of Glasgow, United Kingdom; e-mail: roberto.caldara@unifr.ch)

The human face transmits a wealth of visual signals that readily provide crucial information for social interactions, such as identity and emotional expressions. Yet, a fundamental question remains unresolved: does the face information of identity and emotional expression categorization tap into single or separate representational systems? To address this question we tested PS, a pure case of acquired prosopagnosia, whom uses the suboptimal mouth to process identity and is impaired in categorizing many expressions of the (static) Ekman faces. We used a generative grammar of the Facial Action Coding System coupled with a reverse correlation technique to model 3D dynamic mental representations of the six basic facial expressions of emotion, in PS and healthy observers. Surprisingly, PS's dynamic mental models of facial expressions were comparable to the controls. Subsequent verification tasks revealed that PS accurately categorized her own and average dynamic facial expression models, but not the very same static exemplars. Evidence that PS reconstructed dynamic facial expressions by using all facial features demonstrates that the face-system relies on distinct representations for identity and emotion, flexibly adapting to categorization constraints. Our data also questions evidence of deficits obtained from patients using static images, and offer novel routes for patient rehabilitation.

◆ **Foveal and extrafoveal processing of features within a face underpinning emotion recognition**

A P Atkinson<sup>1</sup>, H E Smithson<sup>2</sup> (<sup>1</sup>Department of Psychology, Durham University, UK; <sup>2</sup>Department of Experimental Psychology, Oxford University, UK; e-mail: a.p.atkinson@durham.ac.uk)

At normal interpersonal distances not all features of another's face can fall within one's fovea simultaneously. Different facial features are diagnostic of different emotions (Smith et al., 2005). Does the ability to identify facially expressed emotions vary according to the feature fixated? We 'forced' fixation on an eye, brow, cheek, or mouth of faces whose size corresponded to a normal interpersonal distance, in a fixation-contingent manner for a time insufficient for a saccade. In Experiment 1 (anger, fear, happiness, neutral) participants were more accurate and faster in identifying anger when fixating the brow and more accurate for fear when fixating the eyes. Higher autism spectrum quotient (AQ) scores were associated with less efficient processing of task-relevant information from the eye and brow and more efficient processing of task-relevant information from the mouth region. In Experiment 2 (anger, fear, surprise, neutral) participants were more accurate and faster for anger when fixating the brow and for fear, surprise and neutral when fixating the mouth. Higher AQ scores were associated with lower accuracy for fear regardless of fixation location. The first saccade after face offset tended to be in the direction of diagnostic features, highlighting the importance of extrafoveal processing of facial features.

◆ **Anomalous optimal points of fixation to faces**

M P Eckstein, C C - F Or, M F Peterson (Psychological and Brain Sciences, University of California, Santa Barbara, USA; e-mail: eckstein@psych.ucsb.edu)

When identifying a face the majority of humans initially look just below the eyes, consistent with the optimal point of fixation of a foveated Bayesian ideal observer (FIO, Peterson & Eckstein, 2012). Here, we show that 17 % of 200 observers tested are inconsistent with the FIO and fixate towards the nose or lower when identifying a face (nose lookers). We assessed whether these anomalous fixation strategies are related to distinct anisotropies in sensitivity across nose lookers' visual fields, or whether they are associated with systematic differences to face-specific mechanisms. Eight eye lookers and seven nose lookers participated in experiments measuring: 1. Accuracy of face identification while maintaining

Wednesday

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fixation at each of four points: forehead, eyes, nose, mouth; 2. Detection of a Gabor signal (6 c/deg) at different points across the visual field. We found that the location of initial fixations correlated with the locations that maximized face identification accuracy. However, there was no correlation between the location of fixation to faces and changes in Gabor detectability across the visual field. Our results suggest that the anomalous optimal points of fixation cannot be explained in terms of lower-level anisotropies across the visual field and are related to face-specific neural mechanisms.

[EY-015925 from the National Institutes of Health to MPE.]

## TALKS: DEVELOPMENT

### ◆ **Cross-modal integration limits preverbal infant abstract rule learning**

C H Tseng, H M Chow, A S M Tsui, Y K Ma, D Yat (Psychology, The University of Hong Kong, Hong Kong; e-mail: CH\_Tseng@alumni.uci.edu)

Although multi-sensory stimulation is frequently promoted in pre-school learning, the scientific support of its effect is limited. We fill in this gap by observing 8-10 month old infants' capacity to extract rule patterns under visual-only, audio-only, or bimodal presentation. With habituation paradigm, we use infants' looking time recovery when a novel rule pattern is presented at test phase as an indication of their ability to distinguish between the novel and habituated rule. We find that bimodal learning facilitation is not merely a simple story of sensory enhancement. Rather, preverbal infants are sensitive to the perceptual and semantic compatibility of the audio-visual correspondence. Bimodal facilitation was only present when cross-modal information was congruent and relevant. Our results suggest that during early human development, sensory streams combine and form a bimodal unit before it enters learning system for later processing. We demonstrate that cross-modal integration is a precursor for successful abstract rule learning, and multi-sensory stimulation does not always warranty learning facilitation.

[Tseng was supported by Hong Kong General Research Funding.]

### ◆ **Measuring perceptual sampling efficiency in adults and children**

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Perception is inherently noisy, so it is often useful to sample multiple information sources before deciding how to act. However, there is a trade-off between resources allocated to information sampling and the benefits of this additional information for performance. For example, when crossing a road, we need to stop looking at some point and decide to cross. We adapted a task developed by Juni, Gureckis & Maloney (2011) that models such situations in the laboratory, to investigate (A) how observers adjust their perceptual sampling strategies when perceptual information changes in its reliability, (B) whether in doing so they achieve an optimal trade-off between the costs and benefits of new information, and (C) how this behaviour develops during childhood. In our child-friendly pointing task, observers 'buy' cues to increase perceptual certainty about the location of a hidden target, thereby trading-off points against perceptual accuracy to maximize scores. Initial results show that adults are able to adapt their sampling strategy as cue reliability changes, and are close to optimal in their performance. Pilot work shows the task to be appropriate for children, allowing us to investigate how information-sampling strategies emerge in developing perceptual systems.

[This work was funded by an Economic & Social Research Council grant RES-061-25-0523]

### ◆ **Efficient strategies for measuring perceptual thresholds in infants using eyetracking**

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Measuring perceptual thresholds in infants is notoriously difficult, as the methods need to work robustly even with unreliable and inattentive observers. Staircase methods are commonly used for rapid estimates of threshold, but formulating appropriate staircase rules depends on assumptions about behaviour (e.g., lapse rates). I will discuss these issues in the context of our development of an eyetracker based test of visual acuity. Data from 57 infants aged 3-12 months show how the choice of staircase parameters can dramatically affect the effectiveness of a test, and how targeting the commonly used 70.7% correct threshold can sometimes lead to spurious results. The reasons for these differences will be discussed, based on analyses of infants' false-negative and false-positive rates. Using Monte Carlo simulations, I will also discuss how the small numbers of trials can affect how threshold is best computed, and will suggest that simply taking the highest correct value may sometimes be preferable to averaging across reversals. The final version of our test provides robust measures of visual acuity, showing that remote

eyetracking, together with well-formulated staircase rules, can provide powerful new techniques for investigating visual development.

[Fight for Sight, and The NIHR Biomedical Research Centre at Moorfields Eye Hospital and the UCL Institute of Ophthalmology.]

◆ **Categorization of faces versus objects in the infant's right occipito-temporal cortex by means of fast periodic visual stimulation**

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Human adults are extremely efficient at detecting faces in complex visual scenes. Yet the developmental course of this remarkable ability remains unknown. We recorded EEG in 15 4- to 6-month-old infants viewing between 5 and 12 20-second sequences of images flickering at 6 Hz (6 images/second). Each sequence included series of 4 objects followed every fifth stimulus by a face. Unsegmented objects and faces varied substantially in size, colour, lighting and viewpoint; faces varying also in gender, age, race and expression. EEG trials were averaged for each infant and analysed in the frequency domain. A sharp response was found over the medial occipital lobe exactly at 6 Hz. There was also a clear response at the oddball face frequency ( $6/5 = 1.2$  Hz) at the right occipito-temporal electrode P8. These findings indicate that 4- to 6-month-old infants discriminate unsegmented faces from other complex objects and generalize across faces despite their high physical variance. They also show that the right hemisphere advantage for face perception emerges early in infancy, being therefore independent of left lateralized letter/word representations emerging later. Finally, they highlight the power of fast periodic visual stimulation to characterize infants' high-level visual functions.

◆ **Neural correlates of age-related changes during multiple object processing**

S Pagano<sup>1</sup>, E Fait<sup>1</sup>, A Monti<sup>1,2</sup>, D Brignani<sup>3</sup>, V Mazza<sup>1,3,4</sup> (<sup>1</sup>Center for Mind/Brain Sciences, University of Trento, Italy; <sup>2</sup>Department of Neurorehabilitation Sciences, Casa Cura Policlinico, Milan, Italy; <sup>3</sup>IRCCS Centro San Giovanni di Dio Fatebenefratelli, Brescia, Italy; <sup>4</sup>Department of Psychology and Cognitive Science, University of Trento, Italy; e-mail: [silvia.pagano@unitn.it](mailto:silvia.pagano@unitn.it))

Simultaneous processing of multiple objects is a fundamental ability that relies on the capacity to individuate multiple items and to maintain the individuated objects in visual working memory (VWM). Here we assessed whether multiple object processing undergoes age-related changes, and whether these changes are related to individuation or VWM, by comparing a group of young ( $M=24.8$ ) and old ( $M=69.7$ ) adults during an enumeration task on a varying number of targets (1-6) presented among distractors. We measured N2pc and CDA- two ERP components associated respectively with individuation and VWM- and oscillatory activity using event-related spectral perturbations (ERSPs). Behavioral results showed that old participants performed worse than younger participants. ERP results indicated that N2pc was suppressed in the old group over the whole numerosity range (1-6), while CDA was suppressed only for the largest numerosities (4-6). This pattern suggests that while individuation is less functional during aging, VWM procedures can compensate for this sub-optimal functioning over small (1-3) numerosities. Preliminary ERSP results showed an increase in theta, alpha and beta activities over anterior sites for older adults, suggesting that aging requires recruitment of additional resources to be able to elaborate multiple targets concurrently.

[This work has been supported by the Italian Ministry of Health grant "Progetto di Ricerca Giovani Ricercatori" awarded to V.M. ]

◆ **Cortical timing of contrast processing in infants with perinatal brain injury**

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Visual measures can provide sensitive early indicators of brain development in children at risk from perinatal brain injury (PBI). Here we investigate the temporal dynamics of contrast processing in a group of 57 preterm and term-born infants with PBI. The latency of the first positive peak (P1) of pattern-reversal VEP develops rapidly, normally asymptoting to adult values around 3.5 postnatal months. However this reflects only initial cortical activation, largely determined by precortical myelination. In contrast, a timing parameter ('calculated latency'), derived from the phase vs temporal frequency gradient for steady-state VEPs, reflects the timing of the entire cortical response. In typical infants, calculated latency shows a more prolonged developmental trajectory than transient P1 latency, reaching an adult



Wednesday

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asymptote ( 100 ms) at 7-8 months postnatal (Lee et al, 2012), indicating continuing development of later cortical processing. Most of the PBI group, tested 3-4 times during 24 post-term months, reached adult P1 latency values by 5 months. However calculated latency remained around 200 msec beyond 1 year for this group. These results show that calculated latency, reflecting cortical processing beyond initial V1 activation, is more sensitive to cerebral impairment than the conventional transient VEP, and may predict later neurological deficits in childhood.

[Supported by the Leverhulme Trust, Castang Foundation, Oxford Biomedical Research Centre, and a Thouron Fellowship from the University of Pennsylvania.]

### POSTERS: FACE PERCEPTION III

◆ **The face inversion effect alters quantitatively and qualitatively information sampling**

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Humans are equipped with a sophisticated machinery that allows the rapid and effective recognition of a wide range of faces exemplars. The visual system actively and flexibly adapts eye movement information sampling to achieve this biological feat. However, recognition performance for inverted faces disproportionately decreases compared to (inverted) objects: the Face Inversion Effect (FIE). Yet, whether the FIE relies on qualitative and/or quantitative changes in information sampling is still debated. To clarify this issue, we implemented the gaze-contingent Expanding Spotlight technique (Mielle et al., 2013), while observers performed a delayed face-matching task with upright and inverted faces. A 2° Gaussian aperture was centered on the observers' fixations and expanded dynamically by 1 degree every 12ms - the longer the fixation duration, the larger the aperture size. We then used Bayesian classifiers to categorize the observers according to their information sampling strategies (i.e., global versus local). As expected, recognition performance decreased and fixation durations were shorter in the inverted compared to the upright condition for all observers. Crucially, while some observers shifted their fixation pattern between upright and inverted faces, others did not. Our data suggest that the FIE relies on quantitative and idiosyncratic qualitative changes in eye movement information-gathering strategies.

◆ **Different mechanisms for male and female facial identity categorization as revealed by sequential effects**

<sup>2</sup> S Hsu (Research Center for Mind, Brain and Learning, National Chengchi University, Taiwan (R.O.C.); e-mail: smhsu@nccu.edu.tw)

Facial identity provides crucial information that guides social interactions. To investigate how the human brain represents facial identities in different sex, this study examined the fine temporal structure of facial identity recognition on a trial-to-trial basis as participants categorized a sequence of male or female facial identities. Different patterns of sequential effects were observed, depending on whether participants recognized the faces of their own or opposite sex. When viewing the faces of their opposite sex, participants tended to categorize the preceding and current faces as belonging to the same identity (assimilation effect) if the two successive faces were from the same identity category, but the current faces were categorized as away from the identity category of the preceding faces (contrast effect) if the two faces were from the different categories. However, when viewing the faces of their own sex, only contrast effects were found regardless whether the preceding and current faces had the same or different identity categories. The present study suggests that the recognition of male and female facial identities involves distinct computational mechanisms and these two types of identities might be differentially represented in the face space in the human brain.

[NSC 102-2410-H-004-045-MY2]

◆ **A preliminary investigation on the role of facial symmetry and facial expressions in attractiveness judgements and pupil dilation**

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We investigated the relationship between attractiveness judgements and pupillary responses for three facial expressions (neutral, surprised, angry) chosen from the KDEF database. These expressions form a minimal set with one control condition and two high arousal expressions with either positive or negative valence. Another factor which is of interest is symmetry, because it is widely accepted that symmetric faces are considered as more attractive. To study this effect, symmetric versions of each picture is generated through a warping scheme. Subjects (18 M, 12 F) evaluated the attractiveness

of face images, while pupil responses are collected via Tobii T120. Results indicate that symmetric images are rated more attractive than their original counterparts ( $p=.000$ ) while eliciting smaller pupil dilations ( $p=.046$ ). On the other hand, neutral facial expressions are rated more attractive than emotional ones ( $p=.004$ ), while eliciting smaller pupil dilations ( $p=.04$ ). Correlation between pupillary responses and attractiveness judgments is negative ( $r=-.460$ ,  $p<.031$ ). We conclude that original faces capture more attention during attractiveness judgements since pupil dilations are larger compared to symmetric pictures. Furthermore, when facial expressions are considered, larger pupillary dilations are generated due to estimated survival value in positively and negatively arousing stimuli instead of sexual arousal related to attractiveness.

◆ **Age perception is influenced by face's race**

4 A Porcheron<sup>1,2</sup>, E Mauger<sup>1</sup>, F Soppelsa<sup>3</sup>, O Pascalis<sup>2</sup>, F Morizot<sup>1</sup> (<sup>1</sup>Chanel R&T, France; <sup>2</sup>LPNC, Grenoble University, France; <sup>3</sup>Biometry, Lincoln, France; e-mail: aurelie.porcheron@chanel-corp.com)

Individuals are better at recognizing faces belonging to their own race than those belonging to another racial group: "Other-Race Effect" (ORE). Here we investigated whether the ORE also affects age estimation. To our knowledge there is little evidence to support this hypothesis (Dehon & Drédart 2001). French Caucasian participants (male and female, 20 to 65 years) had to estimate the age of female faces from four races (black South-African, Chinese, Latin American and Caucasian). The estimation bias and the estimation accuracy were analyzed. In addition, participants were given a questionnaire about inter-racial contact. The direction of estimated bias was different for Chinese faces, being perceived younger than their age, than for the other racial groups being perceived older than their age. The age estimation was more accurate for Caucasian and black South-African faces, than for Chinese and Latin American faces. Interestingly, the participants reported higher contact with African or Afro-Caribbean people than with Asians or Latin Americans during their life. These results support the hypothesis of an ORE on age estimation. In order to conclude about the universality of these results, we need testing other-race observers.

◆ **How does the transformation of 3D-shaped avatar faces based on Support Vector Machine learning increase human sensibility to facial expressions?**

5 Y Arai<sup>1</sup>, S Nagata<sup>1</sup>, Y Inaba<sup>1</sup>, S Akamatsu<sup>2</sup> (<sup>1</sup>Graduate School of Science and Engineering, Hosei University, Japan; <sup>2</sup>Department of Applied Informatics, Hosei University, Japan; e-mail: akamatsu@hosei.ac.jp)

Facial expressions play an important role in all facets of human communication, even in human-machine communications. Facial expressions displayed on an avatar face are interpreted more accurately in 3D than in 2D. To create a 3D avatar face that displays various expressions, we must properly transform the 3D shape of its original sober face. Therefore, we built a morphable 3D face model by learning from many 3D faces displaying various expressions with which each transformation of the 3D shape is described by changing just a few parameters. Kobayashi et al. (2004) conducted such parameter transformation to generate facial expressions by adding an impression transfer vector, which they uniformly obtained for any input face using linear discriminant analysis. We propose a new method for individually obtaining the transformation of the parameters for each input face on the basis of the positional relationships between the parameters of the input face and the discrimination boundaries defined in the parametric space by Support Vector Machine learning. Through preliminary experiments on the subjective discrimination of facial expressions in a forced-choice method, synthesized expressions by our proposed method were found more perceptible than those by the previous method.

◆ **Face race visual classification as revealed by fast periodic visual stimulation**

6 S Peykarjou<sup>1,2</sup>, A de Heering<sup>2</sup>, S Hoehl<sup>1</sup>, S Pauen<sup>1</sup>, B Rossion<sup>2</sup> (<sup>1</sup>Developmental and Biological Psychology, Heidelberg University, Germany; <sup>2</sup>Face Categorization Lab, University of Louvain, Belgium; e-mail: stefanie.peykarjou@psychologie.uni-heidelberg.de)

Other-race (OR) faces are classified according to "race" faster than same-race (SR) faces. Whether this effect reflects perceptual or higher cognitive processes (Levin, 1996) remains unclear. We recorded electroencephalogram (EEG, 32 channels) with SR (Caucasian) and OR (Asian) faces during a fast periodic oddball visual stimulation paradigm providing an implicit, objective and robust measure of visual categorization (Liu-Shuang, et al., 2014). In trials consisting of one minute of stimulation, four different faces of the same race were presented consecutively. Every fifth stimulus belonged to the other race. Base frequency F was 6.033 Hz and the oddball response (1.207 Hz; F/5) and its harmonics (nF/5)

Wednesday

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were used to measure discrimination between OR and SR faces (i.e., face race classification). A race classification response was observed in all participants, and was enhanced for OR oddballs compared to SR oddballs. Importantly, discrimination was decreased and the OR classification advantage reduced for inverted and phase-scrambled faces. This indicates that low-level visual information cannot fully explain face race classification, but this information contributes to the OR classification advantage. Data from 9-month-old infants is currently being collected as well to investigate the contribution of perceptual processes to race classification in infancy.

[This research was supported by an FNRS studentship to S. Peykarjou.]

◆ **The role of eyes in the recognition of fear in faces presented centrally and peripherally.**

<sup>7</sup> P Heard, E Davidson (Health and Social Sciences, University of the West of England, UK; e-mail: priscilla.heard@uwe.ac.uk)

Fearful and neutral faces were presented centrally and 15 degrees peripherally to 14 participants as full face, minus the eyes, only the eyes or as eyes and eyebrows. All these types of face were correctly recognized as neutral or fearful when presented centrally but the eyes alone were worst. When presented 15 degrees peripherally the full face and face minus the eyes were well recognized, the eyes and eyebrows were next and the eyes alone were not above chance. The fearful faces were responded to faster than the neutral faces. This suggests that eyes without their brows are not the most important feature for the recognition of fear in faces.

◆ **Cross-cultural categorization of black and white faces**

<sup>8</sup> H Roeloffs<sup>1</sup>, C Tredoux<sup>2</sup>, G Harsányi<sup>1</sup>, C C Carbon<sup>1,3</sup> (<sup>1</sup>Department of General Psychology and Methodology, Otto-Friedrich University Bamberg, Germany; <sup>2</sup>Department of Psychology, University of Cape Town, Republic of South Africa; <sup>3</sup>Bamberg Graduate School for Affective and Cognitive Sciences, Otto-Friedrich University Bamberg, Germany; e-mail: ccc@uni-bamberg.de)

The processing disadvantage for other-race faces, also known as “own group bias”, is one of the best documented phenomena in face research. The present work deals with the intermediate levels between own- and other-race faces and the categorization of such faces. Black and White participants were shown faces morphed either from a Black prototype to White individual faces or vice versa. The participants judged each facial depiction on an “ethnicity scale” from 0-100 (0=White, 100=Black). The results show that an important factor was whether the morph was based on a White or a Black individual face. Although both sets of faces represent the same amount of ‘raceness’, the race of the individual face that entered had a bigger impact on the rating. Furthermore, white participants showed a gradual change of their evaluation from White to Black faces, while Black participants showed a much steeper transition of evaluations. We interpret this dissociate response behavior as a more quantitative response strategy in whites based on the amount of pigmentation of the faces, whereas Blacks showed a qualitative switch with a very narrow tolerance of interpreting faces in-between both poles as ambiguous.

◆ **An other-race bias when processing groups of faces**

<sup>9</sup> D Srismith<sup>1</sup>, M Oxner<sup>2,3</sup>, W G Hayward<sup>2,3</sup>, I M Thornton<sup>1,4</sup> (<sup>1</sup>Department of Psychology, Swansea University, United Kingdom; <sup>2</sup>Department of Psychology, University of Hong Kong, Hong Kong; <sup>3</sup>School of Psychology, University of Auckland, New Zealand; <sup>4</sup>Department of Cognitive Science, University of Malta, Malta; e-mail: ian.thornton@um.edu.mt)

It is well known that observer race can influence performance when individuating faces. Inspired by recent studies of “ensemble” face processing, we asked whether similar effects occur when making decisions about groups of faces. Here, in each trial, 16 faces were continuously shuffled within a moving 4 x 4 grid which remained visible for 4 seconds. The proportion of Asian and Caucasian faces were varied from trial to trial and observers (16 Asian/16 Caucasian) were instructed to indicate which race was in the majority. Between subjects, we varied the “target” response that should be given when observers were uncertain. We fitted cumulative normal functions to the response distributions and extracted the PSE and JND as dependent measures. For PSE, observers consistently weighted other-race faces more heavily than own-race faces, requiring more faces of their own race to perceive equality. For JND, Asian observers were generally more sensitive, but both groups had smaller JNDs when the target response was the other-race. Overall, our findings indicate that observers can rapidly estimate the racial composition of a group of faces, but these estimates are influenced by their own race.

◆ **Contribution of parts on the whole changes over time in facial attractiveness judgment**

- 10 C Saegusa, K Watanabe (Research Center of Advanced Science and Technology, The University of Tokyo, Japan; e-mail: csaegusa@fennel.rcast.u-tokyo.ac.jp)

Facial attractiveness can be evaluated within a short time. We examined how attractiveness judgment of facial parts and whole faces would develop over time by using photos of whole faces and facial parts (eyes, mouth and nose). Fifty-eight Asian female facial photos were divided into 3 groups to have similar level of attractiveness, and assigned to 3 exposure durations (20-, 100- and 1000-ms). The photos were presented in 4 separate sessions (eyes, mouth, nose, whole face). Each photo was shown twice in each session with a randomized order for pre-assigned duration. The session order was counter-balanced among participants but the whole-face session was always the last. Participants rated attractiveness of the photos with a 7-point scale. The participants were able to judge attractiveness of facial parts with the 20-ms duration as that of whole faces. The attractiveness judgments of the eyes were consistent among all the exposure durations and showed stable contribution to whole-face attractiveness judgments. However, the contribution of mouth and nose attractiveness to whole-face attractiveness was relatively low with the 20-ms duration but increased with longer exposure durations. These results suggest that relative contributions of facial parts on whole-face attractiveness judgments change dynamically over time.

[This work was partly supported by grants from the Cosmetology Research Foundation, Japan and JSPS KAKENHI 24300279.]

◆ **Recognition of emotions in dynamic transitions between facial expressions**

- 11 O A Korolkova<sup>1,2</sup> (<sup>1</sup>Center for Experimental Psychology, MSUPE, Russia; <sup>2</sup>Department of General Psychology, Moscow Institute of Psychoanalysis, Russia; e-mail: olga.kurakova@gmail.com)

Dynamic presentations of emotional facial expressions outperform static images in ecological validity. In everyday life, expressions can switch from one into another in less than a second. Though, the experimental research so far have considered only the dynamic unfolding from neutral face to peak emotion (Krumhuber, Kappas, & Manstead, 2013). To study the recognition of dynamically changing expressions, we used high-speed (100 fps) video clips of poser performing transitions between all pairs of happy, surprised, feared, sad, disgusted, angry and neutral expressions. Differential Emotions Scale ratings of beginning and end of each transition highly correlated with similar ratings of Pictures of Facial Affect. We presented video clips in multiple-choice identification task to 24 subjects, and compared the frequencies of choosing each of seven emotion labels to the same results obtained on last frames of transitions (23 subjects). Fisher's exact test showed difference between dynamic and static expressions for happy/feared, sad/happy, neutral/happy, neutral/surprised, sad/angry, and sad/disgusted transitions ( $p < 0.009$ ). Time-reversed video clips were perceived as different from forward ones ( $p < 0.011$ ), except for feared/sad, neutral/angry, and neutral/disgusted pairs. Overall results expand previous findings on neutral-to-peak dynamic expressions perception and support the notion that direction of dynamics is important factor of facial expression recognition.

[Supported by RFH grant no. 12-36-01257a2.]

◆ **Age discrimination between static and dynamic occluded faces**

- 12 Y T H Schelske<sup>1</sup>, T Ghose<sup>2</sup>, S Schweinberger<sup>3</sup> (<sup>1</sup>Department of Computer Science, TU Kaiserslautern, Germany; <sup>2</sup>Department of Psychology, TU Kaiserslautern, Germany; <sup>3</sup>Department of General Psychology, Friedrich-Schiller-Universität, Jena, Germany; e-mail: ghose@sowi.uni-kl.de)

Our everyday environment requires us to interact with partially occluded faces. However, the majority of face-perception research is with fully visible faces. We study aspects of face-perception, such as age-discrimination and eventually recognition for partially visible faces under static and dynamic conditions. Here we report experiments with an age-discrimination task. Our set of faces was generated from 13 pairs of male and 14 pairs of female faces, with a young and an old face in each pair (aged approximately 20 and 70 years, respectively). Each face was morphed along the age-dimension at (0%, 20%, 80%, and 100% old). We used a full factorial design with Static/Dynamic, Age-Similarity (0/20, 20/80 and 80/100 pairs), onscreen-duration (500, 750, 850, 950 and 1200 ms). In a two-interval-forced-choice task the participants had to choose the interval with the younger face. A hexagonal grid was used as the occluder. In the dynamic condition the face moved behind the occluder with a speed matched to duration. In the static condition 3 frames were shown with a horizontal offset of 170 pixels between the frames. Our

Wednesday

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results indicate better age discrimination for static than dynamic displays and for younger (0/20) than older (80/100) faces suggesting an other-group effect.

◆ **Facial representation form of animation affects skin color judgment**

13 H Han, K Uchikawa (Department of Information Processing, Tokyo Institute of Technology, Japan; e-mail: hanhj1205@hotmail.com)

Skin color reproduction, controlled by preferred skin color based on memory color, has been studied mostly using real skins and photographs. As various display technologies were developed, skin color has become emphasized in various forms of facial expressions, such as animation faces. Ryan and Schwartz (Am. J. Psychol., 1956) reported that cartoon images helped perception more accurately than photographs. Tong et al. (Cogni. Neuropsychol., 2000) reported that cartoon faces made strong responses in FFA (fusiform face area) as much as human faces. In this study, we examined a relationship between facial expression form of animation and skin color judgment. In experiment 1, we compared skin color judgments of animation character's faces and that of the scrambled faces. Observers selected a skin color, which was perceived the same as the reference. In experiment 2, we compared the flat facial image (2D) and the shaded facial image (3D). The skin color's judgment was found to be more sensitive with the normal face than the scrambled face, and with the 2D image than the 3D image. It was obtained that the skin color judgment was affected by face perception, and by shading features of facial images.

◆ **A snake wiggle of reaction time functions to indicate holistic perception**

14 M M Fific<sup>1</sup>, D R Little<sup>2</sup> (<sup>1</sup>Psychology, Grand Valley State University, USA; <sup>2</sup>Melbourne School of Psychological Sciences, The University of Melbourne, Australia; e-mail: fificm@gvsu.edu)

We analyzed the underlying fundamental processes engaged in forming holistic perceptual representations. The subjects participated in a face categorization task over multiple sessions. We applied the systems factorial technology (SFT) to analyze the properties of the observed response time (RT) distributions. The key statistic was a survivor interaction contrast function (SIC). Over the course of extensive practice, the observed SICs exhibited a specific pattern of shape transformations that could be described as a "snake wiggle". The observed SIC signature indicated that the processing mechanism behind holistic perception relies on strong positive facilitation between feature detectors, within the parallel mental network. The converging evidence is provided by the additional qualitative RT test (Fific, Little & Nosofsky, 2010).

◆ **Impact of make-up and facial contrast on femininity perception**

15 A Loegel<sup>1,2</sup>, S Courrèges<sup>1</sup>, E Mauger<sup>1</sup>, F Morizot<sup>1</sup>, A Porcheron<sup>1</sup> (<sup>1</sup>Department of Skin Knowledge and Women Beauty, Chanel Research & Technology Center, France; <sup>2</sup>E2C Team, CeRSM, Université Paris Ouest Nanterre La Défense, France; e-mail: sandra.courreges@chanel-corp.com)

Female faces have higher luminance contrast between the facial features and the surrounding skin than do male faces (Russell, 2009). Increasing facial contrast makes women appear more feminine; and women's use of make-up enhances this contrast (Russell, 2009; Etcoff et al., 2011). In the present study we investigated the influence of make-up and facial contrast on the perception of femininity. French Caucasian participants were asked to rate full face images of Caucasian women with and without make-up. Facial contrast was measured on these images, using the procedure of Porcheron et al. (2013). Results showed that the more the make-up increased the luminance contrast of the eyes, the more feminine the younger women looked. But older women looked more feminine the less that the luminance contrast around the eyes was increased by make-up. Faces wearing lipstick were rated as more feminine than those without, regardless of the age of the face, even when the lipstick decreased the redness contrast of the mouth. These results suggest that the role of facial contrast on femininity may be nuanced by social factors related to make-up, such as the social representations culturally associated to the different lipstick shades.

◆ **Repetition priming of unfamiliar faces as a covert index of eyewitness memory**

16 A J Russ, M Bindemann (School of Psychology, University of Kent, United Kingdom; e-mail: ar270@kent.ac.uk)

Errors in eyewitness identification occur frequently. With a series of laboratory experiments, this study explored whether people who fail to recognize a target person in an identity lineup can still show signs of having done so covertly. Observers were first exposed to two targets in a video and then tried to select these from identity lineups. This was followed by a categorization task, which measured repetition

priming of the target faces, additional non-target faces from the identity lineups, and previously-unseen unfamiliar faces. In three experiments, a consistent negative priming effect was found for the targets compared to all other faces. This effect was reliable regardless of whether a correct or incorrect lineup identification had been made and when observers did not select a target from a lineup at all. These findings demonstrate that covert recognition of targets from identity lineups is possible even when observers cannot do so overtly.

◆ **Comparing face and social models of person perception**

<sup>17</sup> C A M Sutherland<sup>1</sup>, J A Oldmeadow<sup>2</sup>, A W Young<sup>1</sup> (<sup>1</sup>Department of Psychology, University of York, UK; <sup>2</sup>Psychological Science and Statistics, Swinburne University of Technology, Australia; e-mail: cs770@york.ac.uk)

Facial first impression models have emphasised two dimensions of appraisal: trustworthiness (indexing a target's intentions) and dominance (indexing a target's capability: Oosterhof & Todorov, 2008). This is similar to two-dimensional social psychological models of inter-group perception, with warmth (cf. trustworthiness) and competence (cf. dominance) dimensions (Fiske, Cuddy & Glick 2007). Here, we tested the similarity between the face and social model dimensions as well as their generalisability across facial gender. In Study 1, we found that averaged images created from faces high or low on trustworthiness and high or low on warmth were rated as more similar than dominance and competence averaged images. Dominance and competence male pairs were rated as more similar than female pairs. In Study 2 we carried out gender-specific factor analyses of judgements made to 500 male and 500 female faces. We found that the first factor was similar across gender (trustworthiness/warmth) but the second factor differed across gender (dominance/competence for male faces, competence for female faces). We also found a third youthful-attractiveness factor for faces of both genders. We conclude that the first (trustworthiness/warmth) dimension is equivalent across theoretical models and gender but the second (dominance/competence) dimension appears to differ between male and female faces.

[The research was funded by an ESRC studentship to the first author [ES/I900748/1].]

### POSTERS: ILLUSIONS III

◆ **Unidirectional shape distortion effect induced by gradation-flash**

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Prolonged viewing of a circular shape in peripheral vision produces polygonal shape perception of the circle itself (Khuu, McGraw & Badcock, 2002), and visual adaptation to circles also produces polygonal (e.g. hexagonal) afterimages (Ito, 2012). Recently I reported a similar shape distortion effect that could be induced in a short period by presenting alternation of a circle and its inward gradation pattern (Sakurai, 2014). However, Ito's afterimage shape distortion also occurred in the opposite direction. For example, visual adaptation to hexagons produced circular afterimages. To test this possibility in the shape distortion effect induced by gradation-flash, I measured the induction time (latency) of the distortion effect from circle/gradation alternation and from polygon/gradation alternation. Stimuli consisted of 5 black line drawing hexagons placed around a central fixation cross on a white background, and they alternated at 2 Hz with same size hexagonal inward gradation patterns in which luminance increased gradually from periphery to center. None of the observers reported shape distortion from hexagons to circles, while all of them reported shape distortion from circles to polygons. This suggests that shape distortion effect induced by gradation-flash is unidirectional, and it is mediated by different mechanisms from that of Ito's illusion.

[Supported by JSPS Grant-in-Aid for Scientific Research (B) Grant Number 25285202.]

◆ **Experimental studies on the sinusoidal grating, square grating and hermann grid illusions for perceptibility thresholds**

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We have performed some experimental studies on the Sinusoidal Grating, Square Grating and Hermann Grid Illusions by changing specific parameters relating to those illusions while noting their perceptibility. Using the "Method of Limits" (Fechner GT, 1860), we tried to find the thresholds for the parameters within which the illusion is visible. From these experiments, we have found some interesting results.

Wednesday

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First of all, we have observed that, the sinusoidal grating (McCourt, 1982) is a much stronger illusion than the square grating for a given subject even though they appear quite similar. Secondly, for the Hermann grid illusion there are upper and lower thresholds of visibility with respect to the separation between the squares. Thirdly, we have found that even tiny changes in the pattern of the Hermann grid can completely wipe out the illusion, from which one can draw the conclusion that any model of brightness perception must be sensitive to very small changes to the input stimulus. This further indicates that simple linear models such as the DOG (Difference of Gaussians) model, or even the highly successful ODOG model of brightness perception (Blakeslee & McCourt 1999) are inadequate for explaining such illusions.

[Ashish Bakshi would like to thank the Council of Scientific and Industrial Research (CSIR) for providing financial support for his research work.]

◆ **The color conditions by which streaming is perceived in the horizontal and vertical bars in the chromatic hermann grid**  
20

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The original Hermann grid consists of intersecting and vertical white bars placed on a black background, with which we perceive illusory grey spots at the intersections of the white bars (J. Ninino, 2001). There are many pieces of research on the chromatic Hermann grid, which changes the colors of the background and bars (For example, see D. B. Bodkin, "Color, Tilt, and the Hermann Grid Illusion", thesis, The New England College of Optometry, 2008). Most of them discuss how strong the illusory spots are perceived when the colors are changed. Trying to change the background and bar colors, we found that some color combinations produced a dark stream in the bars, which resembles Mackey's illusion (J. Ninino, *ibid.*, Fig. 5-5 on p. 53). For example, a figure with a background painted bluish green (5BG) and with red bars (5R) is perceived with dark bluish green streaming on the bars and vice versa. We remark that the illusion is notable in the combination of the pure color, which is in a direction opposite that of Munsell's hue circle. If a figure in the form of stacked blocks is used, the same optical illusion as seen at the masonry joint will be seen.

◆ **Motion capture of colour-defined background textures by luminance-defined motion signals**  
21

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Motion capture of a static background texture can be caused by spatially-discrete, often subthreshold, first-order motion signals. Object-background segregation was investigated in a display composed of background checks defined by chromatic contrast and a moving stimulus composed of sparse checks defined by luminance contrast. At high luminance contrast, the stimulus appears to move against a stationary chromatic background. At lower contrast the chromatic texture appears to move in accordance with the luminance defined stimulus, demonstrating motion capture. The strength of motion capture varies with the level of background noise and depends on the spatial arrangement of the moving checks. When the moving spatial primitives are subthreshold or sparsely distributed, the motion signals transfer to the static, colour defined texture. At higher luminance contrast, the perceived motion is restricted to the spatial features of the moving stimulus and no longer transferred to the chromatic background. The results suggest that motion capture occurs because of poor figure-ground segregation at low luminance contrast. At higher luminance contrast, the moving target features are segregated from the background and motion capture is no longer observed. This is consistent with the greater motion capture observed with randomly distributed stimulus with spatial features that are less well defined.

[EPSRC Grant reference: EP/I003940/1]

◆ **Magnitude and lightness of figures with "illusory contours"**

22 C Malisano, L Zanuttini (Human Sciences, University of Udine, Italy;  
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Introduction. Previous experiments have proved that illusory expansion can affect lightness of surfaces (Zanuttini & Daneyko, 2010). The packs, contributing to the onset of "illusory contours", can behave as inducing circles in Ebbinghaus displays: the smaller the contextual circles, the larger the figure (Zanuttini, 2012). Method. Three squares of the same geometrical extent, created by packs of increasing size (as they were enlarged they were proportionately lightened) were presented according to Pair Comparison Method to check lightness modifications; two squares (darker and lighter than the light grey

background) were added (ESP.1). To avoid the interfering effect of the lightening of the packs, three disks created by black packs of increasing size (as they were enlarged their number was reduced) were used as experimental stimuli (ESP. 2); two disks (darker and lighter than the background) were added. Results. Both the perceived size and the phenomenal lightness of the “anomalous” figures are affected by the size of the packs; the order and the distance of the stimuli on the two different continua diverge. The magnitude of figures that only phenomenally exist can be illusorily modified, and the enhanced lightness at basis of their appearance can be modified, without any change in luminance.

◆ **Measuring haptics with the eye: The case of the Uznadze illusion**

23 O Daneyko, A Maravita, D Zavagno (Psychology Department, University of Milano-Bicocca, Italy; e-mail: olga.daneyko@gmail.com)

In 1949 the Georgian psychologist Uznadze described a simultaneous haptic size contrast illusion that occurs after adapting, out of vision, one hand to a small sphere and the other to a large one. After the adaptation process (10-15 simultaneous exposures), participants are suddenly exposed to two spheres equal in size and weight, but the impression is that the sphere held by the hand adapted to the large sphere is much smaller than the other one. Here we experimentally sought for the mechanisms underpinning the illusion. One experiment tested the possibility of measuring the illusion's magnitude with a matching method in which right-handed participants were asked to indicate the size of each hand-held sphere on a 12 step visual scale made of spheres painted matt black. Variables were: (a, within) size of the adapting spheres; (b, between) evaluation direction (right-left, left-right); (c, between) position of the small adapting sphere (right, left). Only variables a and b produced significant effects, confirming the possibility to use a visual scale to measure the illusion, however suggesting also a role of handedness in the evaluation process. Further experiments assessed the role of handedness and of simultaneous vs single-hand adaptation in the evaluation process.

◆ **Measuring size in perception and mental imagery**

24 J D Blanuša<sup>1</sup>, S Zdravković<sup>2,3</sup> (<sup>1</sup>Department of psychology, Faculty of philosophy, University of Belgrade, Serbia; <sup>2</sup>Department of psychology, Faculty of philosophy, University of Novi Sad, Serbia; <sup>3</sup>Laboratory for experimental psychology, Faculty of philosophy, University of Belgrade, Serbia; e-mail: jelena.blanusa@gmail.com)

Recent findings that illusions can be created in imagery also introduced quantitative methodology for measuring mental images, revealing that male participants tend to create same mental image size in perception and imagery, while female participants underestimate images in imagery tasks (Blanusa, Markovic, & Zdravkovic, 2013). Therefore we further tested imagery contrasting simple visualizing and inspection. In the first experiment the line size was tested in imagery and perception tasks. Results showed that the increasing line length produced larger differences between perception and imagery tasks ( $F(9,2214)=31.72$ ,  $p<0.001$ ) both for male and female participants. In the second experiment participants inspected banded lines and estimated length of line parts in imagery and perception tasks. The results produced the same pattern of interaction obtained in the previous experiment ( $F(3,1408)=44.38$ ,  $p<0.001$ ). Therefore our experiments showed that male and female participants perform the same when offered simple stimuli: they tend to underestimate the size in imagery. And this is true for both types of imagery tasks, simple visualizing and inspection. In comparison to previous findings, female participants have the same tendency with visual illusion while male had better performance with illusions.

[This research was supported by Ministry of Education and Science, Grants No. 179033 and III47020]

◆ **The relationship between errors in reproducing of time intervals and susceptibility to**

25 **Muller-Lyer illusion.**

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We studied the reproducing of short time intervals among people who are susceptible to Muller-Lyer illusion. The experiment had two phases. Phase 1 was based on a computer program: participants had to drag the central arrow of stimulus Brentano-Muller-Lyer illusion and place it to the center between outer arrowheads. In phase 2 an electronic chronometer was used: the same participants had to reproduce 2-5 seconds time intervals. After the experiment we found that all participants can be divided into three groups depending on the values of deviations time-space perception. The first group includes people that reproduced time intervals shorter than original stimulus; also they had a “classic” illusion – when the part with ingoing-wings looks shorter than part with outgoing-wings. The second includes people that have “reversed” illusion and reproduced interval longer than the original one. The third includes



Wednesday

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participants who are resistant to Muller-Lyer illusion and have reproduced time intervals precisely to the original. Correlation analysis indicated a significant correlation ( $r_s=0,62$ ;  $p < 0,001$ ) between the susceptibility to Muller-Lyer illusion and the value of the error in reproduction of short time intervals. Thus we conclude that there is a strong connection between susceptibility to Muller-Lyer illusion and time errors.

◆ **Perception of the Illusory contours with sine-shaped inducers**

26 I Zakharov, M Stepanenko (Psychology, Moscow State University, Russian Federation; e-mail: zaharov\_ilia@inbox.ru)

Illusory contours (IC) or Kanizsa figures proved to be fruitful phenomena for investigating bottom-up and top-down brain information processing. A number of hypotheses were proposed to explain IC perception emphasizing the role of low level cortical regions (V1/V2) or high level(LOC) regions in IC formation. To test the problem of brain localizations of IC processing we investigated the role of inducer contours of on the IC strength. Thirty five observers (age range 18—22) were tested. Different types of Kanizsa Square displays were constructed: a classic type with straight-shaped inducer contours and eight types with sine-shaped inducer contours having different amplitudes and frequency. Three experiments were performed testing the shape of IC, the brightness of IC figures and ERP amplitudes as functions of IC display types. The results of the first experiment showed the correspondence between illusory and inducer contours. The data of the second experiment revealed the highest brightness for Kanizsa figures with straight-shaped inducer contours as compared to sine-shaped contours. The third experiment showed that sine-shaped Kanizsa figures indicated a classic IC-effect with higher amplitudes of the N170 ERP component. N170 function and its brain localization are discussed.

**POSTERS: BRAIN MECHANISMS III**

◆ **Laminar profile of ongoing and evoked neuronal activities in the inferior temporal cortex of macaque monkeys**

27 J Ito<sup>1</sup>, Y Yamane<sup>2</sup>, I Fujita<sup>2</sup>, H Tamura<sup>2</sup>, S Grün<sup>1,2,3</sup> (<sup>1</sup>Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6), Jülich Research Centre and JARA, Germany; <sup>2</sup>Graduate School of Frontier Biosciences, Osaka University, Japan; <sup>3</sup>Theoretical Systems Neurobiology, RWTH Aachen University, Germany; e-mail: j.ito@fz-juelich.de)

To elucidate the laminar organization of ongoing neural activities and its functional relevance in visual object recognition, we examined spatio-temporal patterns of local field potentials (LFPs) recorded from the inferior temporal cortex of anesthetized macaque monkeys using linear electrode arrays (32 probes spanning 1.55 or 3.1 mm). During the recordings the animals were presented with 128 visual objects (shapes, gratings, faces, fruits, etc.) on a gray background. Stimulus duration was 0.5 s with an inter-stimulus interval (ISI) of 1 s. We found that during the ISIs the LFPs showed strong oscillatory fluctuations in the alpha-beta frequency band (10 – 20 Hz). These oscillations had the strongest power at the lowermost probes, supposedly located in the infra-granular layers. These LFP oscillations were considerably suppressed during the stimulus presentation period. In the initial 0.2 s of the stimulus presentation the LFPs showed a stimulus-evoked excitatory modulation that first occurred in deep layers and then propagated to the superficial layers. The spatio-temporal patterns of the modulation were specific to the presented stimulus. We will discuss the functional implications on the laminar organization of our observations in respect to ongoing and evoked activities and the suppression of ongoing fluctuations by stimulation.

[Partial funding by German-Japanese Joint Computational Neuroscience Program of BMBF (grant 01GQ1114), Strategic International Research Cooperative Program (Japan-Germany) of JST, Helmholtz Alliance on Systems Biology, Helmholtz Portfolio Supercomputing and Modeling for the Human Brain (SMHB), BrainScaleS (EU Grant 269912), The Naito Foundation Subsidy for Female Researchers after Maternity Leave, and JSPS KAKENHI Grant Number 25870405 Grant-in-Aid for Young Scientists (B).]

◆ **Psychophysical and physiological isolation of On- & Off-pathway light adaptation using a sawtooth probed sine-wave paradigm**

28 B M Cooper, B B Lee (Biological Sciences, SUNY College of Optometry, U.S.A.; e-mail: bcooper@sunyopt.edu)

The probed sine-wave paradigm combines an aperiodic probe with a periodic background stimulus aimed to describe fast components of light adaptation, such as threshold modulation with probe phase.

Luminance On-/Off-pathways likely contribute these adaptation threshold modulations (Hood, Graham, et al 1997). Typically, pulses (flashes) have been used as aperiodic probes (Wolfson Graham 2006). However, pulses elicit biphasic electrophysiological responses from macaque retinal ganglion cells (RGCs). Sawtooth stimuli, on the other hand, have been shown to successfully isolate differential responses from On- and Off- psychophysical channels. We report human psychophysical data to incremental and decremental pulsed flashes and on-going and off-going ramps. Ramp probed sine-wave data shows a more pronounced modulation of threshold versus phase in comparison to pulse data for on-going compared to off-going ramps. We relate this data to physiological responses of retinal ganglion cells of anesthetized macaque monkey (in vivo) to the same stimuli. Physiological results show clear distinctions between ramp direction. This was not so clearly apparent in the psychophysical data. We interpret this result as evidence that On and Off-pathways shape psychophysical thresholds of the probed sine-wave paradigm; this implicates On & Off pathways in fast attributes of light adaptation. [National Institute of Health grant EY13112]

◆ **Visual evoked potentials to luminance-modulated and contrast-modulated noise checkerboards**

29 M I Hairol<sup>1,2</sup>, J Gautier<sup>1</sup>, J Siderov<sup>1</sup>, S J Waugh<sup>1</sup> (<sup>1</sup>Anglia Vision Research, Department of Vision and Hearing Sciences, Anglia Ruskin University, United Kingdom; <sup>2</sup>Program Optometri & Sains Penglihatan, Universiti Kebangsaan Malaysia, Malaysia; e-mail: izzuddin.hairol@anglia.ac.uk)

Contrast-modulated noise (CM) stimuli require more stages of processing than do luminance-modulated noise (LM) stimuli and psychophysical visual acuity for CM stimuli is 0.3-0.5 logMAR worse (Hairol et al., 2013). We compared Visual Evoked Potentials (VEPs) elicited by LM and CM checkerboards. VEPs were recorded using a transverse row of 5 electrodes centred at Oz. Checkerboard stimuli with different check sizes (5-200 arcmin) were viewed within a 15 deg field, using pattern onset (50/500 ms onset/offset) and pattern reversal (1Hz) protocols. With pattern reversal, P100 to CM checkerboards is reduced in amplitude (40%) and broader in shape, than for LM checkerboards. The N75 is less pronounced, like that found for blurred LM checkerboards. Peak amplitudes occur for larger checks for CM, than LM stimuli. With pattern onset stimuli, CM checkerboards produce VEP waveforms of reversed polarity or with different latency components than those for LM, or blurred LM checkerboards. The peak amplitude response is largest at Oz, and decreases differently to either side for LM and CM stimuli. Visual acuity for CM versus LM stimuli is worse using both VEP and psychophysical estimates. The different patterns of VEPs suggest that LM and CM stimuli are processed by different neuronal populations.

[Supported, in part, by a grant from the Evelyn Trust, Cambridge. MIH is funded by a postdoctoral grant from Ministry of Education Malaysia and Universiti Kebangsaan Malaysia.]

◆ **Event-related EEG theta-band oscillatory responses to threatening pictures: Modulation by spontaneous emotion regulation strategy**

30 N R Harrison<sup>1</sup>, F Surre<sup>2</sup>, P Chassy<sup>1</sup> (<sup>1</sup>Department of Psychology, Liverpool Hope University, UK; <sup>2</sup>School of Engineering and Mathematical Sciences, City University London, UK; e-mail: harrison@hope.ac.uk)

A number of EEG studies have investigated posterior theta event-related synchronization (ERS) in response to emotional stimuli, but very little is known about the effects of habitual, spontaneous emotion regulation strategies on theta oscillatory responses. To overcome this limitation, we analysed the relationship between the everyday use of regulation strategies such as reappraisal (measured by the Emotion Regulation Questionnaire), and the magnitude of posterior theta-band ERS. Participants viewed a series of neutral and threatening images taken from the International Affective Picture System, and rated each picture for level of threat. Wavelet analysis was used to calculate EEG spectral power changes in response to image presentation. We found increased ERS for threatening stimuli, relative to neutral stimuli, in the upper theta band (6 – 8 Hz) at posterior electrodes between around 300–600 ms after picture onset, indicating enhanced engagement of occipito-parietal cortex in response to negative emotional images. Importantly, participants who typically used the emotion regulation strategy of reappraisal more frequently, showed less increase of posterior theta ERS in response to threatening images. These findings are discussed in relation to theories of emotion regulation and the modulation of the initial phases of processing of affective stimuli.

Wednesday

◆ **Compensation of heading tuning for eye rotations in macaque area MSTd: roles of visual and extra-retinal signals**

31

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Optic flow provides a valuable cue for estimating heading, but eye rotations add global components of motion to the flow field and confound the relationship between optic flow and heading. Previous neurophysiological studies have shown that the heading tuning of neurons in areas MSTd and VIP compensates, at least partially, for eye rotations. However, the relative contributions of visual and extra-retinal signals to this compensation remain unclear because previous studies either used an incorrect visual control for eye rotation or did not include a visual control at all. In addition, it remains unclear whether visual mechanisms of compensation would be more robust if the scene contains rich depth structure. We measured the heading tuning of MSTd neurons while macaque monkeys actively pursued a moving target or maintained fixation while eye rotations were simulated visually. Depth cues were manipulated by presenting either a 3D cloud or a fronto-parallel plane of random dots. Results from one animal show stronger compensation during real eye movements than during simulated rotations. However, substantial compensation is also observed during simulated pursuit when the visual scene has rich depth structure. We conclude that both visual and extra-retinal signals contribute to computations of heading during eye rotations.

[Supported by NIH EY016178.]

◆ **Vection: neuronal representation of optic flow as a cue to self-motion**

32

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Optic flow is one of the most important visual cues to the estimation of self-motion (Gibson 1950; Warren et al., 1988). Representation and processing of visual cues to self-motion have been associated with visual areas MT+, V6; multimodal areas ventral intra-parietal area (VIP), cingulate sulcus visual area (CSv), precuneus (Pc); and vestibular areas parieto-insular vestibular cortex (PIVC), area 2v (Cardin & Smith, 2010). This study assessed whether optic flow is encoded differently according to the presence or absence of a sensation of self-motion (vection), using functional magnetic resonance imaging (fMRI). In the experiment, optic-flow stimulus consisting of dots moving along spiral paths was presented in blocks. During the stimulus-presentation blocks, subjects held down one of the two buttons to report whether they were experiencing vection or no vection. All seven areas responded well to optic flow. Areas including MT+, V6, VIP and PIVC responded more strongly to optic flow while vection was experienced than while it was not. Results suggest that when optic flow is processed as a cue to the viewers' own motion, activation in the visual, multi-sensory and vestibular areas is greater, which may reflect vection.

[Japan Society for the Promotion of Science]

◆ **EEG correlates of short time interval estimation**

33

D N Podvigina<sup>1,2</sup>, A K Harauzov<sup>1</sup> (<sup>1</sup>Physiology of Sensory Systems, Pavlov Institute of Physiology, Russian Federation; <sup>2</sup>Saint-Petersburg State University, Russian Federation; e-mail: daria-da@yandex.ru)

The aim of the study was to reveal EEG correlates of the process of short time interval estimation. Two groups of participants (experimental group – 11 adults, control group – 12 adults) were presented with 1,5 and 1,84 s time intervals marked by visual stimuli. The task of the experimental group was to distinguish between the two durations by pressing one of the two buttons. The task of the control group was to view the same stimuli passively and press any of the two buttons after each presentation. Event related potentials (ERPs) from electrodes Oz, Pz and Fz were averaged for each interval duration. The most prominent difference between the two groups was observed in parietal area for the late positive ERP component with the latency of 400 ms (presumably P3b). Its amplitude was significantly larger in the experimental (time estimation) group. EEG time-frequency decomposition based on wavelet transformation of the signals (using EEGLAB 6 software, Delorme and Makeig, 2004) demonstrated that the synchronization of low-frequency EEG components within delta-band (1-4 Hz) contributes significantly to the observed late ERP component. We suppose that higher oscillation in delta-band reflects the increase of cognitive load during performing a time interval estimation task.

[Supported by the Russian Science Foundation grant no. 14-18-02135]

◆ **The role of lateral occipital cortex and occipital face area in symmetry detection**

- 34 S Bona<sup>1,2,3</sup>, J Silvanto<sup>1,4</sup>, Z Cattaneo<sup>5</sup> (<sup>1</sup>Brain Research Unit, OV Lounasmaa Laboratory, Aalto University School of Science, Espoo, Finland; <sup>2</sup>Advanced Magnetic Imaging Centre, Aalto Neuroimaging, OV Lounasmaa Laboratory, School of Science, Aalto University, Espoo, Finland; <sup>3</sup>BioMag Laboratory, HUS Medical Imaging Center, Helsinki University Central Hospital, Helsinki, Finland; <sup>4</sup>Department of Psychology, Faculty of Science and Technology, University of Westminster, UK; <sup>5</sup>Department of Psychology, University of Milano, Milano, Italy; e-mail: silvia.bona@aalto.fi)

Despite bilateral symmetry is an important characteristic of the visual world, only few studies have investigated its neural basis. Here, we assessed whether the lateral occipital (LO) cortex, a critical region implicated in object processing, is involved in symmetry detection. Participants were asked to discriminate between symmetric and asymmetric dot patterns, while fMRI-guided repetitive TMS was delivered over either left LO, right LO or two control sites in the occipital cortex. Our results showed that TMS over both right and left LO affected symmetry judgments, with a greater impairment following right LO TMS. Our findings demonstrate that LO bilaterally plays a role in symmetry detection, possibly due to symmetry acting as a strong cue in object recognition. In a second study, we investigated whether OFA is also involved in symmetry processing. Participants performed the same task as in the previous study while fMRI-guided repetitive TMS was applied over either right LO, right OFA, left OFA or vertex. Our results showed that stimulation of both right LO and right OFA affected symmetry detection, suggesting that right OFA is involved as well in symmetry processing, possibly due to its critical role in face discrimination, for which symmetry might be a relevant factor.

**POSTERS: ATTENTION III**

◆ **Cortical mechanisms of visual attention: combining insights from eye-tracking and EEG**

- 35 L V Kulke<sup>1</sup>, M Gawryszewski<sup>1</sup>, J Wattam-Bell<sup>1</sup>, J Atkinson<sup>1</sup>, O Braddick<sup>2</sup> (<sup>1</sup>Department of Developmental Science, University College London, UK; <sup>2</sup>Department of Experimental Psychology, Oxford University, UK; e-mail: louisa.kulke.12@ucl.ac.uk)

Directing attention towards a stimulus enhances brain responses to that stimulus (e.g. Morgan et al, 1996). Methods for investigating these effects usually involve instructing subjects to voluntarily direct attention towards a particular location, making them unsuitable for infants and other groups with poor communication. We developed a method for assessment of behavioural and neuronal mechanisms of attention that does not depend on explicit instruction. The approach combines the Fixation Shift Paradigm (FSP, Atkinson et al, 1992) with the measurement of eye-movements using a remote eye-tracker and the monitoring of brain responses using event-related potentials (ERPs) With two identical targets presented at equivalent locations in left and right visual fields, adults showed an enhanced response at around 100 msec in occipital ERP channels contralateral to the subsequently fixated target, consistent with an effect of covert attention prior to the overt switch. An additional central distractor stimulus evoked frontal responses, potentially indicating inhibitory mechanisms. The approach can successfully be used to investigate the effects of attention on cortical activity in infants and other populations who cannot follow instructions.

[The Leverhulme Trust, DAAD]

◆ **Visual representation of words in the left occipito-temporal cortex as evidenced by EEG frequency-tagging**

- 36 A Lochy, G Van Belle, B Rossion (IPSY Face Categorization Lab, University of Louvain-La-Neuve, Belgium; e-mail: aliette.lochy@uclouvain.be)

Although it is clear that words are visually distinguished from pseudowords, it remains difficult to identify selective lexical representations without an explicit linguistic task on the stimuli (e.g., reading, lexical decision). Here we measured scalp electrophysiological discrimination responses to written words by means of electroencephalography (EEG) frequency-tagging. Sequences of pseudofonts, nonwords, or pseudowords were presented through sinusoidal contrast modulation at a 10 Hz frequency rate (F), in which words were interspersed at regular intervals (every fifth item, i.e., F/5, 2Hz). Participants monitored a central cross color change, and had no linguistic task to perform. Within 3 minutes of stimulation only, a robust discrimination response at 2Hz was observed in all conditions and in every participant, predominantly over the left occipito-temporal visual cortex. The magnitude of the response was larger for words embedded in pseudofonts than in nonwords and in pseudowords sequences,

Wednesday

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respectively, suggesting that list context effects classically reported in behavioral lexical decision tasks are due to visual discrimination processes rather than decisional ones. This robust selective signature of visual word discrimination obtained without any explicit task may prove extremely valuable to rapidly and objectively measure sensitivity to word processing in different human populations, including patients with reading difficulties.

◆ **Differential effects of the size of the attentional window in central and peripheral vision.**

<sup>37</sup> A Albonico<sup>1</sup>, M Malaspina<sup>1</sup>, E Bricolo<sup>1</sup>, M Martelli<sup>2,3</sup>, R Daini<sup>1</sup> (<sup>1</sup>Psychology Department, Università degli Studi di Milano-Bicocca, Milano, Italy; <sup>2</sup>Psychology Department, Università Sapienza di Roma, Roma, Italy; <sup>3</sup>Neuropsychology Unit, IRCSS Fondazione Santa Lucia, Roma, Italy; e-mail: a.albonico@campus.unimib.it)

Several studies have shown that visual tasks performance is influenced either by attracting visuo-spatial attention to the target location or by target eccentricity. Nevertheless, the relative influence of position and size of the attentional window in central and peripheral vision has never been investigated. 24 students underwent a detection task in central and peripheral (10° eccentricity) vision, where a “T” target stimulus (1°) could be pre-cued by a dot (0.4°), a small square (1.2°) or a big square (15°) with different SOA (100 or 500 ms). Results showed a significant effect of eccentricity, with faster RTs and enhanced effects of the cues in central vision compared to the periphery. Furthermore, the small square (an optimal cue for spatial resolution) was more effective than either a big square (a non-optimal cue for spatial resolution) or a dot (an optimal cue for spatial position) in reducing RTs. This effect was larger for short (100 msec) compared to long (500 msec) SOAs and, more interestingly, it was observed only in central vision. Our results suggest a dissociation between focal and spatial orientation of attention: the former is evident only in central vision and mainly exogenous, the latter more endogenous and stronger in periphery.

◆ **Working memory and attention determinants of change blindness**

<sup>38</sup> D Zakharkin, O Mikhaylova, A Gusev (Psychology, Lomonosov Moscow State University, Russian Federation; e-mail: angusev@mail.ru)

Our paper focuses on the study of base components of the phenomenon "change blindness" (CB) - failure to notice significant changes in objects that are located within a visual field due to perceptual interruption (Rensink, O'Regan & Clark, 1997). Visual memory test Delayed Matching to Sample (DMS) from the Cantab battery (Juncos-Rabadán & Facal, 2014) and classic "Bourdon's cancellation test" assessing the concentration and distribution of attention (Chekalina & Gusev, 2011) were used. The test assessing the time and accuracy of change detection was used for evaluation of CB evidence (Gusev & Mikhaylova, 2013). The intergroup comparison of the experimental data showed statistically significant effects of concentration on the average percentage of accuracy of detection changes ( $F(1,85) = 4.692$ ;  $p = 0.033$ ) and the distribution on average time detection of changes ( $F(1,85) = 4.692$ ;  $p = 0.033$ ). DMS mean correct latency effect on accuracy of change detection ( $F(1,79) = 4.986$ ;  $p = 0.028$ ) and on average time detection of changes ( $F(1,79) = 6.559$ ;  $p = 0.012$ ). DMS percent correct effect on accuracy of change detection ( $F(1,79) = 19.917$ ;  $p < 0.000$ ) and on average time detection of changes ( $F(1,79) = 13.598$ ;  $p < 0.000$ ). It was shown that a working memory, the distribution and concentration of attention effect on the valuation of evidence CB.

◆ **The eye-of-origin and object-based attention**

<sup>39</sup> H Ogawa (Department of Psychological Science, Kwansei Gakuin University, Japan; e-mail: hirokazu.ogawa@kwansei.ac.jp)

We examined the role of the eye-of-origin information in the object-based attention by using the paradigm of same-object advantage (Egly, Driver, & Rafal, 1994). The display consisted of two rectangles aligned horizontally or vertically. The cue was presented at one of the corners of the rectangles, followed after a variable cue-target onset asynchrony by the target. The target was presented at the cued location, at the opposite side of the cued rectangle, or at the same side of the different object. Unbeknownst to the participants we also varied the eye to which the target, cue and rectangles were presented. We found that discrimination of the targets presented at the cued locations was facilitated even when the cue and target were presented to the different eyes. Counterintuitively, however, the same-object advantage was observed only when the target was presented to the eye to which the cues appeared, and the eye to which the rectangles were presented was irrelevant to the occurrence of the same-object advantage. The results suggest the possibility that the eye-of-origin information may play a role in the mechanisms of object-based attention.

◆ **Attentional and perceptual priming share behavioral characteristics and may rely on common functional mechanisms**

40 M A B Brinkhuis<sup>1,2</sup>, J W Brascamp<sup>2</sup>, Á Kristjánsson<sup>1</sup> (<sup>1</sup>Department of Psychology, University of Iceland, Iceland; <sup>2</sup>Helmholtz Institute and Department of Psychology, Utrecht University, Netherlands; e-mail: manjebrinkhuis@gmail.com)

Perceptual priming is a change in perception over repeated stimulation, whereas attentional priming refers to improved performance over repeated allocations of attention. These forms of priming have typically been studied separately. Here we aim to identify perceptual and attentional priming for rotating random dot spheres, and to investigate their interrelations. To measure perceptual priming, ambiguous rotating spheres were presented intermittently and participants indicated perceived rotation direction with every appearance. For attentional priming, participants searched for a single target (a disambiguated leftward or rightward rotating sphere) among distractors (rotating in the opposite direction). In a final experiment, we interleaved these search displays and ambiguous displays to investigate any interactions between attention priming and perception of ambiguous spheres. Our preliminary results indicate both perceptual priming and attentional priming. Specifically, in the first experiment the likelihood of seeing a given rotation direction increased as a function of having seen that rotation direction before, whereas in the second experiment reaction times to a target of a given rotation direction decreased across repetitions of that target. Moreover, the final experiment provides hints that perception of our ambiguous stimuli may be biased toward the interpretation whose rotation direction corresponds to that of a preceding search target.

◆ **Spatial anisotropies in the resolution of temporal attention**

41 J R Cass<sup>1</sup>, I Gunatillake<sup>1</sup>, E van der Burg<sup>2</sup> (<sup>1</sup>School of Social Sciences and Psychology, University of Western Sydney, Australia; <sup>2</sup>School of Psychology, University of Sydney, Australia; e-mail: johncassvision@gmail.com)

Spatial attention is worse in the upper compared to lower visual fields, and along vertical compared to horizontal meridians. Somewhat surprisingly no such visual field anisotropies exist for judgments involving temporal attention (Aghdaee & Cavanagh, 2007) suggesting the existence of distinct attentional systems devoted to the analysis of space and time. Here we examine the resolution of temporal attention by measuring temporal order judgment thresholds. Four luminance-defined target disks (diameter = 1.5°) located 8 degrees left, right, above and below fixation. On any given trial pairs of target located along either the horizontal or vertical meridian changed from black to white (SOA ranging ±400ms). Each target disk was surrounded by 10 distractor disks, whose luminance remained unchanged (static condition) or reversed polarity throughout the trial (dynamic condition). TOJ thresholds were more than a factor of four greater under dynamic conditions, highest along the vertical meridian and in the upper visual field. By silencing the motion system using contextual flicker we are able to demonstrate for the first time that the resolution of temporal attention exhibits visual field anisotropies qualitatively similar to those observed for judgements of spatial attention.

◆ **Analyses of response time distributions in attentional priming in visual search**

42 Ó I Jóhannesson, Á Kristjánsson (Laboratory for Visual Perception and Visuomotor Control, Faculty of Psychology, School of Health Sciences, University of Iceland, Iceland; e-mail: oij1@hi.is)

Response times (RTs) are frequently used to measure attentional function in visual tasks. But what do changes in mean RT tell us about visual attention? Their interpretation is not straightforward as they can reflect lateral shifts in RT distributions, changes in distributions, increased skew or some mixture of all this. Ex-Gaussian distributions fit response times reasonably well giving three parameter descriptions of distributions with  $\mu$  the mean of the normal part,  $\sigma$  its standard deviation and  $\tau$  representing the exponential part. This three-parameter method provides a good description of response times, compared to traditional mean RT analyses where normal distributions of RTs are assumed. We fit response times from repetition priming in feature and conjunction visual search to ex-Gaussian distributions finding that the parameters of the ex-Gaussian distribution are differently modulated by search repetition. Most notably, repetition in conjunction, but not in feature search, affected  $\sigma$  suggesting important differences in priming effects between feature and conjunction search. We conclude that analyses of RT distributions can inform theoretical accounts of attentional priming in visual search. Yet whether

Wednesday

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ex-Gaussian parameters represent particular functions or processes is unclear so caution should be taken when parameters are interpreted as representing particular mental processes.

[Ómar Jóhannesson and Árni Kristjánsson are supported by the Research Fund of the University of Iceland and the Icelandic Research Fund (RANNÍS).]

◆ **Tuning in: How attention to motion direction shapes visual sensitivity across time**

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If a particular direction of motion becomes behaviourally relevant, feature-based attention (FBA) selectively improves our ability to see that motion direction while sensitivity to orthogonal directions is reduced or remains unaffected. Here, we used a motion-detection task to investigate how the tuning of FBA to motion direction evolves across time. A pre-cue, controlling FBA, indicated the most likely direction of a brief pulse of coherent motion (50% in the pre-cued, 50% in random directions), presented after a variable cue-stimulus interval (CSI). The pulse was present in 50% of the trials and embedded in a dot pattern that otherwise moved incoherently. Following the disappearance of the pattern, we presented a post-cue indicating the true direction of motion of the pulse (if it was present; a random direction otherwise) and observers judged if motion in that direction had been presented. To assess perceptual tuning to the pre-cued direction, we capitalised on the fact that in 50% of the trials, the expected (pre-cued) motion direction differed—by varying degrees—from the presented one. Sensitivity was lowest at the earliest CSI (100 ms), then increased globally (200 ms), and finally tuned broadly around the pre-cued direction (300-500 ms).

[Supported by the German Research Foundation (DFG): Emmy Noether Programme (grant RO 3579/2-1) and Graduate School “Sensory Computation in Neural Systems” (GRK 1589/1).]

## POSTERS: PERCEPTION AND ACTION III

◆ **Spatial association for visually presented note height: does the instrument played influence the direction of internal representation?**

44 M De Tommaso<sup>1</sup>, V Prpic<sup>1</sup>, A Fumarola<sup>1</sup>, G Boschetti<sup>1</sup>, A Brusaferrò<sup>2</sup>, T Agostini<sup>1</sup> (<sup>1</sup>Department of Life Sciences, University of Trieste, Italy; <sup>2</sup>Music, State Conservatory “Jacopo Tomadini”, Italy; e-mail: matteo.detommaso@gmail.com)

A SMARC effect (Spatial-Musical Association of Response Codes) has been demonstrated in note height processing, with faster left-hand responses to low pitches and faster right-hand responses to high pitches (Rusconi et al., 2005; Lidji et al., 2007). In the present study we investigated whether this association exists for visually presented note height on the staff and whether musicians, playing different instruments, show changes in the association direction. Therefore, we separately tested two groups of amateur and expert musicians and two groups of piano and flute players. This choice was made since the piano is configured with high notes on the rightmost side of the keyboard, while the flute is configured with high notes on the leftmost side of the instrument, and vice versa. Results revealed that groups composed of expert musicians showed a left-hand advantage in processing relatively low notes and a right-hand advantage in processing relatively high notes, with no variation between piano and flute players; amateur musicians revealed no evidence of a spatial association. It’s remarkable that the physical position on the instrument does not influence the internal spatial representation of notes. This evidence suggests that all musicians share the same direction of internal representation for musical notes.

◆ **Effect of negative emotions on the cognitive maps acquisition**

45 A O Tetereva<sup>1</sup>, M V Pestun<sup>2</sup>, G Y A Menshikova<sup>1</sup> (<sup>1</sup>Psychology Department, Lomonosov Moscow State University, Russia; <sup>2</sup>Computer Graphics Systems, Keldysh Institute of Applied Mathematics, Russia; e-mail: alina.tao@mail.ru)

In our previous study the method for testing of allocentric cognitive maps (ACM) acquisition was developed (Lakhtionova, Menshikova, 2013, Perception, 42, 53). We applied the method to investigate the influence of negatively valenced states (fear) on the ACM structure. Two virtual mazes were created. Each maze consisted of 12 rooms having the same sizes and wall textures, but different mutual arrangement in space. Fearful sounds were enabled while the observer was passing some rooms of the second maze. Mazes were presented using the CAVE system. 26 observers (age range 18—23) were tested. Their task was to go through all rooms and remember their arrangement. After passing each

maze the observers were asked to use the interface consisted of rectangles and door symbols which could be located on the interface screen and varied in accordance with acquired ACM. The degree of ACM deformations caused by fearful sounds was estimated by comparing ACM of both mazes including the number and sizes of correctly located rooms/doors. The results showed the influence of negative emotions on ACM acquisition: the perceived sizes and mutual arrangement of rooms were changed for the maze where fearful sounds were enabled.

[Supported by the Russian Science Fund.]

◆ **Position invariance and object affordance in human parietal cortex**

46 Z N Roth<sup>1,2</sup>, E Zohary<sup>1,2</sup> (<sup>1</sup>Department of Neurobiology, Hebrew University, Israel; <sup>2</sup>The Edmond & Lily Safra Center for Brain Sciences, Hebrew University, Israel; e-mail: zvroth@gmail.com)

It has been proposed that visual image analysis occurs in two parallel pathways: the ventral “what” stream, processing object identities, and the dorsal “where” stream encoding location information. More recently, the dorsal stream has been characterized as a “how” network involved in planning and executing actions on objects. But what if others’ actions are viewed without self action? Here, the main goal of the visual system might be prediction of the action outcome rather than its exact location. We studied viewed object-related grasping actions, characterizing the information available in the patterns of multi-voxel activity in EVC (early visual cortex), aIPS (anterior intra-parietal sulcus) and pIPS (caudal intra-parietal sulcus) and LOC (lateral occipital complex). Both aIPS and pIPS (in addition to LOC) carry information on hand and tool-identity, regardless of the position of the seen tool-directed action. However, exact location-information (regardless of identity) is lost along the dorsal pathway – whereas the patterns of activation in EVC allow for high localization precision, it is worse in pIPS, and close to chance in aIPS. We conclude that the representation of object-directed action becomes more abstract along the posterior-to-anterior axis of the IPS, focusing on object affordance which is essential for action anticipation.

◆ **Linking perception and action via stochastic forward physical models.**

47 E Vul, K Smith (Psychology, UCSD, USA; e-mail: evul@ucsd.edu)

Perception and action are linked by the physical constraints of our environment; thus, they should be calibrated to the physical regularities of the world around us. Here we measure the internal physical models that people use to link perception to action, and formalize them as stochastic forward models. In E1 we ask people to play a variant of a “Pong” game in which they place a paddle to catch a ball emerging from a period of occlusion (and potentially bouncing). We show that human trajectory extrapolation through bounces under occlusion is consistent with noisy Newtonian physics. In E2 we ask people to predict which of two regions on a “bumper table” the ball will enter first by pressing one of two buttons throughout the trial. Such online predictions are consistent with the forward extrapolation of the noisy Newtonian models estimated in E1. Finally, in E3 we add periods of occlusion to the bumper-table setting of E2, and show that the within-trial, within-subject dynamics of prediction switching provide evidence for a resource-efficient algorithm for carrying out these otherwise computationally intensive forward simulations. Altogether, these results begin to characterize the forward physical models that people use to link perception to action.

[NSF CPS 1239323 and Bial Foundation 141/08]

◆ **How do material and orientation of an object influence precision grip?**

48 V C Paulun<sup>1</sup>, K R Gegenfurtner<sup>1</sup>, M A Goodale<sup>2</sup>, R W Fleming<sup>1</sup> (<sup>1</sup>Department of Experimental Psychology, University of Gießen, Germany; <sup>2</sup>The Brain and Mind Institute, The University of Western Ontario, Canada; e-mail: Vivian.C.Paulun@psychol.uni-giessen.de)

Everyday objects vary drastically in their extrinsic (e.g. position, orientation) and intrinsic (e.g. shape, weight, material) properties. A successful manual interaction requires an adjustment of the movement according to these features. We investigated how the orientation and the material properties of an object influence precision grip. Therefore, we asked right-handed participants to grasp and lift four equally sized cylinders (height: 10cm, diameter: 2.5cm) made of different materials (styrofoam, wood, brass and an additional brass cylinder covered with vaseline to make it slippery) and move them to a goal position. Stimuli were placed at six different angles with respect to the participants (0°, i.e. horizontally, 30°, 60°, 90°, 120°, and 150° rotated counterclockwise). We found that materials with higher weight and lower friction required more time to be grasped, as did cylinders in an orthogonal orientation. The influence of an object’s material was larger in post-contact phases of the movement, as evident from larger timing differences during handling and transport of the objects. The overall spatial configuration of



Wednesday

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the movement was mainly influenced by the object's orientation, but the specific aspects were modified by its material. Orientation and material both modify how we approach and handle objects.

[This work was supported by the DFG International Research Training Group IRTG 1901 "The Brain in Action - BrainAct".]

◆ **Disentangling concurrent visual masking, response priming, and cognitive control processes**

49 S Panis, F Schmidt, A Weber, T Schmidt (Faculty of Social Sciences, Experimental Psychology Unit, University of Kaiserslautern, Germany; e-mail: sven.panis@sowi.uni-kl.de)

According to the rapid-chase theory of response priming, visual primes and targets initially elicit feedforward sweeps that traverse the visuomotor system in rapid succession (Schmidt, Niehaus, & Nagel, 2006). Because the prime signal reaches motor cortex first, it is able to activate the motor response assigned to it, which is consistent or inconsistent with the motor response assigned to the chasing target. Here we test the predictions of this theory by manipulating the relative strengths of the 13 ms disc-prime and 147 ms annulus-target (through varying color saturation), the prime-target stimulus-onset-asynchrony (13, 40, 67, 93 ms), and the prime-target color consistency (green, red). We analysed response latency and accuracy distributions using discrete-time competing-risks event history analysis which allows one to model the time-varying main and interaction effects of the variables on the hazard of response occurrence and their conditional accuracy (we also included trial number to control for overall learning effects). Results show that many (main and interaction) effects change over time during a trial, and illustrate how event history analysis can be employed to disentangle the time-varying effects of concurrent cognitive processes that can be active on different time-scales, such as response priming, masking, and reactive top-down cognitive control.

◆ **Perceived speed is biased by intended voluntary action**

50 Y Monno, H Kaneko (Department of Information Processing, Tokyo Institute of Technology, Japan; e-mail: yasunaga.monno@k.ip.titech.ac.jp)

It has been shown that perceived direction of ambiguous motion, such as stream-bounce display, is biased by the observer's goal-directed action. However, the quantitative effect of observer's action on perceived motion has not been shown clearly. In addition, the cause of the bias is not known yet. Present research investigated whether perceived speed of object is biased by observer's voluntary action. Observers compared the speed of stimulus moved by themselves to that moving spontaneously. In experiment 1, the observers were instructed to move the stimulus by their hand with either fast, slow, or neutral speed and the actual speed of the stimulus was identical to that of hand. In experiment 2, the observers were instructed to move the hand with the same speed of a reference without thinking of the speed and the actual speed of the stimulus varied regardless of the speed of hand. The results showed that the faster they move the stimulus, the faster they perceived the speed only when the observers thought about the hand speed. These findings suggest that perceived motion is biased by the observer's action quantitatively and the bias is caused by the intention of the observer but by the speed of hand.

## POSTERS: EYE MOVEMENTS III

◆ **Decoding eye movements to predict social interaction in real-world scenes**

51 G J Zelinsky<sup>1,2</sup>, H Adeli<sup>1</sup> (<sup>1</sup>Department of Psychology, Stony Brook University, USA; <sup>2</sup>Department of Computer Science, Stony Brook University, USA; e-mail: gregory.zelinsky@stonybrook.edu)

Is there sufficient information in fixation behavior to predict whether a scene will be described as depicting an interaction? Participants (n=15) freely viewed a scene for 100ms, 1000ms or 5000ms, then freely described the scene that was just viewed. All 96 scenes depicted two people in various contexts, but were divided into interacting and non-interacting conditions depending on whether a given participant mentioned an interaction in their description. Scenes were manually segmented into objects and fixations were associated to described segments. Twenty-two gaze features were derived to capture the order in which key object types were fixated, and these features were used to train an SVM classifier. Interaction classification was above chance (64%), indicating that this high-level of scene understanding could be determined solely from fixation behavior. Further analysis revealed that fixations on a person or fixations between people are predictive of an interaction description, and fixations on objects or between objects and people are predictive of a non-interaction description. We conclude that eye movements are important to achieve a high-level of scene understanding, that this understanding increases with more

fixations, and that fixation behavior can be decoded to predict whether a scene will be interpreted as depicting an interaction.

[This work was supported by NSF grants IIS-1111047 and IIS-1161876 and NIMH Grant R01-MH06374 to G.J.Z.]

◆ **The neural mechanisms underlying competition for oculomotor selection: An eye-tracking and ERP study**

52 M Weaver, C M Hickey, W van Zoest (Center for Mind/Brain Sciences (CIMEC), University of Trento, Italy; e-mail: matthew.weaver@unitn.it)

In a concurrent eyetracking/EEG study we explored the neural basis of oculomotor distraction and selective control. Participants made eye movements to a line-segment target embedded in a search display that also contained a salient distractor. Target and distractor salience was manipulated by varying degree of orientation offset from a homogenous background. Results show that successful saccadic responses to less-salient targets on the vertical midline were characterised by contralateral positivity to the lateralised distractor. This distractor positivity (Pd)—which preceded the saccadic response—is thought to index an inhibitory mechanism suppressing distractor salience. In other trials employing identical search displays, the eyes were misdeployed to the distractor, and here we instead observed a distractor-elicited contralateral negativity (Nt/N2pc), indicating deployment of covert attention. Given that visual stimulation was identical in both conditions we looked to EEG activity in the pre-stimulus interval as a predictor of overt behaviour. Results show consistent modulation in the alpha band that predicted both oculomotor behaviour and characteristics of the pre-saccadic ERP. These results are consistent with the idea that pre-stimulus state plays a role in the representation of visual salience, or alternatively that such state determines the efficacy with which attentional mechanisms can operate on visual input.

◆ **You can't judge a book by the cover, but you do so (at least with joint attention)**

53 R Actis-Grosso, B F M Marino, N V Maiorana, P Ricciardelli (Psychology, University of Milano-Bicocca, Italy; e-mail: rossana.actis@unimib.it)

We investigated whether the information regarding face age and social status conveyed either by top-down or bottom-up manipulation have different effect on gaze following behaviour (GFB), as an index of joint attention. Participants performed a saccade towards an instructed target while ignoring the gaze-shift of a distracter of different age-ranges (18-25; 35-45; over 70). In Experiment 1 distracters were associated with fictional résumés, which could describe them as high or low social status people - top-down manipulation of social status. In Experiment 2 the same distracters were presented wearing clothes either implicitly associated with high status (e.g., tie and business suit) or with low status (e.g., builder worker uniform) - perceptual (bottom-up) manipulation of social status. Results showed that face age affected both saccade accuracy and latencies (i.e. the over 70 year-old distracters exerted the least interference effect), with a significant effect also of the distracter gender (i.e. male faces exerted the strongest effect). Social status had an effect on accuracy only when manipulated in a bottom-up manner (Exp.2), providing further evidence for the automatic nature of GFB and suggesting a key role of social relevance in the genesis of joint attention.

◆ **iMap3.5: a graphical statistical data-driven approach for fixation mapping of eye-movement data**

54 S Miellel, Y Liu, M Papinutto, J Lao, R Caldara (Psychology, University of Fribourg, Switzerland; e-mail: sebastien.miellel@unifr.ch)

iMap is a freely available open-source Matlab toolbox dedicated to data-driven, robust statistical mapping of eye movement data (Caldara and Miellel, 2011). In previous versions of iMap (iMap1 to iMap2.1) data-driven fixation clusters were isolated from fixation and contrast maps averaged across observers. Hence, iMap1-2.1 required additional statistical analyses on individual data extracted from data-driven fixation clusters to assess statistical significance with regard to the inter-observer variability. Moreover, bootstrapped split-half verification analyses were used to rule out the risk of double-dipping. We present iMap3.5, the latest version of iMap, which is based on a radically novel approach. iMap3.5 is based on TFCE (Threshold-Free Cluster-Enhancement) transformed pixel-wise t-values across observers. A bootstrapping procedure under the null-hypothesis is used to assess significance and correct for multiple comparisons. Additionally, iMap3.5 offers new features such as for instance improved numerical and graphical outputs, individual fixation maps, downsampling, import/export functions and exploratory analyses. To sum up, iMap3.5 keeps the general data-driven philosophy of iMap by avoiding the use of

Wednesday

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arbitrary Regions-Of-Interest. Crucially this new, formally validated version provides a self-contained statistical graphical analysis making interpretations more straightforward. iMap3.5 is an open-access, valid and powerful tool for data-driven statistical mapping of eye-movement data.

◆ **Visuomotor learning in a craniocentric reference frame**

55 K Havermann, S Wahl (Institute for Ophthalmic Research, Eberhard Karls University Tuebingen, Germany; e-mail: katharina.havermann@medizin.uni-tuebingen.de)

In a natural scenario gaze is directed towards an eccentric target by a combination of a saccade and a head movement. While saccades are executed open-loop only, head movements can be executed open-loop as well as considering visual or proprioceptive feedback. Furthermore, although both, saccades and head movements, are altered for optimized movement performance, saccadic and head movement motor learning are relying on greatly different mechanisms. Whereas there is a strong literature on the adaptation of the saccadic system, learning of head movements in gaze performance maximization is only rarely described. In the current study visuomotor learning of gaze movements is induced in a craniocentric reference frame. For identical gaze amplitudes the amplitude and dynamics of head movements is compared between 15 subjects who experienced prolonged craniocentric learning, to 16 subjects with unaltered gaze dynamics. Learning effects on head movements are described for head movement amplitudes as well as head movement dynamics, identifying motor learning of head movements as part of the visuomotor system.

◆ **The impact of scene luminance levels on fixation durations: An examination based on simulations using the CRISP model**

56 R C Walshe, A Nuthmann (Psychology, The University of Edinburgh, United Kingdom; e-mail: calen.walshe@gmail.com)

An important question within studies of naturalistic scene viewing is what mechanisms control the duration of individual fixations. By altering the quality of a scene it is possible to observe the impact that such quality changes have on fixation durations when inspecting those scenes. Several recent studies (Henderson, Nuthmann & Luke, 2013; Walshe & Nuthmann, 2014) demonstrated that fixation durations tend to be parametrically related to the overall level of scene luminance. Furthermore, these studies have demonstrated that gaze contingent degradation to the scene via a reduction in luminance results in an immediate increase in fixation durations. Using simulations with the CRISP model we demonstrate that increases to fixation durations are a consequence of a decrease in the rate at which the timing mechanism approaches the threshold for saccade initiation. This model suggests that difficulties in processing scene content results in extended fixation durations due in part to interactions between high-level encoding and low-level saccade preparation timelines.

◆ **Linking gaze to objects: Individual biases in gaze judgments and how they can be altered by training**

57 J Schulz<sup>1</sup>, B M Velichkovsky<sup>2</sup>, J R Helmert<sup>1</sup> (<sup>1</sup>Unit of Engineering Psychology and Applied Cognitive Research, Technische Universitaet Dresden, Germany; <sup>2</sup>Moscow Institute of Physics and Technology and Department of Neurocognitive and Social Sciences, Kurchatov Research Center, Moscow, Russian Federation; e-mail: johannes.schulz@tu-dresden.de)

In every-day life, people are experts in linking others' gazes to objects. Little is known about the relevance and interaction of factors like visual information (gaze position) and prior knowledge for this skill. We tested how participants linked depicted gazes to objects presented in a 4x4-matrix on a computer screen. Gaze positions indicating different objects varied only minimally from each other (viewed from 68 cm distance, visual angle differed in a range of 0.05° to 0.47° between gaze positions). We measured judgment accuracy in order to reveal possible systematic biases. Subsequently, we trained participants by providing feedback about correctness, and tested them afterwards again. Participants indicated looked-at objects correctly well above chance (mean: 46.6%). Direction of judgment biases varied strongly between individuals. Training increased accuracy (mean: 65.2%) and decreased biases' strength and judgment uncertainty (measured in reaction time and participants' gaze patterns). The directions of bias did not change. We conclude that others' gaze alone is not sufficient to establish a link to objects. Prior knowledge about object-gaze-contingencies (as induced by training) is another important component. It may allow people to deal effectively with gazes of others with squints or glass eyes, in which visual information itself is biased.

[Johannes Schulz and Jens R. Helmert were co-financed by the European Social Fund and the Free State of Saxony, Germany, in the framework of the junior research group CogITo.]

**POSTERS: COLOUR AND ILLUMINATION III**◆ **Color representations in Hungarian-Serbian bilinguals**

58 I Jakovljević<sup>1</sup>, S Zdravković<sup>2,3</sup> (<sup>1</sup>Laboratory for Experimental Psychology, University of Novi Sad, Serbia; <sup>2</sup>Faculty of Philosophy, University of Novi Sad, Serbia; <sup>3</sup>Laboratory for Experimental Psychology, University of Belgrade, Serbia; e-mail: jakovljevic.ivana@yahoo.com)

Studies on categorical perception of color (CPC) in bilinguals suggested that they do not entirely resemble monolingual speakers of any language, but tend to shift to the more often used language (Athanasopoulos et al., 2010). Therefore, we addressed CPC in bilinguals that use both languages equally frequently. We exploited the fact that unlike Hungarian, Serbian language has two linguistic categories for blue. We also investigated cognitive flexibility of bilinguals, by testing them in both languages. In two experiments (E1 in Serbian, E2 in Hungarian), on 14 bilinguals, we measured RT in color discrimination task. In E1, CPC was demonstrated and bilinguals were faster in discriminating colors that belong to different linguistic categories ( $F(1,14) = 11.78$ ;  $p < 0.05$ ). There was no significant difference when compared to Serbian monolingual speakers (Jakovljević & Zdravković, 2013), indicating that bilinguals shifted toward Serbian language. Results were replicated in E2 ( $F(1,14) = 22.55$ ;  $p < 0.001$ ), suggesting that language of experimental setting does not influence CPC. This finding could confirm the hypothesis that bilinguals tend to permanently modify color naming behavior by using the system that is maximally informative (Jameson & Alvarado, 2003), in our case the language with a greater number of color categories.

◆ **Rapid averaging of multi-coloured ensembles**

59 J J Maule<sup>1</sup>, J Banks<sup>1</sup>, C Witzel<sup>2</sup>, A Franklin<sup>1</sup> (<sup>1</sup>School of Psychology, University of Sussex, UK; <sup>2</sup>Laboratoire Psychologie de la Perception, Université Paris Descartes, France; e-mail: J.Maule@sussex.ac.uk)

We have previously demonstrated that, when viewing an ensemble of simultaneously and rapidly presented differently-coloured patches, observers tend to 'recognise' the mean hue even if it never appeared in the ensembles (Maule, Witzel & Franklin, 2014). This study sought to further characterize the limits and mechanisms of ensemble perception of colour. Data from two experiments (overall  $N = 37$ ) show that participants, when asked to select the "average colour" following rapid (500ms) presentation of an ensemble of different hues, are more likely to choose the unseen colorimetric mean than a non-mean distractor. Consistent with claims that ensemble perception is a parallel process, increasing the number of items in the ensembles had no effect on performance. However, increasing the number of different colours in an ensemble reduced performance to chance levels for ensembles containing eight colours or more. A second experiment revealed that when the range of colours in ensembles was controlled there was no effect of the number of colours on the tendency to pick the mean. The findings suggest that summary statistics of colour can be rapidly extracted from multi-coloured ensembles where the range of colours is manageable. Implications for understanding ensemble perception of other domains are also discussed.

[Research supported by an Economic and Social Research Council studentship to JM (ES/J500173/1) and a European Research Council funded project 'CATEGORIES' (283605) to AF.]

◆ **Illuminant chromaticity differentially affects color constancy**

60 D Weiß, K R Gegenfurtner (Department of Psychology, Justus-Liebig-Universität Gießen, Germany; e-mail: david.weiss@psychol.uni-giessen.de)

Research on color constancy has mainly focused on surfaces illuminated by a restricted set of illuminants. Since research on color discrimination showed systematic variations with hue, we wanted to investigate whether systematic differences in the degree of color constancy also show for varied illuminant-hues. We varied chromaticity and saturation of the illuminant in rendered two- and three-dimensional scenes, which depicted different versions of an illusion introduced by Lotto & Purves (2004). Ten naïve observers performed achromatic matches on scenes illuminated by illuminants of 20 different chromaticities and two saturation levels. The surface reflectances were chosen from the axes of DKL-color-space, rotated in steps of  $18^\circ$  azimuth in accordance with the illuminants. Each illuminant was chosen so that it exactly canceled the chromaticity of one of the surface colors used. Observed levels of constancy were between 25% and 75% for different observers and conditions, differing insignificantly between 2D- and 3D scenes and the two different saturation levels. There was a trend towards higher constancy for illuminants varying in color directions close to the daylight locus. Overall, color constancy seems to be fairly stable across different illuminant directions.

Wednesday

◆ **Color classification of leaves**

- 61 Z Milojevic, R J Ennis, K R Gegenfurtner (Psychology, University of Giessen, Germany;  
e-mail: Zarko.Milojevic@psychol.uni-giessen.de)

Individuals can give a single color name to a natural object, even though these objects often have color variations across their surfaces. It is unclear how observers do this. Since autumn leaves have varying color distributions, we instructed naive observers to assign color names to them. Observers viewed 16-bit photos (constant focus, camera distance, and background under a D65 illuminant) of 276 autumn leaves that ranged from pure "red" to pure "green". Observers stated whether each leaf appeared "red" or "green". Next, we scrambled the spatial positions of the pixels in each leaf, leaving the color distributions and outline of each leaf untouched, and performed the color naming experiment again. The leaves in each photo were segmented and converted to their corresponding MB-DKL coordinates for our monitor. Various statistics were computed for each leaf's color distribution. To find the most informative statistics, linear classifiers were trained on every combination. When training the linear classifier, the most frequent color name assigned by observers to each leaf was taken as "ground truth". On average, the mean isoluminant color predicts 91.5% of observer's classifications for both experimental conditions. Thus, when assigning color names to our images, observers might extract the mean isoluminant color.

◆ **Reaction times dependence on luminance spatial noise for a pseudo-isochromatic stimuli**

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The objective is to analyze the role of amplitude and mean luminance noise for color reaction time -RT- task using pseudoisochromatic stimuli. The stimuli were composed by a Landolt-C surrounded by a background that differed only in chromaticity. Target chromaticity varied along chromatic vectors (0, 90, 180 and 270 deg). Subjects had to find the orientation of the C-Landolt gap while the chromatic vector was decreased. The RT task was performed against luminance noise at three noise mean luminance (13, 19, and 25 cd/m<sup>2</sup>). The luminance noise modulation was composed by patches with luminance ranging between 7 cd/m<sup>2</sup> above and below stimulus mean luminance (constant delta protocol) or by luminance ranging between 70% above and below stimulus mean luminance (constant proportion protocol). The results showed that RT decreased with luminance with constant delta protocol while in the case of constant proportion protocol there is no dependence with luminance within the luminance range analyzed, being longer -  $\approx 100$  ms - in the later case. Gomes et al, 2012, showed similar results but measuring color discrimination vector length. On the other hand, the number of wrong answer depends on the protocol, bigger for constant proportion protocol than for constant delta protocol.

◆ **Reduced peri-saccadic sensitivity to both luminance and color-opponent contrast**

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Vision goes through turbulent times when the eyes rapidly move to a new location. One of the hallmark consequences of saccades is a reduced sensitivity to luminance contrast that starts 50 ms before saccade onset and lasts into the next fixation. Previous studies have observed little or no peri-saccadic drop in sensitivity to color-opponent contrast, and argued that a reduction in gain of early visual responses selectively suppresses input to the magno-cellular pathway. We reevaluated this idea by measuring the fine temporal evolution of visual sensitivity around the time of saccades. Observers judged the location of a large low-spatial frequency grating, flashed briefly—at varying times relative to saccade onset—at the top or the bottom of the screen. We observed a substantial peri-saccadic loss of visual sensitivity to luminance contrast. Critically, we also found a smaller but systematic reduction of sensitivity to colour contrast along the L-M dimension in DKL color space, which was most pronounced shortly after saccade onset. Considering the difference in shape of the temporal impulse response function for chromatic and achromatic input, we will discuss whether a unified mechanism can explain these different magnitudes of perisaccadic insensitivity.

[M.R. was supported by the EU Seventh Framework Programme (Marie Curie IOF 235625) and by the Emmy Noether Programme of the Deutsche Forschungsgemeinschaft, DFG (RO 3579/2-1).]

**POSTERS: CLINICAL III**◆ **A systematic study of topographical agnosia and posterior cerebral artery infarcts**

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Posterior Cerebral Artery Infarction (PCAI) accounts for 5-25% of ischemic strokes. Topographical agnosia or topographical disorientation, defined as the inability to orient oneself in one's surroundings, was sometimes reported, but has never been systematically studied. Considering the high frequency of PCAI, we conducted the first systematic investigation of topographic orientation in left and right PCAI patients. We tested 15 patients with two sets of visuo-spatial tests to assess topographical skills: one set included five computerized tasks (famous building recognition, new scenes memory, landmark recognition, heading orientation, route learning) and one ecological topographical orientation test including four tasks (pictures recognition, pictures ordering, map drawing, backward path). Topographical agnosia was evidenced in 50% of PCAI patients, with more severe outcomes in patients with PCAI in the right hemisphere, irrespective to the presence of visual field defect. Computerized and ecological tests were highly correlated but the ecological test was more sensitive in objectivizing topographical orientation impairments. Voxel-based lesion-symptom mapping demonstrated that two regions located in the cuneus and the calcarine sulcus correlated significantly with behavioral performance. Our results demonstrate the high prevalence of topographical agnosia after PCAI and highlight the importance of right anterior occipital areas in spatial cognition.

◆ **Differences between autisms and typically developed people in cortical activation during global/local tasks: a NIRS study**

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It has been argued that autistic people are different from typically developed people in global/local processing. However, series of studies show inconsistent results. Here, we examined whether the two groups have any differences in cortical activation pattern while they process visual global/local tasks. METHODS: Navon figures made by alphabets or simple shapes (triangles, squares etc) were used as stimuli. At the beginning of the trial, an indicator was shown which shape to respond, global (whole) or local part of a stimulus figure. Presentation of a sample figure was followed by a test stimulus. Participants answered if they were same or different. The task was repeated during a block of trials. Hemodynamic changes around prefrontal and temporal-occipital lobes were monitored with a Near Infrared Spectroscopy (Hitachi, ETG-4000) before to after the task block. Nineteen undergraduates and fifteen people with clinical diagnosis of high-functioning Autism Spectrum Disorders participated in the study. RESULTS: The task performance was significantly faster and more precise in TD than in ASD group. Cortical Activation did not differ during the task, however rather did so after the task periods, inferring their different cognitive/cortical processing in visual object perception.

[Supported by JSPS Grant-in-Aid for challenging Exploratory Research No. 22653077.]

◆ **Occasional awareness of trees with never a forest in Balint simultanagnosia**

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Patients with Balint syndrome following bilateral parietal damage are unable to perceive multiple objects simultaneously, despite correct identification of individual visual objects (simultanagnosia). We report observations with Balint syndrome patient DP that shed new light on the syndrome and on the role of posterior parietal cortex in conscious perception. We found: (1) Visual disappearance of a single salient object or object parts, as well as anti-correlated disappearance of two competing objects; (2) Spatial crowding in which a surprisingly intact ability to identify very small digits or color patches was dramatically degraded by flanking patterns. (3) A severe deficit in reporting the relative position of objects or point to marked locations on a touch screen; (4) Preserved ability for

## Wednesday

perceptual grouping and averaging, including non-perceived elements in the group or average. These novel findings are not consistent with common single-object perception descriptions of this syndrome, and theories stressing global/focal imbalance. We suggest that posterior parietal cortex serves as a short-term data-holding mechanism for spatially coded information by which internal and external context factors modulate perception-action and perception-declaration links. Bilateral posterior parietal damage may cause simultanagnosia due to failed maintenance of visual information in spatio-temporal working memory.

◆ **Magno - and parvo - systems and cognitive functions of the visual system in healthy subjects and patients with multiple sclerosis.**  
67

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In order to determine the contribution made by the magno - and parvo - systems software in cognitive functions of the visual system have been carried out comprehensive studies , including electrophysiological, eye movement research and studies based on optical coherence tomography in healthy subjects and patients with multiple sclerosis in the early stages of the disease . In this work we use a combination method of recording visual evoked potentials to stimuli subjected to wavelet filtering and registration of eye movements using aytrekera camera. As wavelets used DoG- function (Difference of Gaussians) and wavelets, whose spectrum was limited domain special- frequency. Data were obtained, showing the dependence of the type of eye movements on the special- frequency structure of test images. Initially when recognizing clear images dominated work parvo system. Gradual blurring increases the contribution of magno system and determines the nature of eye movements. The method of optical coherence tomography revealed anatomical features magno and parvo systems in healthy people and their changes in patients with multiple sclerosis.

◆ **The effects of perceptual noise on the speed of reading words and recognising facial emotions in autism spectrum disorder**  
68

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The neural noise could probably account for the complex pattern of visual enhancements and impairment in individuals with autism spectrum disorder (ASD) (Simmons et al., 2007). To verify this suggestion, we applied newly developed tests evaluating the effects of perceptual noise on the speed of reading words (real unrelated words as well as pseudowords) and recognising facial emotions. External noise was produced by random vertical displacement of letters during the reading tasks and by random rotating faces at different angles from the vertical in the emotion recognition task. The results obtained in reading tasks showed that recognition time increased proportionally to the noise increase. The differences between ASD individuals and aged-matched typically developing controls were at high levels of text degradation, rather than without text degradation. During the face recognition task the rotation noise strongly increased the emotion recognition time of ASD individuals while did not affect responses of typically developing controls. The lowered ability to extract relevant information from noisy background demonstrated by ASD individuals in the present study clearly suggests presence of abnormally high internal noise in the visual domain.

◆ **Correction of binocular visual mechanisms in primary school children with reading difficulties**  
69

N N Vasilyeva (Department of Developmental, Pedagogical and Special Psychology, I. Yakovlev Chuvash State Pedagogical University, Russian Federation; e-mail: vasnadya@rambler.ru)

Reading characteristics and binocular vision were assessed in 120 school children aged 8 yr. It was found that children with reading difficulties manifested lower binocular vision capabilities, such as: stereo acuity, fusional reserves and rate of binocular integration. The main purpose of the study was to determine the possibility of improving reading capabilities in children with reading difficulties by means of correctional procedures aimed at the development and strengthening of binocular vision. A special program of correctional sessions was elaborated. This program was based on interactive software designed to develop and strengthen binocular stereopsis mechanisms, motor and sensory fusional mechanisms and binocular integration mechanisms. The software was created at the Institute for Information Transmission Problems of the Russian Academy of Sciences. Every pupil took part in 25 correction sessions lasting 13 school weeks. It was revealed that, as a result of this training course, a

significant improvement was achieved not only in fusional reserves, rate of binocular integration and stereo acuity but also in reading skills, such as reading rate, reading accuracy and reading style.

[Supported by the Ministry of Education and Science of the Russian Federation (Project № 1688)]

◆ **Visuospatial and visuoconstructional skills in children with reading difficulties**

70 A Vasilyeva (Ageing and development, Lomonosov Moscow State University, Russian Federation; e-mail: vasilyeva\_ap@mail.ru)

Dyslexia / reading difficulties have been shown to be related to deficits in visual function (Evans, 2005; Mackeben, 2004; Prado, 2007). Therefore investigation of visual-spatial and visuoconstructional skills is required for an efficient individual correction therapy in school children. In the present study, two groups of children aged 8 years old were tested. One group comprised children with high- or middle-level reading skills, the other one included children with poor reading skills. Each child was requested to copy the Taylor complex figure (Taylor, 1969) and a cube. Organisational quality of the visual field, strategy of copying, as well as coordinate, metric, structural-topological and projecting representations, reflected by individual scores were assessed. Results indicate a difference between the two groups, in particular, children with reading difficulties tended to make mistakes related to: distortion of figure parts, omission details, alteration of a general pattern of the figure containing equal differently placed elements; and difficulty in 3D visuoconstruction, specifically, shallow-depth (2D) perception of an object or its perception in orthogonal projection. These abnormalities of visuospatial skills in children with reading difficulties conceivably indicate deficits in the development of certain visual mechanisms.

### POSTERS: MULTISENSORY PROCESSING III

◆ **Auditory rhythms influence perceived time durations of a tunnelling object**

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We study perceived time durations of visual events in which an object temporarily disappears from sight. More in particular, we investigated whether auditory rhythms influence time perception accompanying the tunnel effect or not. The tunnel effect refers to the perceived presence of a moving object that disappears behind an occluder and then reappears at the other side of the occluder, which under proper conditions, is perceived as a continuous movement of a single object passing behind the occluder. We asked participants to judge the moment that the object would reappear, and found that perceived time duration of the visual event depended on auditory rhythms presented while the moving object was occluded. More in particular, even though the objects had the same visual speed before entering the tunnel, a slow-rhythm condition induced longer perceived durations than a fast-rhythm, and no-sound condition. Remarkably, the perceived duration of the visual event when accompanied by the fast rhythm was also estimated to be longer than the no-sound condition. Therefore, we found two underlying distortions: an expansion of perceived time duration of a tunnelling object due to additional auditory input, and a rhythm specific modulation.

◆ **Seeing the body produces limb-specific modulation of skin temperature**

72 R Sadibolova, M R Longo (Department of Psychological Sciences, Birkbeck, University of London, UK; e-mail: rsadib01@mail.bbk.ac.uk)

Vision of the body, even when non-informative about stimulation, affects somatosensory processing (e.g., Kennet et al., 2001; Harris et al., 2007; Longo et al., 2009; Mancini et al., 2001). We investigated whether seeing the body also modulates autonomic control in the periphery by measuring skin temperature while manipulating vision. Using mirror-box, the skin temperature was measured from left hand dorsum while participants: (a) had the illusion of seeing their left hand, (b) had the illusion of seeing an object at the same location, or (c) looked directly at their contralateral right hand. Skin temperature of the left hand increased when participants had the illusion of directly seeing that hand but not in the other two view conditions. In the second experiment, participants viewed directly their left or right hand, or the box while we recorded both hand dorsum temperatures. The temperature increased in the same hand-view but not while the other (contralateral) hand or box were viewed. These results show that seeing the body produces limb-specific modulation of thermal regulation.

[This research was supported by European Research Council grant (ERC-2013-StG-336050) to Matthew R. Longo.]



Wednesday

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◆ **Visualization of sounds: Crossmodal transfer of affective information**

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Previous research showed that crossmodal correspondences are influenced by affective congruity of stimuli from different sensory modalities (Jankovic, 2010). In other words, the more visual and auditory stimuli are congruent in affective valence and arousal, it is more likely that they will be crossmodally matched and integrated in unique percept. In the present study we tested how effectively different affective dimensions will be crossmodally transferred in auditory-induced visual imagery. In phase one of the experiment, participants were asked to produce monochromatic abstract visual patterns corresponding to presented auditory stimuli (3s long sound clips). Presented sounds were varied according to affective valence, arousal and cognitive evaluation. In phase two, the same group of participants evaluated both the presented sounds and visual patterns on the set of bipolar affective scales measuring three affective dimensions. The results showed that affective meaning of auditory stimuli and corresponding auditory-induced visual imagery is strongly correlated. Findings provide evidence that all three affective dimensions are substantially crossmodally transferred from one sensory modality into the other. The most efficiently is transferred affective valence, followed by cognitive evaluation and arousal. [This work was supported by the Ministry of Education and Science of the Republic of Serbia, grant number 179033.]

◆ **Effects of depth position of virtual hand on perceived position of one's own hand**

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Although previous studies of the rubber hand illusion have investigated the effect of congruence of angle of the real and rubber hand, the effect of congruence of depth position is unclear. In this study, we investigated the effect of binocular depth position of a virtual hand on the drift of the perceived position of the observer's own hand. A 3D display was positioned horizontally and above the left hand of a participant which was unseen. After presentation of a virtual hand with or without synchronous visuo-tactile stroke, small circles were presented continuously at a random position. The participants judged whether the circles were displayed on the right or the left position relative to their left middle finger. The perceived position of middle finger calculated from the results of the task showed that the perceived position drifted depending on the position of the virtual hand. Also, the horizontal drift was significantly larger when the depth position of the virtual hand was congruent with that of the real hand, especially in the latter half of the position judgment task. These results suggest that the congruence of depth position enhances the illusion and maintains the illusion for longer time.

◆ **Multimodal effect of color and aroma on predicted palatability of bottled teas**

75 A Takemura<sup>1</sup>, S Okuda<sup>2</sup>, K Okajima<sup>3</sup> (<sup>1</sup>Living and Environmental Design, Setsunan University, Japan; <sup>2</sup>Human Life Studies, Doshisha Women's College of Liberal Arts, Japan; <sup>3</sup>Faculty of Environment and Information Sciences, Yokohama National University, Japan; e-mail: a-takemu@led.setsunan.ac.jp)

We enjoy the color as well as the aroma of tea. Therefore, both color and aroma are important factors influencing tea consumption. We quantified the multimodal effect on the predicted palatability of color and aroma of tea. Ten types of bottled tea drinks on the market as visual stimuli: green tea, oolong tea, black tea and jasmine tea, and three types of flavor samples as olfactory stimuli: green tea, oolong tea and black tea were evaluated by forty participants in their twenties. Each visual stimulus was in a plastic bottle, and each olfactory stimulus was soaked into absorbent cotton in a brown bottle. In the visual evaluation experiment, participants observed one tea bottle without any olfactory stimulus. In the olfactory evaluation experiment, they smelled a flavor sample without any visual stimulus. Finally, they observed one of the bottle teas while smelling an olfactory sample in the visual-olfactory evaluation experiment. Evaluated items were "predicted sweetness, sourness, bitterness, umami taste, deep flavor, roasted flavor", and "predicted palatability". The results show that "predicted palatability" can be explained by an averaging function of visual and olfactory evaluations with weighting factors which depend on the evaluated items.

**POSTERS: SENSORY DEVELOPMENT AND AGING III**◆ **The role of cortical plasticity in age-related visual declines**

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The effect of adaptation to a high-contrast-grating was used to investigate the mechanisms underlying contrast-sensitivity loss in the elderly. The relative threshold elevation caused by contrast-adaptation is a short-term modification of visual perception that can be interpreted as short-term plasticity in the response of small cell assemblies of the primary visual cortex. Adult participants were active-workers, 55–65 years-old, half or them experienced in visual perception experiments (experts). Young participants were aged 18–25. All participants had normal or corrected to normal vision. The outcomes showed that 1) adult-expert observers displayed no contrast-sensitivity declines at medium spatial-frequencies, as compared to young-observers; 2) contrast-sensitivity declines at high spatial-frequencies are similar for both expert and naïve adults; 3) threshold elevation caused by contrast-adaptation depends on the contrast of the adapting-grating for young people but not for adults; 4) for both expert and naïve adults, the threshold elevation caused by contrast-adaptation is smaller with a slower velocity of recovery of the visual abilities, in contrast with young observers. These patterns suggest that practice prevents age-related declines in the processing of medium spatial-frequencies, but not the underlying neural response dynamics. The latter might be responsible for the longer dazzling-effects reported in adult drivers as compared with young people.

◆ **Age-related changes in brain activation during the Task-Switching Paradigm**

77 M Kunimi, S Kiyama, T Nakai (NeuroImaging & Informatics, National Center for Geriatrics and Gerontology, Japan; e-mail: kunimi@ncgg.go.jp)

This study compared brain activation of young and old subjects during the Task-Switching Paradigm with varying task speeds to examine the relationship between task difficulty and brain activation using functional magnetic resonance imaging. Age-related activation differences in task-set reconfiguration and inhibition of task-switching function, depending on gradual task speed in mixed blocks, were predicted; task difficulty was controlled by altering speed. Although younger subjects engaged the left inferior parietal lobule, this region was not activated in older subjects. Moreover, a significant age-dependent increase in activation was observed in the right inferior frontal gyrus, bilateral middle frontal and fusiform gyri, and right superior parietal lobule. This study indicated that activation of regions linked to working memory associated with TSP performance increased with age and that the degree and pattern of activation depended on the content and difficulty of the task being performed. This was indicating that age- and task difficulty-dependent augmentation of brain activation varies by brain region.

[This research was supported by Grant-in-Aid for Scientific Research (KAKENHI) #24300186 from the Ministry of Education, Culture, Sports, Science, and Technology and Grant-in-Aid #25780456 from the Japan Society for the Promotion of Science.]

◆ **Memory colour in infancy?**

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The current study investigates whether infants have memory colour for faces, a highly salient object in their environment. Kimura et al. (2010) found that infants look longer at objects that are typically than atypically coloured (e.g., a yellow vs. blue banana), and argued that infants have memory colour for objects by 6-months. Here we further investigate infant memory colour with stricter colorimetric control of typical and atypical hues, and a control condition to rule out a priori hue preferences. Five and 8-month old infants were shown face stimuli that were either naturally coloured, unnaturally coloured (green, purple, blue) or achromatic. Atypical hues were generated by rotating the hue angle in the four orthogonal directions of the natural stimulus in an isoluminant DKL space, controlling for stimulus-background contrast. As a control, phase-scrambled faces were used to assess hue preferences independent of object identity. Stimuli were shown to the left and right of fixation, with every hue paired against each other whilst infant eye-movements were recorded. Infants looked equally at the natural and atypically coloured faces, and the pattern of looking across hues was the same for face and phase-scrambled stimuli. This suggests that infants do not have memory colour by 6-months.

Wednesday

◆ **Modelling age-related chromatic adaptation mechanisms**

79 T Chauhan<sup>1</sup>, D Karatzas<sup>2</sup>, K Xiao<sup>1</sup>, S Wuerger<sup>1</sup> (<sup>1</sup>Department of Experimental Psychology, University of Liverpool, United Kingdom; <sup>2</sup>Computer Vision Centre, Universidad Autónoma de Barcelona, Spain; e-mail: Tushar.Chauhan@liverpool.ac.uk)

The aim of this study was to assess how colour appearance is affected by illumination changes when observers are fully immersed in the prevailing illumination. Adaptation models were evaluated and the effect of age on these adaptation mechanisms was investigated. A large dataset of unique hue settings was obtained with the observers (185 colour-normal observers; 18-85 year old adults) fully immersed in the ambient illumination (CWF, D65 and dark). A hierarchy of adaptation models was tested, including cone adaptation and models allowing cross talk between linear channels. Mixed models allowing contributions from both the ambient illumination and the surround were also tested. The largest hue shifts were observed for unique green, for illumination changes from dark to CWF and D65. For the other hues, the settings were not greatly affected by a change of illumination. Preliminary results suggest that simple cone adaptation models do not predict appearance changes, even if the coefficients of the adaptation transforms are allowed to vary freely. Introduction of channel cross-talk is necessary to achieve predictions that are in qualitative agreement with the observed hues shifts. Interactions between adaptation mechanisms and age were only found for unique green settings.

◆ **Uncovering the functional role of infants' biases in viewpoint selection during object exploration**

80 A F Pereira<sup>1</sup>, E Sousa<sup>2</sup>, I C Lisboa<sup>1</sup>, L B Smith<sup>3</sup>, K H James<sup>3</sup>, J A Santos<sup>1,2</sup> (<sup>1</sup>CIPsi, School of Psychology, University of Minho, Portugal; <sup>2</sup>Centro Algoritmi, University of Minho, Portugal; <sup>3</sup>Psychological and Brain Sciences, Indiana University Bloomington, USA; e-mail: alfredo.pereira@psi.uminho.pt)

As we move objects close to us, and act on them, we generate dynamic views. Recent studies have examined the viewpoints that infants select during free play and found large developmental changes in dwell time distribution, namely an increasing preference for orienting objects on or around planar views – i.e. viewpoints where the main axis is parallel (foreshortened) or perpendicular to the line of sight. This bias is characteristic of mature viewing and was found to promote more efficient learning. The functional role of this active viewing bias is unknown. We investigated two general properties of object views that seem relevant: (1) main axis expansion/foreshortening, and (2) instability – related to dynamic viewing, where rotations around planar views typically yield larger visual changes. There were two key results: (1) main axis is typically maintained in view (infrequent foreshortening) – this suggests that elongation is a distinctive property of preferred views and supports other evidence that points to the main axis as an important structural property; (2) planar views correspond to more stable periods of the object manipulation – this suggests that sampling planar views corresponds to moments of focused attention and perhaps learning of a static view is occurring.

[This research was funded by Fundação para a Ciência e Tecnologia (FCT) with Portuguese Government funds under the project PTDC/PSI-PCO/121494/2010 “Visual Object Recognition and Children’s Self-Generated Object Views: Developmental Changes in Active Viewing” and under the project Scope: PEst-OE/EEI/UI0319/2014. AFP was also supported by a Marie Curie International Incoming Fellowship PIFI-GA-2011-301155.]

## POSTERS: VISUAL COGNITION

◆ **Pattern from visual noise motion: animacy versus intention**

81 K Takahashi, K Watanabe (RCAST, The University of Tokyo, Japan; e-mail: takahashi.kohske@gmail.com)

People tend to see patterns in random noises, which is referred to as “pattenicity.” Animacy perception is a variation of patternicity. However, in previous studies of animacy perception, the relation between animacy and intention was ambiguous. The present study investigated how animacy and intention would be perceived from noise motion and whether they would depend differently on stimulus parameters and contextual information. We presented some dots moving with motion profiles generated by Perlin noise series. The observers’ task was to rate the strength of animacy and intention of the central red dot. We manipulated the speed of dot motion. Contextual information was also manipulated: (a) all dots moved independently, (b) only the central red dot moved and the other dots did not, and (c) all dots moved with the same trajectory. We found that the speed affected only animacy rating but not

intention rating. Furthermore, while (b) induced stronger intention than (a), they were comparable in the animacy rating. (c) induced weaker animacy and intention than other conditions. These results suggest that the perception of animacy and that of intention depend on different processes and on the contextual information.

[This work was partially supported by JST CREST and JSPS KAKENHI (25700013).]

◆ **Threat modulates neural responses to looming visual stimuli**

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Objects on a collision course with an observer produce a specific pattern of optical expansion on the retina known as looming, which in theory exactly specifies time-to-collision. We recently demonstrated that the affective content of looming stimuli influence perceived time-to-collision, with threatening objects judged as approaching more rapidly than non-threatening objects. Here, we investigated the neural mechanisms by which perceived threat modulates spatiotemporal perception. We recorded the electrical brain activity while participants judged the time-to-collision of threatening or non-threatening stimuli, which expanded in size at a rate indicating one of five time-to-collisions. We analysed event-related potentials (ERPs) and oscillatory neural responses. Consistent with our previous findings, the arrival time of threatening stimuli was underestimated compared to non-threatening stimuli. Further, both speed of approach and threat modulated both ERPs and oscillatory responses from occipito-parietal channels. Critically, however, there was no overlap between which signals were modulated by speed of approach and threat, nor any interactions between these cues. These results are consistent with the interpretation that threat induces a spatio-temporal bias on vision independent of the optical information about looming. Alternatively, interactions between these cues may occur sub-cortically.

[Economic and Social Research Council]

◆ **Multisensory stimulation of the face affects personal preference but not racial prejudice**

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Recent research has shown that the representation of our own face is flexible. When observers' view another face being stroked while they receive similar stimulation of their own face, synchronous but not asynchronous stroking produces a bias in self-recognition which modulates observers' social perception toward the other face. In this study, we explored whether this manipulation also modulates observers' racial prejudice and personal preference. In Experiment 1, Caucasian observers received facial stimulation that was synchronous with the stroking of an African face, or received no stimulation while the African was being watched. In Experiment 2 and 3, Caucasian participants received either synchronous or asynchronous stimulation with an African face. In all experiments, the observers consistently experienced an enfacement illusion in the synchronous condition, whereby they reported to embody the African face. This effect did not produce concurrent changes in implicit racial prejudice, as measured with an IAT test, but it produced a change in personal preference toward the model.

◆ **Please do not disturb: Declarative associative learning with and without interference**

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Subsequent learning may disrupt memory traces acquired during preceding learning, but the time course of this interference remains unknown. We investigated whether and if yes, at which time points another task administered following initial visual declarative learning would affect memory performance on the initial task. Adolescents had to learn repeatedly presented lists of corresponding German and Japanese words. After attaining a predefined learning criterion, either another word-list learning task (duration, 3 min) was introduced at 0-9 min in 3-min steps (interference conditions) or an empty/rest break of equal duration (control conditions). Finally, participants had to recall the initially learned word associations. The results indicated an overall decrease in the correctly recalled associations in the interference compared to control conditions with the greatest reduction at 3 min from initial learning completion. Boys learned to a greater degree, but lost the advantage with both interference and mere time passage from learning completion. They were most affected by the interfering task administered right away, whereas girls at 3 min after learning completion. The findings offer the first evidence on the

Wednesday

time course of interference in declarative memory formation with important implications for models of declarative memory, learning, education, and treatment of memory disorders.

◆ **Feeling-of-warmth judgments in category learning with pictorial stimuli**

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The aim of the study was to investigate feeling-of-warmth judgments (or participants' judgments about how close they are to the acquisition of categorization rule) during the process of learning rule-based categories with pictorial stimuli. Each stimulus consisted of three positions which represented a dimension in which either of two thematically related drawings of objects (candle–light bulb, violin–trumpet, and bolt–nut) could appear as values. Tasks varied on three levels of categorization difficulty based on conjunctive, conjunctive-disjunctive or complex rule. Seventy psychology students participated in the study. Differences in classification accuracy and feeling-of-warmth judgments with respect to three levels of task difficulty, four learning stages and two performance groups (good and poor learners) were analyzed. The results showed that classification accuracy linearly increased through four learning stages for subjects who have successfully mastered the conjunctive and complex task, while classification accuracy in conjunctive-disjunctive task increased starting from the second learning stage. Similarly, feeling-of-warmth judgments linearly increased through four learning stages for subjects who have successfully mastered the complex task, while in conjunctive and conjunctive-disjunctive tasks, judgments increased starting from the second learning stage. Classification accuracy and feeling-of-warmth judgments for poor learners remained low through the whole learning process.

◆ **Diagnosing age-specific sexual interest with pupil dilation**

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In the visual processing of sexual content, pupil dilation is an indicator of sexual arousal that has been positively associated with observers' sexual orientation. To what extent, however, can this measure be extended to determine age-specific sexual preferences? In this study, we explored this question by measuring the pupillary responses of male student observers with diverse sexual orientations to images of males and females of different ages. This was followed by a self-report sexual orientation questionnaire, and an interest in child molestation proclivity scale as an indication of any sexual interest towards children. We found that non-deviant males showed pupil dilation specific to the adult-categories consistent with their sexual orientation compared to images of the male and female children. These findings indicate that eye tracking could provide a useful tool for diagnosing age-specific sexual interests. This might be relevant for assessments of deviant sexual interests, which is paramount in the management of child sex offenders by forensic psychologists.

◆ **Amplification effects of processing fluency on implicit affective evaluation**

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Makin, Pecchinenda, and Bertamini (2012) showed that the Implicit Association Test (IAT) can serve as an appropriate method to measure effects of processing fluency on liking. Since experiments on fluency usually are done with affectively neutral stimuli (see Albrecht & Carbon, 2014), the present study (N = 45) aimed in evaluating implicit associations on stimuli varying in fluency and – in particular – stimulus valence. Words with positive or negative valences, differing in language (German vs. English), were manipulated regarding processing fluency by either showing them upright (high fluency condition) or inverted (low fluency condition). The task was to categorize the stimuli in respect of language. Following the IAT procedure, language categories were combined with valence categories, resulting in compatible trials (e.g. “freedom” matched combined category English/positive) and incompatible trials (e.g. “Liebe” [love] did not match combined category German/negative). Results revealed greater differences in reaction times between compatible and incompatible trials in the high fluency than in the low fluency condition – regardless of the stimulus valences. Processing fluency seemed to amplify affective reactions: Positive stimuli were evaluated more positively, negative stimuli more negatively when fluency was high. These results challenge the assumption of a hedonic marking of processing fluency.

◆ **Testing the geographical stability of evocative pictures evaluation in Russia**

88 O P Marchenko<sup>1</sup>, Y G Pavlov<sup>2</sup> (<sup>1</sup>Center of Experimental Psychology, MSUPE, Russian Federation; <sup>2</sup>Laboratory of Psychophysiology and Psychophysics, Ural Federal University, Russian Federation; e-mail: olga.marchenko@psyexp.ru)

Processing evocative visual scenes dependent on cultural factors. It has been previously shown that there is a significant difference between Russian and North American norms for hedonistic valence, arousal, and dominance scores for a considerable number of scenes from the International Affective Picture System (Marchenko & Vasanov, 2013). Russia covers more than one-eighth of the Earth's inhabited land area. Thus, before making inferences and generalizing the evaluation of emotional scenes to the whole of Russian culture, it is crucial to test the geographical stability of these findings. In order to address this need, samples from distant regions of the country were tested. Seventy participants from Moscow and 70 participants from Ekaterinburg evaluated one set of 60 pictures from the International Affective Picture System. The results reveal that scores of valence, arousal, and dominance are highly correlated between these two regions, meaning cultural specificity of emotionally evocative scenes evaluation is geographically stable and can be generalized to the whole Russian population.

[Supported by RFH, 14-36-01309]

◆ **The interaction between phonological processing, naming speed and age in the reading performance of school age children**

89 E Kassaliete, I Lacis, G Krumina (Optometry and Vision Science, University of Latvia, Latvia; e-mail: evita.kassaliete@lu.lv)

3-9% of school age children have specific reading difficulties (Witton et al., 1998). Various models exist to explain reading problems, but their adaption limited by specific language properties. The aim of our study was to create package of tests useful to evaluate reading skills in Latvian school age children. 2258 children participated in the study; 640 children (7-18 y.) performed all tests. Reading speed was compared with the results of specially developed tests: developmental eye movement test for saccadic eye movements and naming speed, accuracy of single word and non-word identification for ability to use phonic skills and memory. We used outlier detection to determine criterion's in each age group showing that 10% of children had difficulties with reading performance. We observed highly significant correlation between reading speed and the results of separate tests (0.54-0.88;  $p < 0.05$ ). Our results demonstrate the relevant role of lexicon in reading process; word semantics gives 33% benefits at word identification comparing to non-word recognition task. Multifactorial regression analysis shows that we can explain about 82% ( $R^2$ ) of reading speed variations using our package of tests. The results confirm phonological theory of reading difficulty showing significant relationship between naming-speed processes, written language, and age.

◆ **Early visual orthographic processes: dissociation between magnocellular and parvocellular systems in pseudoword processing**

90 T Vahine, S Mathey, S Delord (Laboratoire de Psychologie, Santé et Qualité de Vie EA4139, Université de Bordeaux, France; e-mail: theodora.vahine@u-bordeaux.fr)

Visual word recognition is driven by both visual and language processes. The main objective was to dissociate the implication of the magnocellular (M) and the parvocellular (P) visual systems in the orthographic neighborhood effect using spatial frequency filtering of pseudoword stimuli. A repetition priming paradigm was used in Experiment 1. Prime was a band-pass filtered version of the target (biasing processing toward the P system), a low-pass filtered version (toward M system), or a control blank. Targets were either hermit pseudowords (i.e., with no orthographic neighbor) or anagram pseudowords (i.e., with one orthographic neighbor by letter transposition). Results showed that both band-pass and low-pass filtered primes accelerated rejection for anagrams only, with a larger extent for the band-pass version. Experiment 2 used a lexical decision task with direct filtering of the target. Results showed that both filtered versions were as efficient for anagrams and that the band-pass version was more efficient than the low-pass version for hermits. Taken together, results are consistent with the hypothesis of dissociation between the two visual systems for orthographic activation: the M system conveys letter position while the P system rather conveys letter identity.

Wednesday

◆ **Characteristics of interference in discrimination tasks within short periods of time**

91 S Ohtsuka (Department of Psychology, Saitama Institute of Technology, JAPAN;  
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Irrelevant information sometimes interferes with human discrimination performance. We investigated interference properties within short periods of time, using the color Stroop effect, number Stroop effect, and spatial Simon effect. Experimental stimuli included the task-relevant feature and consistent or conflicting irrelevant features: the written color word and its ink color (experiment 1), the digit and number of digits (experiment 2), and the relative direction and its location (experiment 3). Participants were required to identify the relevant feature while ignoring the irrelevant feature. Stimulus onset asynchrony (SOA) between the appearances of relevant and irrelevant features was manipulated ranging from -200 ms to +200 ms. The irrelevant feature appeared first in negative SOAs, and the relevant feature first in positive SOAs. Mean reaction time showed a reversed V-shaped function with a peak at 0 ms SOA in experiments 1 and 2. Reaction time was also longest at 0 ms SOA in experiment 3; however, the function was asymmetrical between signs and the interference effect was lesser than other experiments. The data are consistent with the theory that linguistic interference occurs at the stimulus encoding stage, whereas spatial interference takes place at the response generation stage or later.

◆ **Influence of cartographic visualization methods on cognitive processing: comparison of extrinsic and intrinsic visualization of avalanche hazard maps**

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The aim of this research was to explore the influence of cartographic visualization on users' information processing. In our experiment, two alternative visualization methods were used (Kunz, 2011): an intrinsic method (bivariate colour scheme) and an extrinsic method (combination of colour and shape). The presented topic was the combination of avalanche hazard and uncertainty level. In the first case, both characteristics were visualized using a specific colour schema, where colour hue visualized the avalanche hazard and colour saturation depicted the uncertainty level. Secondly, the avalanche hazard was visualized by colour scale and the uncertainty level by graduated size circles. The first phase of the experiment was performed on the MuTeP testing platform (Šašinka & Stachoň, 2013) enabling collective data gathering. The second phase of the experiment used an eye-tracking tool to enable deeper understanding of the ongoing cognitive processes. The current contribution presents results of the subtest focused on intuitive understanding of the combined map legend and its influence on the achievements in the map field. Among other findings, it appears that the intrinsic method is more intuitive while with the extrinsic method, participants oscillated more often between the map field and the legend.

[This work was supported by the project „Employment of Best Young Scientists for International Cooperation Empowerment“ (CZ.1.07/2.3.00/30.0037) co-financed from European Social Fund and the state budget of the Czech Republic and by the project of Masaryk University (MUNI/FR/0413/2014).]

◆ **Red card for red: Questioning the positive effect of the colour red on male attractiveness**

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Elliot and colleagues (2010) reported a series of experiments to demonstrate that the colour red enhances the attractiveness of men to women. A more recent comment of Francis (2013), however, suspects this finding to be contaminated with a publication bias. Due to the very limited variance of the stimulus material (actually,  $n = 1$ : one photo of a male) it is further questionable whether the red-attractiveness effect published by Elliot is ecologically valid. We conducted two replications of Experiment 1 from the original series of 2010. In a one-to-one replication ( $N = 89$ ), the original stimulus used by Elliot et al. (2010) was presented on either a red (LCh 49.4, 57.5, 29.8) or a white background. In a modified replication ( $N = 32$ ), we increased the variance of the stimuli by using photos of various men dressed in suits or training wear presented on either a red or a white background. While in the modified replication men wearing suits were perceived as being more attractive, we could not find any significant

impact of red with regard to attractiveness ratings in either of the studies. These findings challenge the red-attractiveness effect and point to limitations of any perceptual effect due to too restricted material.

◆ **Affective facial microexpressions and adult attachment**

94 F M Felisberti, E Chipi, J Trueman (Psychology, Kingston University London, UK; e-mail: f.felisberti@kingston.ac.uk)

This study investigated whether adults' ability to recognize brief facial expressions of emotion (i.e. microexpressions: anger, contempt, disgust, fear, happiness, sadness) was linked to their attachment style and early family environment. Experiment 1 showed that the overall accuracy to anger and disgust tended to be low whereas the inverse pattern was true for happiness and contempt, independently of the duration of the microexpressions (100-200 ms). Experiment 2 revealed a negative correlation between the number of siblings and the accuracy to microexpressions of fear (Felisberti et al., ECVF 2013). The recognition of contempt was positively associated with a dismissive attachment style (Experiment 3), whereas the effect of parental authority style had a wider modulatory effect on recognition accuracy (Experiment 4). Paternal permissive and authoritative scores were positively correlated with contempt recognition, whereas a paternal authoritarian scores was negatively correlated with contempt and fear accuracy. Maternal authoritative scores increased with accuracy to sadness, whereas maternal permissiveness scores decreased with accuracy to disgust. The findings showed that the recognition of microexpressions, especially fear and contempt, was reliably affected by the participants' number of siblings and parental authority styles and point to their relevance in affective processing in adult life.

## POSTERS: ART AND VISION

◆ **Attractiveness of female body parts: Effects of global-local presentation**

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The purpose of the present study was to investigate the effect of completeness of context on attractiveness of female body parts. Complete context was specified for whole body presentation (global condition), while reduced context was specified for isolated body parts presentation (local condition). In Experiment 1 participants (108 males and 122 females) were presented with four sets of body parts in the local condition: breasts, buttocks, waist and hip. Each set included six stimuli ranked in size. Participants were asked to choose the stimulus within each set which appears most attractive. In Experiment 2 participants (105 males and 120 females) were presented with the same body parts in the global condition (contextual body was visible; contextual body parts were rated as average in preliminary study). Analysis of variance showed that compared to local, in the global presentation participants preferred larger breasts, thinner waists and wider hips. These results indicated that the presentation of body parts in the global context induced the preference for more feminine characteristics than in the local presentation. In addition, male participants preferred more feminine (larger) breasts and buttocks than female participants. This result was in line with previous studies of female body attractiveness. [This work was supported by the Ministry of Education and Science of the Republic of Serbia, grant number 179033.]

◆ **Aesthetic preference for color vs. black and white photographs: Effect of the category of photographed objects**

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Previous studies suggested that color photography was preferred over black and white photography. In the present study we investigated the effect of motif (i.e. category of photographed objects) on preference for color vs. black and white photographs. Five categories of photographs were used: portraits, nature, architecture, food and abstract patterns. Each category included 14 photographs. Two versions of these photographs were used: colored (original) and black and white. Two groups of adult participants (N1=13, N2=13) rated the beauty of photographs on a seven-step scale (participants in two groups rated either color or black and white version of same photograph). Color photographs of food and architecture were rated as being more beautiful than their black and white version ( $Z=2.13$ ,  $p=0.033$  for architecture and  $Z=3.11$ ,  $p=0.002$  for food). For portraits, nature and abstract patterns there was no difference between ratings of color and black and white photographs. These findings suggest that although color



Wednesday

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may play a crucial role in preference for some categories of objects, preference for other categories may be influenced by other factors (such as shape, texture etc.).

[This work was supported by the Ministry of Education and Science of the Republic of Serbia, grant number 179033.]

◆ **The effects of context and individual art interests on perception and evaluation of visual art**

97 A Gartus, N Klemer, H Leder (Department of Psychological Basic Research and Research Methods, Faculty of Psychology, University of Vienna, Austria; e-mail: andreas.gartus@univie.ac.at)

Artworks are traditionally defined as autonomous objects that stand on their own. However, at least since the emergence of Pop Art in the 1960s, art can look like almost anything and therefore it cannot be defined without reference to the context. We presented modern art and graffiti art embedded into museum and street contexts to participants with different art interests. In a first experiment, we found an interaction effect of context and individual interests: Interest in graffiti art had a stronger positive effect on valence ratings in a street context than in a museum context. In a second experiment, in addition to the ratings, we also applied eye-tracking to assess viewing differences. There, we found the same interaction of context and interest in graffiti art for beauty and interest ratings, but also for number of fixations on the presented artworks. Therefore, we conclude that the context in which artworks are presented—in interaction with individual interests—can have an important influence on aesthetic evaluations and viewing behavior.

◆ **The effect of short-term familiarity on the perception of beauty in fractal images**

98 J Eom, W H Jung (psychology, Chungbuk National Univ., Republic of Korea; e-mail: com4man@gmail.com)

It was investigated whether the more short-term familiarity increase, the more fractal images are perceived beautifully. Stimuli were 100 fractal images. The experiment consisted of five blocks of trials. In each block, participants rated the beauty of fractal images. The order of each blocks was counterbalanced across participants. The fractal images divided into 5 sets. An image set could be repeatedly presented up to 5-times, while other sets were presented four, three times, twice, or once. For the 5-time presented image set, different groups of participants rated the images' beauty in the 2nd, 3rd, 4th, or 5th blocks. The beauty perception was found to be a U-shaped function of familiarity; for the 5-time presented image set, the beauty rating score decreased from the 2nd to the 3rd block and increased there after. In addition, regardless of the number of presentation, the overall beauty rating score tended to be a U-shaped function of familiarity. These results imply that the familiarity by repeated exposure in short term could affect on beauty perception and that the category familiarity of fractal images may be more important than the familiarity of the identical images in beauty perception.

[This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government(2013S1A5B6054557).]

◆ **Perceptual complexity and liking of fractal-like statistical geometric patterns**

99 Y Güçlütürk, R H A H Jacobs, R van Lier (Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Netherlands; e-mail: y.gucluturk@donders.ru.nl)

We investigated the relationships between complexity, liking, and fractal dimension (FD). We generated fractal-like statistical geometric patterns (SGPs) using a space filling algorithm that randomly places non-overlapping geometric shapes with monotonically decreasing sizes. Our stimulus set consisted of 125 grayscale SGP images of basic geometric shapes (circles, hexagons, squares and triangles). Thirty participants gave nine-point likert scale complexity and liking ratings for each image. We found significant negative correlations between FDs and liking ratings (average  $r = -0.54$ ), whereas FDs and complexity ratings displayed a robust non-linear relationship and significant correlations (average  $r = 0.77$ ). Additionally, we found remarkably high significant correlations between complexity ratings and the logarithm of PNG compressed file sizes of SGPs (average  $r = 0.97$ ), providing support for Kolmogorov complexity (estimated by bits in a compressed image) as a predictor of perceptual complexity. Surprisingly, we did not find any significant correlations between liking and either measure of complexity. All in all, two findings stand out: We found no evidence for a direct relationship between the complexity and liking ratings, and we observed a clear susceptibility of both ratings to systematic variations in FD. These findings can have implications for models that relate perceptual complexity to liking.

◆ **Seeing the wood and the trees? Characteristics of local and global visual processing during representational drawing**  
100

R Chamberlain, L de-Wit, J Wagemans (Laboratory of Experimental Psychology, KU Leuven, Belgium; e-mail: rebecca.chamberlain@ppw.kuleuven.be)

Old Masters such as Leonardo da Vinci became versed in their art by developing strategies to hone in on detail and represent the unique features of particular viewpoints, whilst preserving the holistic integrity of their subject matter. The ability to isolate the details of a subject from the overall picture helps artists to avoid drawing what they know rather than what they see. In a previous study local visual processing ability was correlated with drawing accuracy (Chamberlain et al, 2013), and that this ability was related to a reduction in interference of holistic information. In the current study, a battery of visual processing tasks is employed to explore the more specific characteristics of local processing in proficient draftsmen. This battery includes tasks that measure the ability to switch between local and global representations in hierarchical stimuli, and the relationship between local processing and judgments of orientation and continuous quantity. On the basis of research on the integration of parts into wholes (Perdreau & Cavanagh, 2013), we also test global processing abilities of coherence in a Mooney image and coherent motion experiment. The findings provide insights into the relationship between attention to local and global features in proficient and novice draftsmen.

◆ **What can the pupil size tell us about aesthetics? Towards a multidimensional model of complex continuous experience**  
101

M H Raab<sup>1,2</sup>, C Muth<sup>1,2</sup>, C C Carbon<sup>1,2</sup> (<sup>1</sup>Department of General Psychology and Methodology, University of Bamberg, Germany; <sup>2</sup>Bamberg Graduate School of Affective and Cognitive Sciences, University of Bamberg, Germany; e-mail: marius.raab@uni-bamberg.de)

While there have been attempts to employ pupil size measurement for the evaluation of movies (Troscianko et al., 2012), most pupil research confines itself to discrete visual stimuli and episodes of cognitive processes (e.g., Laukka et al., 2013) examining, e.g., arousal, liking and decision making. We related continuous pupil size data to a continuous stream of aesthetic experiences induced while watching a movie. Using a lever, participants evaluated the movie continuously on the dimensions liking, surprise, interestingness, determinacy and prototypicality (each person a combination of two dimensions blockwise); objective data were calculated frame-by-frame for luminance, contrast, coarseness and complexity (via JPEG compression, see Chikman et al., 2012); pupil diameter was measured separately. For each dimension, data were averaged over participants. For further analysis, pupil diameter data were corrected by luminance ( $\beta = -.771$ ) and then entered into a stepwise regression. A linear model with liking ( $\beta = .378$ ), surprise ( $\beta = -.327$ ), interestingness ( $\beta = .487$ ), determinacy ( $\beta = -.619$ ) and prototypicality ( $\beta = .377$ ) accounts for 46 percent of pupil diameter variance ( $p > .001$ ). Our results integrate existing findings and show that pupil size can be best understood as highly dynamic variable continuously reflecting aesthetic elaboration and appreciation.

◆ **In the mood for kitsch? Towards a functional model linking aesthetic appreciation to the dynamics of social motivation and self-determinacy**  
102

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Art is often contrasted with kitsch (Greenberg, 1936; Kulka, 1996). Unlike art, scholars have dispraised kitsch as reactionary, simple-minded and consoling (Greenberg, 1936; Broch, 1969). Behind these highly judgmental statements however stands an intriguing hypothesis: kitsch helps us to cope with uncertainty and negative emotions. According to Norman (2004) we do not value keepsakes because they are particularly beautiful, but because they evoke pleasant memories which are able to cheer us up on a rainy day. If this is the case, we expect appreciation of kitsch to be dynamically related to feelings of security and self-determinacy: whenever people feel vulnerable and dependent they should become more susceptible to the familiar, clear-cut and benign qualities of affirmative aesthetics (Carbon, Faerber, Gerger, Forster & Leder, 2013) which are ideally represented by kitsch. Based on these theoretical considerations we present a functional model which relates preference for novelty, ambiguity and fluency to the basic needs of social motivation (Bischof, 1985; Schneider, 2001) and self-determinacy theory (Deci & Ryan, 2000): security, arousal, affiliation, control, and autonomy. Moreover, we present the results of an interview study (N=15) which support our basic assumption that kitsch is liked because it contributes to wellbeing, e.g., by conveying feelings of security and belonging.

Wednesday

◆ **Mindscape colors**

103 A J van Doorn<sup>1</sup>, J J Koenderink<sup>1,2</sup>, L Albertazzi<sup>3</sup>, J Wagemans<sup>2</sup> (<sup>1</sup>Psychologische Functieeler, University of Utrecht, the Netherlands; <sup>2</sup>Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; <sup>3</sup>CIMEC/Department of Humanities, University of Trento, Italy; e-mail: andrea.vandoorn@telfort.nl)

Observers judged depth order in bipartite images in which the two fuzzily delineated half-images were filled with different hues. For the majority we find a systematic dependence of depth order of these fields on their hue and/or brightness difference. There turn out to be two varieties of observers, that respond in mutually quite distinct manners. These clusters of participants are mutually separated. We attempt to correlate our findings with the statistical distribution of hue and brightness in generic “open landscape” photographs. Perhaps remarkably, such distributions are very robustly determined. One group of observers correlates well with hue distributions; the other with brightness distributions. This suggests that human observers apply “generic landscape” templates in their microgenesis of visual awareness – in our case of abstract pictures, perhaps also in real scenes.

◆ **Effects of environmental factors on movie perception**

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Despite the fear of the entertainment industry that illegal downloads of films will ruin their business, going to the movies continues to be a popular leisure activity. Maybe, people enjoy watching movies in cinemas so much because of the physically huge room and screen size. Physical screen size is often confounded with visual angle, but this need not be so. We tested whether the enjoyment of movies is affected by screen size, visual angle, or other environmental cues. We built a model cinema that holds all the visual information a real cinema does. In a series of experiments, subjects watched movie clips under different conditions, including a real cinema, the model cinema, and a display monitor in isolation. We found that screen size was overestimated by 50% when watched in the context of the model cinema, but not in the other conditions. We further found that people enjoyed the movie more when watching it in the model cinema, as compared to the display monitor condition. Conclusion: Whereas the isolated display monitor is inferior, the addition of a contextual model can improve the viewing enjoyment to the extent that it is comparable to the movie theater experience, provided the viewing angle is the same.

◆ **Classifying spatial visual illusions – illustrating with works of art**

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Richard Gregory produced a formal classification of illusions, based on their causes. The present classification is less ambitious but more focused, classifying static illusions that involve errors in perceiving spatial relationships. It also presents examples from the art world. Classification is based on the dimensionalities of (a) the input visual stimulus and (b) the resulting percept. Given that both input and percept can be either two-dimensional (2-D) or three-dimensional (3-D), the classification results in 4 classes, forming a 2x2 table: (1) 2-D input, 2-D percept: Among the best-known representatives of this type are the Muller-Lyer, the Ebbinghaus and the Poggendorff illusions; the last one is responsible for the misalignment of collinear segments in several paintings. (2) 2-D input, 3-D percept: This is the most common class, as most photographs and paintings with linear perspective belong here; Julian Beever and Kurt Wenner create very powerful illusions in this class. (3) 3-D input, 2-D percept: These are the hardest to come by; Felice Varini creates 2-D percepts out of stimuli that are scattered in 3-D space. (4) 3-D input, 3-D percept: These typically involve depth inversion, exemplified by the work of Patrick Hughes's reverspectives. Examples from each class will illustrate the classification.

## POSTERS: COMPUTATIONAL NEUROSCIENCE

◆ **A neurocomputational model of lightness illusions**

106 D Domijan (Psychology, University of Rijeka, Croatia; e-mail: ddomijan@ffri.hr)

A neurocomputational account is offered to explain how perceptual grouping with remote surfaces can influence the computation of target lightness. In order to implement the proposed computational function, I modified the selective integration model of lightness perception (Ross & Pessoa, 2000). Computer simulations showed that the neural activity in the filling-in layer correctly predicts appearance of gray patches in duneon illusion (Bressan, 2001) and in illusory figures designed by Agostini and Galmonte (2002) and Economou, Annan and Gilchrist (1998). Importantly, the current model is also

able to account for other lightness illusions such as White's effect, Benary's cross, Todorovic's illusion, checkerboard contrast and second-order simultaneous contrast. Moreover, the model can explain variants of the White's effect which do not contain T-junctions such as Howe (2005) or Yazdanbakhsh et al. (2002). Finally, when conditions for perceptual grouping are not met, the model generates simultaneous lightness contrast. In conclusion, the proposed model offers new insights on how contour grouping can affect lightness perception.

◆ **An artificial human observer: camouflage assessment and object recognition**

<sup>107</sup> T N Volonakis<sup>1</sup>, O E Matthews<sup>1</sup>, N E Scott-Samuel<sup>1</sup>, I C Cuthill<sup>2</sup>, R J Baddeley<sup>1</sup> (<sup>1</sup>School of Experimental Psychology, University of Bristol, United Kingdom; <sup>2</sup>School of Biological Sciences, University of Bristol, United Kingdom; e-mail: tim.volonakis@gmail.com)

Psychophysical testing is an intuitively straightforward method to assess the visibility of objects in an environment, but can be impractical if the number of objects is large. Using existing knowledge of low-level visual processing, an alternative is to design a biologically inspired classifier. We present a visual recognition system using the linear and non-linear properties of V1 in a simple three-stage process. Object features are modelled using the mixture of probabilistic principal components density estimation technique. Recognition is achieved by using Bayes' rule to identify the object of highest posterior probability. When recognising a camouflaged object in a natural scene, the model accuracy is consistent with human performance. In a face recognition task, using well-established publically available, accuracy is comparable to (or exceeds) state of the art performance. The model allows for analysis of its internal representations and, for faces, these reveal views of objects under the difficult conditions that make recognition so difficult, i.e. object pose, illumination and facial expressions. Analysing these internal representations has implications for understanding visual search.

◆ **When similarity makes a difference: a computer vision-based framework to investigate**

<sup>108</sup> **shared history in man-made textures**

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Visual similarity can often be a good indicator of shared history in man-made artefacts, especially where function and identity are almost exclusively determined by the surface pattern of an object, such as in the case of textiles (e.g. Matthews et al., 2011). However, this approach holds two main challenges: 1) obtaining an objective (and preferably automatic in the case of large datasets) measure of similarity between textures; and 2) the history and identity of patterns have to be available independently of their visual information in order to avoid circular arguments. We propose a computer vision-based model that uses mixtures of factor analysers (Ghahramani & Hinton, 1996) to cluster pre-processed images of patterns into classes. By calculating the vector of posterior probabilities for a pattern arising from a set of classes, we show that the distances between such vectors can be used as a similarity metric between patterns. To test for 'evolutionary' shared history in man-made textures, we applied the model to a dataset of over 600 camouflage uniform patterns, where information is available about the year of issue (history) and issuing country (identity), and all patterns were designed for concealment (common function).

◆ **FVDP - A visual difference model of human fixations in natural scene search**

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Visual search is a ubiquitous task that has been modelled in many different ways (Borji & Itti, 2013). A large number of these models use a saliency-based approach after that of Itti and Koch (1999), but for target driven search tasks, a relevancy map (Fecteau & Munoz, 2006) might produce a more accurate model of human behavior. Here we present the results from a new relevancy model of visual search, based upon the Visual Difference Predictor model of human perception (Tolhurst, To, Chirimuuta, Troscianko, Chua & Lovell, 2010). We compare the performance of this new model against the output from several other established models of both relevancy and saliency, and show that this new algorithm performs better than previous heatmap generating models for predicting fixations. The result obtained from this comparison of models suggests that human search is guided by target relevancy when the

Wednesday

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target is present, and scene saliency when the target is absent, and indicate that the two mechanisms might work in parallel.

[This work was supported by a CASE studentship to the first author funded by EPSRC and QinetiQ.]

◆ **The navigational information content of panoramic images**

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Insects (as probably most animals) use panoramic scene memories to find routes and significant places, such as their nests (reviewed in Zeil 2012, Collett et al. 2014). Computational modelling and experimental evidence suggest that navigational instructions can be derived by comparing the current panoramic image with reference views that insects acquire en route and close to their nest. Correct homing directions can be determined locally at a scale of tens of meters by cross-correlating the current panoramic image with an oriented reference, which delivers the home or route direction as the minimum of an image difference function (IDF). In natural environments the accuracy, precision and accessibility of the navigational information content of panoramic images depend differentially on image representation: (1) IDFs based on motion signals (resulting from head rotation) show sharper tuning than luminance based IDFs and are more robust against changing illumination. (2) The low spatial resolution of insect compound eyes affects the tuning width of IDFs, but preserves target direction. By quantifying the navigational information content of natural habitats, we aim to understand the minimal information required for navigation together with suitable neural image representations, which should be of interest to cognition and robotics research.

◆ **Improving models of early vision through Bayesian analysis**

111 D H J Janssen<sup>1</sup>, F A Wichmann<sup>1,2</sup> (<sup>1</sup>Neural Information Processing Group, University of Tuebingen, Germany; <sup>2</sup>Intelligent Systems, MPI Tuebingen, Germany; e-mail: janssen.dhj@gmail.com)

Computational models are often used in vision science to formalize theories about how the visual system functions. The most general models attempt to relate visual input—images—to results obtained through psychophysical experiments. Typically, image-based models contain many parameters. Maximum likelihood estimation (MLE) is a commonly used technique to statistically estimate the model parameters from the data, but MLE only provides point estimates. Even when MLE is complemented by a variability estimate based on the normal approximation at the posterior mode, it does not explore the confidence regions of, and dependencies between, model parameters in sufficient detail. We present an image-driven model of early vision within a Bayesian framework in which we estimate the posterior distributions of the parameters via Markov Chain Monte Carlo (MCMC) sampling. This provides us both with a "best fitting model" and estimates of the confidence intervals on and correlations between the model parameters. We demonstrate how this information helped guide our model-design and avoid non-obvious pitfalls that would not have been apparent via MLE. Finally, we provide an aside on why subband decompositions do not function well within standard models of early vision and provide a computationally intensive but functional alternative.

◆ **Pain-free bayesian inference for psychometric functions**

112 H H Schütt<sup>1</sup>, S Harmeling<sup>2</sup>, J H Macke<sup>3,4</sup>, F A Wichmann<sup>1,2,3</sup> (<sup>1</sup>Neural information processing group, Faculty of Science, Eberhard Karls Universität Tübingen, Germany; <sup>2</sup>Empirical Inference, Max Planck Institut for intelligent systems, Germany; <sup>3</sup>Tübingen, Bernstein Center for Computational Neuroscience, Germany; <sup>4</sup>Neural Computation and Behaviour, Max Planck Institute for Biological Cybernetics, Germany; e-mail: heiko.schuett@student.uni-tuebingen.de)

To estimate psychophysical performance, psychometric functions are usually modeled as sigmoidal functions, whose parameters are estimated by likelihood maximization. While this approach gives a point estimate, it ignores its reliability (its variance). This is in contrast to Bayesian methods, which in principle can determine the posterior of the parameters and thus the reliability of the estimates. However, using Bayesian methods in practice usually requires extensive expert knowledge, user interaction and computation time. Also many methods—including Bayesian ones—are vulnerable to non-stationary observers (whose performance is not constant). Our work provides an efficient Bayesian analysis, which runs within seconds on a common office computer, requires little user-interaction and improves robustness against non-stationarity. A Matlab implementation of our method, called PSIGNFIT 4, is freely available online. We additionally provide methods to combine posteriors to

test the difference between psychometric functions (such as between conditions), obtain posterior distributions for the average of a group, and other comparisons of practical interest. Our method uses numerical integration, allowing robust estimation of a beta-binomial model that is stable against non-stationarities. Comprehensive simulations to test the numerical and statistical correctness and robustness of our method are in progress, and initial results look very promising.

◆ **A computational model of push-pull inhibition of simple cells with application to contour detection**

113 G Azzopardi<sup>1</sup>, A Rodriguez Sanchez<sup>2</sup>, J Piater<sup>2</sup>, N Petkov<sup>1</sup> (<sup>1</sup>Intelligent Systems, Johann Bernoulli Institute for Mathematics and Computer Science, University of Groningen, Netherlands; <sup>2</sup>Intelligent and Interactive Systems, Institute of Computer Science, University of Innsbruck, Austria; e-mail: g.azzopardi@rug.nl)

We propose a computational model of push-pull inhibition (ON inhibition in OFF subfields and vice-versa) of simple cells. It is based on an existing orientation-selective model called Combination of Receptive Fields (CORF), which combines, by an AND-type operation, the responses of model LGN cells with appropriately aligned center-surround receptive fields. A push-pull response is computed as the response of a CORF model cell that is selective for a stimulus with preferred orientation and contrast minus a fraction of the response of a CORF model that responds to the same stimulus but of opposite contrast. The proposed push-pull model exhibits an improved signal-to-noise ratio and achieves two properties that are observed in real simple cells: contrast-dependent changes in spatial frequency tuning and separability of spatial frequency and orientation. For two benchmark data sets (RuG: 40 images, Berkeley: 500 images), we demonstrated that the proposed push-pull model outperforms (with very high statistical significance) the Gabor function model with (and without) surround suppression and Canny contour detector. The push-pull model that we propose contributes to a better understanding of how the brain processes visual information and is highly effective in edge detection, which is considered as the primary biological role of simple cells.

◆ **Visual numerosity: A computational model based on a topological invariant**

114 T Kluth, C Zetsche (Cognitive Neuroinformatics, University of Bremen, Germany; e-mail: tkluth@math.uni-bremen.de)

The estimation of the cardinality of objects in an environment requires a high degree of invariance. Numerous experiments showed the immense abstraction ability of the numerical cognition system. Numerosity is assumed to be an abstract feature which is represented on a high level in the processing hierarchy. But there is also evidence for a “direct visual sense for number” since number seems to be a primary visual property like color, orientation or motion, to which the visual system can be adapted by prolonged viewing (Ross & Burr, 2010) and the precise relation to other low-level features (like density as computed from spatial frequencies) is unclear (Dakin, Tibber, Greenwood, Kingdom, Morgan, 2011). Here we try to approach numerosity from a mathematical perspective. Based on concepts and quantities like connectedness and Gaussian curvature, we provide a general solution to number estimation and apply it to visual stimuli. We show that the estimation only requires derivatives of the luminance function and a multiplicative “AND”-like combination of these features, which can be realized by neurophysiologically realistic Gabor-like filters and by the neural mechanism of cortical gain control. A neural hardware thus would be able to estimate the number of objects using this neural correlates.

## POSTERS: LIGHTNESS AND BRIGHTNESS

◆ **Brightness perception in daylight office with scene**

115 R Tanaka, H Shinoda, Y Seya (Graduate School of Information Science and Engineering, Ritsumeikan University, Japan; e-mail: is0024xx@ed.ritsumeai.ac.jp)

There has been an increasing interest in the use of daylight through windows for maintaining bright visual environments while saving lighting energy. Recent studies have reported that although horizontal illuminance—used as an index of human brightness perception in space—is increased by daylight, brightness perception is not as efficiently enhanced by horizontal illuminance as expected. In the present study, we examined the effects of daylight on space brightness perception in the presence of a scene outside a window. In an experiment, two scale models simulating an office with (test room) and without a window (reference room) were utilized. Participants viewed the two rooms repeatedly and estimated the brightness of the test room. Window size and intensity of simulated daylight and room illumination were manipulated. The results revealed that although participants reported higher brightness with increasing

Wednesday

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daylight, the enhancement was less than that in the control condition in which the test room was illuminated without daylight. Furthermore, the enhancement was less than that in previous studies examining daylight effects without a scene, suggesting that, independently of horizontal illuminance, a scene outside a window can affect brightness perception.

◆ **Effect of grouping on the Koffka-Benussi ring**

116 A Riga, E Economou (Psychology Department, University of Crete, Greece; e-mail: anna\_riga@yahoo.gr)

In the Koffka-Benussi ring illusion, a homogeneous gray circle seems uniform in lightness despite the fact that half lies on the black and half on the white background. The effect is attributed to the circle being perceived as a single object with a single lightness value. In this study we tested the parameters that make the ring appear as one object and thus homogeneous in lightness. We constructed two illusion versions in which we substituted the ring with either a bar or a set of discs in a circular pattern. Naïve observers matched the lightness of our targets by adjusting the luminance of a patch on the screen. We varied the following parameters: length and shape of the bar, number and motion of discs, and position of discs with respect to the edge of the two backgrounds. The results indicate that the effect of grouping factors on the lightness of our targets is graded. Thus, stronger grouping leads to more homogeneous lightness. Second, the position of one disc along the edge of the backgrounds is critical for the lightness computations of all the discs in the group. These results tend to support theories that tie lightness to grouping.

◆ **Testing the ODOG brightness model with narrowband noise stimuli**

117 T Betz<sup>1</sup>, F A Wichmann<sup>2</sup>, R Shapley<sup>3</sup>, M Maertens<sup>1</sup> (<sup>1</sup>Modellierung Kognitiver Prozesse, Technische Universität Berlin, Germany; <sup>2</sup>Neural Information Processing Group, University of Tübingen, Germany; <sup>3</sup>Center for Neural Science, New York University, United States; e-mail: torsten.betz@bccn-berlin.de)

The oriented difference of Gaussians (ODOG) model (Blakeslee and McCourt, 1999) computes the perceived brightness of an image region through the operation of orientation and frequency selective filters. The model successfully predicts the brightness of test regions for a number of brightness phenomena, including White's illusion. Salmela and Laurinen (2009) showed that masking White's illusion with narrow-band noise affects the strength of the illusion. The effect of the narrow-band noise mask depended on its spatial frequency and orientation, suggesting that orientation- and frequency-selective mechanisms are important for generating the illusion. The ODOG model is comprised of orientation- and frequency-selective mechanisms, and thus the effect of narrow-band noise on its output is a critical test of its adequacy as a mechanistic account of White's illusion. We analyzed the effects of narrow-band noise on the output of the ODOG model. The orientation of the noise had a similar effect on model and human performance, but the model was much more sensitive to the noise than were human observers. Furthermore, the model was sensitive to noise at low frequencies, where observers were unaffected. We explain the discrepancies through a detailed analysis of the individual components and computational steps of the model.

[This work was supported by the Deutsche Forschungsgemeinschaft (GRK1589/1 and MA5127/1-1)]

◆ **When dark is left and bright is right: evidence of a spatial-luminance association effect**

118 V Prpic, A Fumarola, M De Tommaso, G Angelon, M Murgia, T Agostini (Life Sciences, University of Trieste, Italy; e-mail: valter.prpic@gmail.com)

The existence of an association between number magnitude and the space of response execution was conclusively demonstrated with the SNARC effect (Spatial Numerical Association of Response Codes). It consists in faster left key-press responses to small numbers and faster right key-press responses to large numbers. In the present study we investigated whether a spatial-luminance association, with similar features to the SNARC effect, exists. For this purpose, we ran two distinct experiments. In Experiment 1 (brightness discrimination task) the association between response side and the luminance of chromatic stimuli was tested directly. In Experiment 2 (hue discrimination task) the association was tested indirectly. Results showed a left key-press advantage in processing lower luminance and a right key-press advantage in processing higher luminance. This effect was found in both direct and indirect tasks. These findings suggest that luminance is spatially coded, similarly to other types of magnitudes (e.g., numbers, physical size, pitch height). The present study provides empirical evidence supporting the ATOM model proposed by Walsh (2003), proving that spatial representation might be the most suitable form for representing various types of magnitudes.

◆ **What do the relative probabilities of the possible sources of the luminance profile tell us about the Craik-O'Brian-Cornsweet illusion?**

119

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Lotto and Purves (Lotto, Shimpi & Purves, 1999; Purves & Lotto, 2004) account for the Craik-O'Brian-Cornsweet illusion in terms of the relative probabilities of the source eliciting the Cornsweet edge. They claim that the edge profile can be attributed either to the illumination gradient at the boundary of two differently illuminated areas of different reflectance, or to a reflectance gradient at the boundary of two equally illuminated areas of equal reflectance. They show that the illusion grows stronger in the former case, while it is reduced in the latter, by placing the Cornsweet edge in illumination-or reflectance-compatible environments. We substituted the Cornsweet edges in these images by simple luminance step edges, which elicited the same effects. Since the same effects and changes occur even when no Cornsweet edge is present in the image, it is not the COC illusion that was changed by the different environments. Therefore, no conclusions can be drawn from the phenomena shown by Lotto et al. as for the explanation of the COC illusion.

◆ **Effects of illumination level, shades order and framework configuration on lightness**

120

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Lightness of a gray shade is influenced by a variety of scene features, such as the number of surfaces and illumination levels, range of shades, adjacent as well as remote surfaces and edge sharpness and structure (Todorovic & Zdravkovic, 2013; Zdravkovic, 2007; Zdravkovic & Agostini 2003). In three experiments, with simple but not impoverished conditions, we contrasted effects of order of presented gray shades, configuration of the framework and illumination level. Subjects (the same ten in each experiment) made lightness matches. The main effect of shade was always significant confirming that observers distinguished between gray shades. Also there was a difference in lightness when the overall illumination was decreased ( $F(1,9)=37.265, p>0.00$ ) and when the display changed configuration from rectangle to square ( $F(1,9)=9.752, p>0.01$ ). The finding that a decrease in overall illumination significantly changes matches in a single illumination setting contradicts previous findings and cannot be explained by existing models. The effect produced by the change of framework configuration might be explained by the different edge and adjacency structure. Finally, the lack of a significant order effect can be fully accounted for by Anchoring theory and previously published data.

[This research was supported by Ministry of Education and Science, Grants No. 179033 and III47020.]

## POSTERS: NEW METHODS

◆ **The benefits of applying modern 3D technologies in computer-aided diagnostics and functional treatment of amblyopia and binocular disorders**

121

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The validity of computer-based methods for functional diagnostics and treatment of binocular vision disorders is now well established, but their potential capabilities are far from being exhausted. Regarding the fast development in 3D technology and visual science, the search for new methods is still a live issue. During the last two years we have assessed the benefits of the modern 3D technologies based on the circular polarization principle of left-right image separation. With a view to choosing the best methods for binocular vision testing, we have measured stereothresholds and fusional reserves in children and adults employing anaglyph and polaroid separation methods in conditions of generating test images of both types on the same 3D display. These experiments revealed evident advantages of polaroid technology as concerned the test-retest agreement, the best values obtained, and the degree of discomfort. In our practical work with children who have binocular disorders and/or amblyopia, it has been found that employment of 3D techniques based on the polarization principle allows making treatment procedures more variable, effective, and comfortable. As a result, such procedures appear to



Wednesday

be less fatiguing and more interesting for the patients. In most children treated, significant progress was already noticeable in two weeks.

[Supported by the Program of DNIT Russ Acad Sci.]

◆ **Visual acuity measurement: Optimization of the test chart design**

122 M Gracheva, G Rozhkova, S Rychkova (Modelling of Bioinformatic Processes in Visual Systems, Institute for Information Transmission Problems (Kharkevich Institute) of Russian Academy of Sciences, Russian Federation; e-mail: mg@iitp.ru)

At present, the following two main designs of the test charts for visual acuity measurement are in use: regular and proportional. Regular design means uniform spacing of the optotypes while proportional design implies scaling the intervals between the adjacent optotypes in proportion to their sizes. Proportional design was proposed to equalize the crowding effect over the whole chart, thus providing more accurate visual acuity measurements. However, it should be taken into account that the visual system functions in permanent cooperation with oculomotor and accommodation systems, each of which requires specific conditions for normal operation. From this point of view, in the case of small, threshold level optotypes, proportional design seems to be inappropriate for the oculomotor system: the optotypes are positioned too close for separate fixation of each one. Our experiments with eye tracking revealed that the minimal distance for a stable fixation is about  $25'$ . As for regular design, it is disadvantageous for the accommodation system near threshold: a single small optotype is too poor a stimulus for a good focus. On our opinion, the solution is a so-called "inclusion design" with spacing that guarantees the possibility of each optotype fixation and with special stimuli included for better accommodation.

[Supported by the Program of DNIT Russ Acad Sci]

◆ **Improving visual mobility performance in low vision with depth-based smart glasses**

123 J J van Rheede, I Wilson, S L Hicks (Nuffield Department of Clinical Neurosciences, University of Oxford, United Kingdom; e-mail: joram.vanrheede@ndcn.ox.ac.uk)

Severe visual impairment can have a profound impact on personal independence through its effect on mobility. We investigated whether the mobility of people with vision low enough to be registered as blind could be improved by presenting the visual environment in a manner that enabled easier detection of obstacles. We accomplished this by developing a pair of 'smart glasses' that use cameras and head mounted displays to present information about the distance of obstacles to the wearer as brightness, such that obstacles closer to the wearer are represented more brightly. We assessed the impact of the smart glasses on the mobility performance of visually impaired participants during the completion of a set of obstacle courses. Participant position was continuously monitored, which enabled us to capture the temporal dynamics of mobility performance. This allowed us to find correlates of obstacle detection, target detection and related adjustments of walking speed, in addition to the more commonly used measures of trial completion time, overall speed and number of collisions. All participants were able to use the smart glasses to navigate the course, and mobility performance improved for a number of visually impaired participants.

[This work was funded by an NIHR i4i grant NIHR i4i II-LB-1111-20005]

◆ **A system for projecting wide-field visual stimuli within fMRI scanners**

124 M C Morrone<sup>1</sup>, A Sordini<sup>2</sup>, D C Burr<sup>4</sup>, V Greco<sup>2</sup>, F Frijia<sup>3</sup>, K Mikellidou<sup>1</sup>, D Montanaro<sup>3</sup>, A Farini<sup>2</sup>, M D'Uva<sup>2</sup>, P Poggi<sup>2</sup>, M Pucci<sup>2</sup> (<sup>1</sup>Department of Translational Research on New Technologies in Medicine and Surgery, University of Pisa, Italy; <sup>2</sup>Istituto Nazionale di Ottica, CNR Florence, Italy; <sup>3</sup>Fondazione CNR/Regione Toscana G. Monasterio, Pisa, Italy; <sup>4</sup>Department of Neuroscience, University of Florence, Italy; e-mail: concetta@in.cnr.it)

We present a novel optical setup capable of projecting wide-field images at 120 Hz. Stimuli are generated outside the scanner room on the LCD of a projector (EH-TW5910, Epson, Long Beach, CA). The projector lens was replaced with a megapixel objective (efl 12 mm, f/1.4) to image the LCD on the termination of a image-fiber (10000 picture elements, 500  $\mu$ m diameter, FIGH-10-500N, Fujikura, Koto-ku, Japan). The other termination of the fiber, placed inside the scanner room, was then imaged through another megapixel objective (efl 8 mm, f/1.4, PVC housing) via a mirror onto a rear projection screen above the head coil at 10 cd/m<sup>2</sup>. The 110 mm image subtends 80° field of view, viewed through +10D glass (that magnify 1.4-fold). To validate our system, we measured cortical BOLD response to various retinotopic stimuli, and obtained strong responses ( $p < 0.02$ ) over 80° of vertical and horizontal eccentricity. This custom-built, lost-cost, optical setup can reliably map visual primary and associative areas with large-field visual stimuli. This could be crucial also for clinical applications, in particular for

preoperative planning in tumors (requiring mapping of the entire field) and detecting retinal and central pathologies.

◆ **A parametric three-dimensional stimulus set controlled for perceptual similarity**

125 V Willenbockel<sup>1</sup>, A Lochy<sup>2</sup>, R Laguesse<sup>2</sup>, A R Dryden<sup>1</sup>, B Rossion<sup>2</sup>, Q C Vuong<sup>1</sup> (<sup>1</sup>Institute of Neuroscience, Newcastle University, United Kingdom; <sup>2</sup>Institute of Psychology, Institute of Neuroscience, University of Louvain, Belgium; e-mail: verena.willenbockel@ncl.ac.uk)

Physical and perceptual similarity play an important role in object recognition, yet they are difficult to quantify and to relate to each other. To address these challenges, we developed a set of novel objects in which we can parametrically manipulate the global structure, object parts, configuration of parts, and texture. These objects consist of a body and five parts arranged in a similar configuration. The three-dimensional structure of the body and parts is tightly controlled by a set of parameters. Our new manipulation was to systematically add noise to the structure, part configuration, and texture. This allowed us to create many stimuli with individual variations. We also configured the parts so that stimuli appeared “face-like” when oriented one way but not the other way. To validate this set, observers discriminated pairs of objects and rated their similarity. Observers were sensitive to the parameters despite the added noise, and their responses were similar for face-like and non-face-like orientations. Observers’ responses were well correlated with objective measures of similarity. These findings suggest that observers represent the underlying structure despite individual variations and other factors. We are currently using this stimulus set to investigate the nature of visual expertise and acquired prosopagnosia. [This research was supported by an Economic and Social Research Council grant (ES/J009075/1) to QCV and BR.]

## POSTERS: BINOCULAR VISION

◆ **People with wider inter-ocular distance see less depth in random dot stereograms**

126 S Taya (Human Sciences, Taisho University, Japan; e-mail: s\_taya@mail.tais.ac.jp)

Binocular disparity (difference in the retinal image between the left and right eyes) is one of the most powerful depth (3D) cues. However, we cannot determine stimulus depth solely from binocular disparity. This is partly because the size of disparity depends on the size of inter-ocular distance; for example, even when observing the same 3D object, the binocular disparity given by the object is larger for an observer with greater inter-ocular distance. Thus to perceive “veridical” depth observers have to calibrate the size of disparity to the size of stimulus depth with considering their inter-ocular distance. If the visual system actually conducts such calibration, perceived depth from the same amount of disparity would be smaller in the person with wider inter-ocular distance than the person with narrower inter-ocular distance. To test this, we measured the correlation between perceived depth in random dot stereograms and inter-ocular distances. The results from 54 observers showed that the perceived depths were negatively correlated with the observers’ individual inter-ocular distances. The results suggest that the visual system calculates depth from binocular disparity using the observer’s inter-ocular distance information.

[This work was supported by JSPS KAKENHI Grant Numbers 26870590]

◆ **Dominated position coding mechanism for binocular disparity revealed by fMRI**

127 W Yu, C Chen (Department of Psychology, National Taiwan University, Taiwan; e-mail: r01227113@ntu.edu.tw)

Electrophysiological evidence suggests that the visual cortical neurons encode disparity through either the position or phase differences between the left and right receptive fields. Here, we investigated the disparity coding in population level with fMRI. We measured retinotopic BOLD activation under the binocular and the two monocular (the left and right eye) viewing conditions. The stimuli were rotating wedges or expanding rings of low contrast checkerboard patterns. The waveform in each viewing condition was fit to a population receptive field (pRF) model (Dumoulin and Wandell, 2008). The difference between fitted pRF profiles across the three viewing conditions was tested with a bootstrapping method. For most binocular voxels (60-80%), the center of the left eye pRF was significantly different (at  $\alpha=0.01$  level) from that of the right eye, suggesting a position coding of disparity at the population level. The radius of the pRF in the dominant eye was smaller than those in the non-dominant eye, implying a better visual acuity in the dominant eye. In sum, our results revealed a dominance of position coding for disparity and the difference between dominant and non-dominant eye at the population level.

Wednesday

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◆ **The inversion effect in continuous flash suppression: Earlier detection or identification of upright objects?**

128

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It was shown recently that upright faces break predominance of dynamic noise patterns in the first epoch of binocular rivalry about 400 ms earlier than inverted faces (Jiang, Costello, & He, 2007). In the “breaking continuous flash suppression paradigm” (b-CFS) subjects usually indicate the moment when they become aware of the test pattern for the first time. Using face and house stimuli we had subjects indicate pattern presence (detection), and judge the orientation (orientation identification). We found pronounced face inversion effects in both tasks, and marginal inversion effects for houses. Interestingly, the critical durations for detection and orientation identification practically coincided, indicating that in the moment when the subjects perceived a pattern they knew what it was. These results substantiate that subconscious processing during interocular suppression concerns the whole object representation rather than single lower level object features.

**THURSDAY****TALKS: PERCEPTUAL MECHANISMS**◆ **Towards a unified account of dynamic visual feature binding**

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Displays alternating rapidly between orthogonally oriented gratings give rise to the perception of persistent transparent surfaces. If the gratings are differently coloured, observers can report accurately which colour is associated with which orientation at alternation rates in excess of 15Hz (Holcombe & Cavanagh, 2001). Here, we examined such colour-orientation binding while manipulating the angular difference between the gratings. For differences below 20° we observed a non-monotonic effect: performance remained high at 8-10Hz and below 3Hz but dipped close to chance levels at 5Hz, where the percept was of a single grating changing in orientation and colour over time. The decline in performance as alternation rate decreases from 10Hz to 5Hz indicates that binding of colour and orientation is not occurring at the temporal resolution of single cycles of the stimulus. Instead, we propose that accurate colour-orientation judgments at rates in excess of 5Hz depend upon the rapid formation of persistent surface representations which can then be accessed by binding mechanisms, circumventing the latter's relatively low temporal resolution. Such an account can also be applied to the binding of colour and direction-of-motion, which shows a similar non-monotonic effect of alternation rate on performance (Moradi & Shimojo, 2004).

◆ **A computational model of a class of orientation illusions**

D Todorović (Psychology, University of Belgrade, Serbia; e-mail: dtodorov@f.bg.ac.rs)

The set of visual configurations which induce illusory perception contains a subset in which the appearance of the illusion strongly depends on the luminance values of its elements. In this paper I present a neurally based computational model of these effects, constituted by a 2D network of units which simulate simple cells in V1. Inputs to the model were fifteen different visual configurations which contained horizontally oriented edges, and the outputs were 2D patterns of reactions of the model units to these inputs. About half of the inputs were configurations which evoke illusory percepts of orientation (involving edges perceived as tilted away from horizontal), and the others were configurations with identical or very similar geometric structures but altered luminance values, which do not evoke orientation illusions. The main result was that all illusion inducing configurations exhibited similar output patterns along edges, involving characteristic local activity profiles, similar to patterns caused by stimuli with actually tilted edges. In contrast, displays that did not evoke tilt impressions lacked such patterns. This suggests that the reason that illusory tilt is induced in these displays is that they cause neural activity patterns similar to those caused by actually tilted displays.

[This research was funded by grant ON179033 of the Serbian Ministry of Science.]

◆ **Compressive mapping of number to space reflects dynamic encoding mechanisms, not static logarithmic transform**

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Mapping of number onto space is fundamental to measurement and mathematics. However, numberline mapping of young children, unschooled adults and adults under attentional load or making speeded responses shows strong compressive non-linearities, thought to reflect intrinsic logarithmic mechanisms, later "linearized" by education. Here we advance and test an alternative explanation: that the non-linearity results from adaptive mechanisms incorporating the statistics of recent stimuli. This theory predicts strong serial dependencies, whereas a static logarithmic non-linearity predicts trial-wise independence. We found strong and highly significant correlations between numberline mapping of the current trial and the magnitude of the previous trial, in both adults and school children. The dependencies were particularly strong at the beginning of pointing trajectories (Doton and Dehaene, 2014). The current response influenced by up to 20% by the previous trial value, sufficient to account quantitatively for the compressive shape of the numberline. A Bayesian-like model shows that the dynamic serial dependency leads to a reduction of reproduction error, and hence improvement in overall accuracy.

Thursday

◆ **The New Moon illusion and the perception of straight lines**

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When the sun is near the horizon and the moon is visible and higher in the sky, there is a compelling illusion that the sun is not in a direction perpendicular to the light/dark boundary of the moon, as is physically the case (Rogers and Anstis, 2014). Our explanation is that we make systematic errors in judging the straightness of lines that extend over large distances when there is insufficient 3-D information. To test this hypothesis, observers were asked to judge the alignment of three artificial 'stars' distributed across the 'sky' in the Saint Petersburg Planetarium. The outer 'stars' were separated in horizontal azimuth by 60°, 90° or 120° with elevations of 20° or 40°. Observers adjusted the elevation of the central 'star' until it appeared to lie on an imaginary straight line joining the outer stars. Systematic errors were made, setting the central star below the physically correct position. Errors increased with horizontal separation of the outer stars and were largest in the 20° elevation conditions. The results support our hypothesis that observers are forced to use the changing angular separation between straight and parallel lines to judge straightness when there is insufficient 3-D information (Rogers and Rogers, 2009).

[Supported by Saint-Petersburg State University research grant: 8.50.2098.2013]

◆ **Poor voluntary averaging of spatial orientations**

J A Solomon, K A May, C W Tyler (Centre for Applied Vision Research, City University London, United Kingdom; e-mail: J.A.Solomon@city.ac.uk)

It seems obvious that increased viewing should allow for the accumulation of more visual information, but scant support for this idea has been found in studies of voluntary averaging, where observers are asked to make decisions based on average size or average orientation. We wondered whether previous estimates of efficiency might have reflected limitations in memory capacity rather than limitations in voluntary averaging per se, and asked trained psychophysical observers to compare the average orientation in an array of N=8 Gabor patterns with that of probe stimuli that were visible before, during, or only after the Gabor array. Despite large individual differences, our results suggest only a modest improvement in efficiency as display duration increases. Even when the Gabor array and probe were simultaneously visible for 3.3 s, effective set sizes (i.e. efficiency times N) were only 3. This poor voluntary averaging was further supported by a replication of Dakin's (2001) orientation-averaging experiment, in which just 4 of 29 undergraduate observers were able to achieve effective set sizes greater than 4 with N=32 and N=96. Even when memory limitations are excluded by simultaneous presentation, the majority of observers are incapable of integrating over more than a few spatial orientations.

[This research was sponsored by the Engineering and Physical Sciences Research Council (grant # EP/H033955/1).]

◆ **Effects of number, contrast, density and motion on estimation of number**

N E Scott-Samuel, N Davies, C Molloy, S Panas O'Brien, A To (Experimental Psychology, University of Bristol, UK; e-mail: n.e.scott-samuel@bris.ac.uk)

Opinions vary as to what underpins the ability to enumerate objects. We investigated how accuracy of enumeration varied with changes in number, contrast, density and movement. Subjects reported either the number of dots shown in an single interval task (SI), or which interval contained more dots in a temporal two-alternative forced choice task (2AFC). Both static and moving dots were underestimated for higher numbers, with greater underestimation for static dots (number of dots = 30-3660; SI). Reduced contrast increased uncertainty in the judgement of relative number (number of dots = 40, contrast range = 6.25%-50%; 2AFC); uncertainty was generally lower for moving dots. Increased density yielded slightly larger negative errors in estimates of numerosity for higher dot numbers (number of dots = 1-64; SI). 10% fewer moving dots appeared as numerous as static dots, with no effect of density; this effect decreased with the speed of the moving dots (number of dots = 40, speed range = 0-10deg/s; 2AFC). We conclude that contrast, density and motion can all affect estimation of number, and that these effects can differ at low and high numerosities. This boundary between low and high does not reflect a distinction between counting and estimation.

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**TALKS: CLINICAL**
**◆ The Middle Temporal (MT+) area mediates global motion processing: evidence from patients with schizophrenia and non-invasive brain stimulation**

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We studied the causal involvement of area MT+ in an optic flow paradigm. Firstly, we explored the performance of 15 schizophrenic patients and age and education-matched controls in a task that assessed the local and global contributions to trajectory perception of a moving probe in an optic flow field. Schizophrenic patients showed a significantly reduced bias in trajectory perception for global motion processing only. Secondly we studied the effects of non-invasive transcranial electric stimulation (TES) over the MT+ region. We hypothesised that TES would interfere with processing in the MT+ by modulating spatial suppression of global motion signals. Participants indicated the direction of the moving probe in the global or local optic flow task, while receiving 20 minutes of anodal, cathodal, HF-RNS or sham TES stimulation at 1.5 mA. We found that cathodal and HF-RNS stimulation had opposite effects on trajectory perception in global optic flow condition. While HF-RNS stimulation reduced the bias of trajectory perception, cathodal stimulation increased it. Using HF-RNS stimulation over MT+ we demonstrate that the behavioural pattern seen in patients with schizophrenia can be mirrored in neurologically intact participants. Moreover, cathodal stimulation could be used to ameliorate sensory deficits in motion discrimination tasks in schizophrenic patients.

**◆ Efficacy of pupil response as predictor of blindsight**

A Sahraie<sup>1</sup>, M J MacLeod<sup>2</sup>, C T Trevethan<sup>3</sup>, J Urquhart<sup>1</sup>, L Weiskrantz<sup>4</sup> (<sup>1</sup>School of Psychology, University of Aberdeen, UK; <sup>2</sup>School of Medicine & Dentistry, University of Aberdeen, UK; <sup>3</sup>Department of Clinical Neuropsychology, Aberdeen Royal Infirmary, UK; <sup>4</sup>Department of Experimental Psychology, University of Oxford, UK; e-mail: a.sahraie@abdn.ac.uk)

Sudden onsets of grating patterns even in the absence of additional light flux result in a transient constriction of the pupil, the amplitude of which varies as a function of the spatial frequency in healthy adults, resembling the contrast sensitivity function. The existence of pupil grating responses within the blind field of a hemianopic patient and two hemi-decorticated monkeys were reported previously. The findings led to the suggestion that pupillometry may be utilised as an objective technique for detection of visual function within the field defect. We have systematically investigated the presence of a spatial channel of processing in the blind field of 19 hemianopic patients using a psychophysical forced-choice technique and obtained the corresponding pupil responses at a range of spatial frequencies. In addition, in 13 cases we determined the pupil responses in a sighted field location matching the blind field eccentricities. Our findings demonstrate that blindfield pupil responses are similar to those for the sighted field, but attenuated in amplitude. Pupillometry correctly characterised the presence or absence of a significant psychophysical response, in 85% of cases and thus is worth examining in the cortically blind fields as predictor of blindsight.

**◆ Comparison of fMRI measurements in lateral geniculate nucleus (LGN) and primary visual cortex (V1) with visual deficits in glaucoma**

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The purpose of our study was to determine whether, in glaucoma patients, selective behavioural deficits in the three main visual pathways (magnocellular, parvocellular, koniocellular) are associated with selective changes in the neural activity in LGN and V1. A POAG group (n=20) and a control group (n=20) were examined using the following tests: Standard automated perimetry (SAP); the Cambridge Colour Vision test (CCT); thresholds along the three cardinal directions of colour space (BW, RG, YV). For a subset of the participants (n=9 in either groups), BOLD signals in the LGN and V1 were measured in response to supra-threshold modulations along the cardinal directions. We find significant visual threshold differences between the Glaucoma and the control group, in particular for S-cone isolating stimuli. The average BOLD signal in primary visual cortex (V1) is lower in the Glaucoma group compared to the controls; contrary to our expectations, the LGN signal is increased in POAG

Thursday

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patients compared to the controls. We speculate that this may reflect altered feedback from primary visual cortex.

[Supported by the UK & Eire Glaucoma Society]

◆ **Learning to see shapes following late emergence from blindness**

A McKyton<sup>1</sup>, I Ben-Zion<sup>2</sup>, E Zohary<sup>1,3</sup> (<sup>1</sup>Neurobiology Department, The Hebrew University of Jerusalem, Israel; <sup>2</sup>Goldschleger Eye Institute, Sheba Medical Center, Israel; <sup>3</sup>The Edmond and Lily Safra Center for Brain Sciences, The Hebrew University of Jerusalem, Israel; e-mail: ayelet.mckyton@mail.huji.ac.il)

Visual object recognition develops through experience during the first years of life. Object structure can be assessed from various cues: either simple (e.g. intensity or color-based contours) or more sophisticated (e.g. 3D shape from shading). But what if one is deprived of vision during the early stages of development and regains sight only later in life? We studied a unique group of patients in Ethiopia (n=14) that suffered from bilateral congenital cataracts, which were treated only years after birth. Our results suggest that the newly sighted rapidly acquire the ability to recognize an odd object within an array, based on color, size or shape. However, they are poorer than sighted peers in utilizing more elaborate cues such as subjective contours, shading, or occlusion relationships. Generally, this deficiency is more pronounced, the longer the deprivation period. Little recovery of function is seen with time following surgery. We suggest that vision based on learned inference assumptions (e.g. illumination is from above, contours are often partially occluded), can only be established through experience within a critical period of development, ending probably before adolescence.

[Israel Science Foundation, Individual Research Grant for Ehud Zohary: "Learning to see: Vision following late emergence from congenital blindness", 2013.]

◆ **Selective impairments of reactive but not scanning saccade adaptation in a patient with a focal thalamic lesion**

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In order to monitor its own movements the oculomotor system sends signals from downstream oculomotor areas through the thalamus back to the frontal eye field. If systematic errors occur in saccade landing, the oculomotor system adapts to compensate for this error. In order to investigate the neural substrates of reactive and scanning saccade adaptation, we studied a patient with a lesion in the posterior ventrolateral thalamic nucleus. Adaptation and localization were tested for reactive saccades, which are performed to suddenly appearing targets and for scanning saccades, which are performed to stationary targets. For reactive saccade adaptation we found a clear impairment in motor learning ipsilateral to the lesioned side. For scanning saccade adaptation motor learning was intact on both sides and not different from the control group. We also tested visual localization for probes presented before execution of the saccade by asking the subject after saccade execution to report the perceived position. We found adaptation-induced mislocalization for the control group and for the patient. Our results provide the first lesion evidence that adaptation of reactive and scanning saccades relies on distinct reafferent pathways from brainstem/cerebellum to cortex. Our results strongly suggest separate cortical targets of these pathways.

◆ **Contrast sensitivity in treated and untreated patients with schizophrenia**

I Shoshina<sup>1,2</sup>, K Novikova<sup>1</sup>, Y Shelepin<sup>2</sup> (<sup>1</sup>Psychology, Siberian Federal University, Russian Federation; <sup>2</sup>Physiology of Vision, Pavlov Institute of Physiology Russian Academy of Sciences, Russian Federation; e-mail: yshelepin@yandex.ru)

We studied the features of visual perception in patients with first-episode schizophrenia and chronic schizophrenia. We provide the contrast discrimination of Gabor elements in the range of low, medium and high spatial frequencies, to which are sensitive varying neurons of the magnocellular and parvocellular channels. It was found that patients with first-episode schizophrenia, who had not received antipsychotic medication, are characterized by increased contrast sensitivity at distinguishing the contrast of low spatial frequency gratings, to which are more sensitive magnocellular channels. This is in contrary to the view of the reduction of contrast sensitivity of the magnocellular channels in schizophrenia. The contrast sensitivity in range of medium and high spatial frequencies is reduced in schizophrenia. Treated

patients with first psychotic episode demonstrate a decrease of the contrast sensitivity in the whole range of test frequencies, that and the patients in chronic schizophrenia. The obtained data are considered as the evidence of the mismatch in the functioning of magnocellular and parvocellular systems, and increased of internal noise levels in patients with schizophrenia. Increased sensitivity of magnocellular channels in patients with first episode schizophrenia allows explaining the clinical data of changing the perception on the initial stages of that psychosis.

## TALKS: PERCEPTION AND ACTION

### ◆ **Two multisensory illusions reveal a dissociation between implicit and explicit representations of the body**

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There is ample evidence that the brain maintains multiple representations of the body and that these are heavily based on perception. We used two multisensory illusions, the hand-held Ames' window (Bruno et al, 2006) and the fake-hand illusion (Botvinik & Cohen, 1998.; Bruno & Bertamini, 2010) to investigate whether representations of the body can be enlarged, shrunk, or both enlarged and shrunk, as a consequence of multisensory stimulation. Our results suggest a dissociation between explicit representations, which are tapped by matching methods or verbal reports and seem to be plastic in both directions, and implicit representations used to guide movements, which seem to enlarge but not shrink. Our findings provide a way to reconcile seemingly contradictory reports on the plasticity of body representations.

### ◆ **Nudge, nudge, nudge - How floor patterns impact on walking trajectories**

U Leonards, J G Fennell, D W Redmill (Experimental Psychology, University of Bristol, United Kingdom; e-mail: ute.leonards@bristol.ac.uk)

Do floor patterns influence our sense for walking straight-ahead? Current biomechanical models would say "no" as walking in an obstacle-free environment on even ground is heavily automated and overlearned, and does hardly rely on visual input. Work on the impact of visual reference frames on balance would not predict much impact either, as most influence of reference frames should arise from the lateral visual periphery, not a comparatively narrow part of the lower visual field. In 3 experiments, participants walked straight down a 2.5 meter wide and 15 meter long laboratory, performing an RSVP task projected onto the wall straight ahead. Using 3D motion capture, we measured lateral veering induced by different orientations of a range of floor patterns (simple high-contrast spatial frequency patterns, visual illusions, paving slabs) relative to walking direction, but keeping the outlines of the floor patterns constant. Both direction and extent of lateral veering directly depended on the orientation of the patterns, with oblique as compared to control patterns inducing considerable veering over the measured travel distance of 10 meters. Results will be discussed both with regard to basic vision-and-action understanding as well as possible impact on everyday walking in man-made environments. [This work was supported by a research grant from the BRACE charity]

### ◆ **Action molds the perception of facial expressions**

W Gerbino, M Manzini, S Rigutti, C Fantoni (Department of Life Sciences - Psychology Unit, University of Trieste, Italy; e-mail: gerbino@units.it)

Current models of perceived facial expressions of emotions are focused on visual information. However, facial expressions are typically experienced while observers process multisensory information resulting from their active interaction with the environment. Since bodily interaction with everyday objects within the peripersonal space has been shown to produce powerful effects on perception, we hypothesized and found that the comfort/discomfort of motor actions modulates the perception of facial expressions, thus playing a pivotal role in human cognition and communication. Using MAMIP (a novel Motor Action Mood-Induction Procedure), we adapted participants to comfortable/uncomfortable visually-guided reaches and obtained consistent mood-congruency effects on facial emotion identification under different experimental paradigms. Using the method of constant stimuli we found that comfortable actions made a neutral face appear happy and a slightly angry face neutral, while uncomfortable actions induced the opposite effect. Using signal detection theory we found that the sensitivity for facial expressions was improved when they were congruent, rather than incongruent, with the action-induced mood. Our results suggest that the bias revealed by the method of constant stimuli has (at least partially) a perceptual origin:



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the action-induced mood affects the valence of facial expressions through an emotional modulation of visual processing.

[Italian Ministry of Economic Development: EcoAutobus - Industria 2015, WG; University of Trieste - FRA 2013, CF]

◆ **Luminance transients and inhibition of return in a movement-congruency effect.**

S P Doneva, G G Cole (Psychology, University of Essex, UK; e-mail: sdoneva@essex.ac.uk)

In the 'movement-congruency' effect two participants alternate responses to one of two targets appearing either to the left or right hand-side of a shared workspace. Results indicate that reaction times are generally shorter when participants initiate an action that imitates, within an egocentric framework, their partner's previous response. This effect is commonly explained with an action co-representation account according to which the two co-actors represent each other's actions. However, alternatively, low-level luminance transients might be inducing inhibition of return (IOR) at the location where the partner previously responded. In three experiments we examined the contribution of both action and attentional mechanisms to the effect. Experiment 1 revealed that the basic phenomenon occurs only as a function of target location but not action. However, the findings also demonstrated that the type of performed action modulates the effect, since it was present only when the partners made the same response. Experiments 2 and 3 showed that the time course of the effect concurs with what is known about IOR and that it is not influenced by the valence of the relationship between the co-actors. These findings suggest that although primarily an attentional phenomenon, the effect is also modulated by action co-representation.

◆ **The influence of visual and haptic cues on early grasping force**

W M Bergmann Tiest, A M L Kappers (MOVE Research Institute, VU University Amsterdam, Netherlands; e-mail: W.M.BergmannTiest@vu.nl)

When holding or manipulating an object, grip force is adjusted to match the coefficient of friction of the object's surface. In order to investigate whether visual information about an object's texture, which is available before the object is touched, influences the grip force, we measured grip force from 12 subjects picking up six objects with equal mass but distinctly different surface textures in two conditions: with and without visual information (blindfolded). It was found that already at 10 ms after contact is made, there were significant differences in grip force in the blindfolded condition, but not in the sighted condition. After 40 ms, significant differences were found also in the visual condition. These measurements show that grip forces are already adjusted to object friction during the very early phase of picking up an object, also in the absence of visual cues. This confirms that the human haptic system operates at an impressive speed. When visual information is present, it could be that humans pay more attention to it, disregarding the haptic information, which could explain the initial lack of significant differences in grip force in the sighted condition.

[This work has been partially supported by the European Commission with the Collaborative Project no. 248587, "THE Hand Embodied", within the FP7-ICT-2009-4-2-1 program "Cognitive Systems and Robotics".]

◆ **Predictive plus online visual information optimizes temporal precision**

J López-Moliner, C de la Malla (Institute for Brain, Cognition & Behaviour (IR3C), Universitat de Barcelona, Catalonia; e-mail: j.lopezmoliner@ub.edu)

Two opposing views prevail on the visual control of actions. One supports predictive models of future states of the environment and the other the use of online visual information. The latter contemplates prediction only if online input is missing, otherwise it disregards past information. If this view is correct, precision performance would be similar for when there is full vision and when there is only late vision. We tested this hypothesis by using virtual balls that people had to catch and comparing three conditions: early, late and full vision of the parabolic path. Parabolae were used because useful information is different for early and late phases and we can disrupt early vision without significantly impairing temporal integration of motion. We recorded the time at which subjects closed the hand. Response initiation accuracy was high and was not significantly different among viewing conditions but response variability was. The initiation of responses was more precise in the late condition than in the early one. Interestingly the precision of the timing under full vision was very well predicted by optimally combining early and late precision. This is consistent with past information being integrated with online vision rather than being discarded.

[Supported by an ICREA Academia Distinguished Professorship award]

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**TALKS: GROUPING PRINCIPLES**
**◆ Rapid redeployment of the symmetry axis preference reveals an adaptive frame-of-reference principle in human symmetry processing**

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It is easier to detect symmetry about a vertical axis than about any other orientations, an effect that has been linked to evolutionary adaptation to environmental contingencies. However, Tyler, Hardage & Miller (1995) found no axis orientation bias in a block-design paradigm, and Wenderoth (1994) found that axis preference could be reversed by biased sampling of axis orientation in a randomized design. To investigate this adaptability, we precued the observers to symmetry axis orientation before they had to detect a symmetric pattern of one of four possible orientations in a randomized design. The cue was either valid or neutral. The symmetry patterns were seen through apertures that either obscured or revealed the symmetry axis. Vertical advantage was observed in all the neutral cue conditions but was eliminated, or reversed, in the valid cue conditions. Our result cannot be explained by a hard-wired, filter-based mechanism, but requires an allocation of perceptual resources in the visual processing based on the cueing information. The vertical advantage is thus a Bayesian precueing of the vertical axis by the visual system, as it is the most probable symmetry orientation based on short-term past experience.

**◆ Bayesian Hierarchical Grouping in perceptual organization**

V Froyen, J Feldman, M Singh (Department of Psychology, Center for Cognitive Science, Rutgers University, New Brunswick, NJ, United States; e-mail: vickyf@rutgers.edu)

We propose a novel Bayesian framework for perceptual grouping, called Bayesian Hierarchical Grouping (BHG). Central to the framework is the assumption that the image elements are generated by a mixture of distinct "objects" each generating the image elements according to some stochastic generative model. Consequently, grouping is defined as the simultaneous estimation of the number of objects and their parameters, and which image elements are "owned" by which objects. Although in theory there is an exponential number of possible grouping hypotheses, our implementation, based on the hierarchical clustering approach by Heller & Gharamani (2005), allows for a tractable approximation of the posterior distribution over grouping hypotheses. The result is an intuitive hierarchical representation, containing grouping hypotheses at a variety of levels of structural scale, along with each hypothesis's posterior. We show results for several classic grouping problems including dot clustering, dot lattices, contour integration, and part decomposition. Even shape completion can be understood within our framework, which due to its generative nature can make predictions about missing parts of the image. Importantly, BHG proceeds in the same way regardless of the grouping problem, simply by modifying the generative model. It thus provides a unifying formalization of the Gestalt principle Prägnanz.

[This research was supported by NIH EY021494 to J.F. and M.S., and NSF DGE 0549115 (Rutgers IGERT in Perceptual Science).]

**◆ (in)Validating measures of local and global processing**

J Wagemans, R Van der Hallen, R Chamberlain, S Van de Cruys, L de-Wit (Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: johan.wagemans@psy.kuleuven.be)

A lot of research has attempted to test whether there is a general shift towards a more local (or away from a global) bias in visual perception in people with autism spectrum disorders (ASD). A variety of different tests have been employed to test this broad conceptualization of a processing bias. There is however less work attempting to validate whether the different paradigms used as supposed measures of local or global biases actually measure a common underlying bias (although see Milne and Szczerbinski, 2009). In this research we have developed new implementations of three important measures often used in the context of the debate regarding local or global biases in ASD, namely the embedded figures test, a coherent motion test and the hierarchical letter (Navon) test. In each of the three tests we attempt to optimize the extraction of individual differences such that they more directly reflect differences in perceptual processing rather than motivation or response strategies. Our results from over 250 (undergraduate) participants provides little evidence for correlated individual differences between tests. This research suggests that the concept of an overall 'local' or 'global' bias may have no empirical basis and is of questionable scientific value in guiding research.

Thursday

◆ **Competition between grouping principles: a primed-matching study**

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Most research on the competition between grouping principles focuses on their relative strength as measured by subjective reports, and not much is known about the underlying representations of the competing organizations, or the time-course of this competition. A 'winner-take-all' approach predicts that only the dominant organization is represented, hence, ultimately reaches conscious perception. We hypothesized that multiple organizations are represented, and while one of them is chosen for conscious perception the others are suppressed. We used the primed matching paradigm, in which a prime stimulus is followed by a pair of test figures that are either identical to one another or different. Typically, "same" responses to the test-pair are faster and/or more accurate when they are similar to the prime than when they are dissimilar to it. Our primes depicted either a single grouping principle (e.g. element connectedness or brightness similarity; no-competition condition), or two grouping principles that lead to different organizations (competition condition). The time course of representations construction was examined by varying prime duration. The results show that priming effects for the dominant organization were abolished at intermediate durations, indicating interference from the non-dominant organization. These findings strongly suggest that both organizations were represented and a competition occurred. [This study was funded by the Israel Foundation Trustees.]

◆ **Contour integration in dynamic scenes and selective attention**

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Contour integration is an integral part of visual information processing requiring observers to combine aligned edge configurations into coherent percepts. Human observers are efficient in detecting contours, reaching peak performances for stimulus presentation times as low as 100ms. However, studies depicting these findings used flashed static stimuli. In nature we rarely encounter this situation, rather, we observe visual scenes over time and develop a coherent picture taking into account dynamic changes. Here, we investigated contour detection in dynamic stimuli comprising Gabor elements rotating at both unique speeds and directions. Contours formed at a predefined time when a number of rotating Gabors reached a configuration of perfect alignment. Since contour integration is believed to be a pop-out process, we expected similar performances for brief and extended presentations. However, performance dropped from 83% to 65% for extended presentations, indicating that contour detection in dynamic scenes is much more demanding, possibly requiring more attention. We quantified to what extent a location cue, a shape cue, or a combination of both, facilitates detection. We found that for brief presentations single cues, and their combination, improved performance by 13%. For long presentations, single cues did not increase performance, but their combination led to an 11%-improvement.

[This work has been supported by the BMBF (Bernstein Award Udo Ernst, grant no. 01GQ1106).]

◆ **Intermodulation components as a neural signature of Gestalt formation in illusory surfaces**

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Gestalt psychologists pointed out non-linear interactions between parts by stating that "the whole is more than the sum of its parts" but current methods have not been able to pinpoint how non-linear interactions happen at the neural level. Here we used the Kanizsa square to detect neural markers of a Gestalt in the visual system by using EEG recording combined with the "frequency tagging" technique. In the experimental condition, four pacmen were placed to form an illusory square. In the control condition, four pacmen were rotated so that no illusory surface perceived. Two diagonal pacmen pairs were contrast-modulated at different frequency rates ( $f_1 = 3.57$  and  $f_2 = 2.94$  Hz) for 13 sec. Fourier transformation showed robust low-level responses at these fundamental frequency, which did not differ between conditions. Most importantly, strong nonlinear intermodulation (IM) components (e.g.,  $3.57-2.94 = 0.63$  Hz) were found in response to the illusory figure, where all the parts (pacmen) are integrated into a coherent whole (illusory surface), while the IMs were much smaller for the non-illusory figure. Neuronal populations that integrate the two image elements non-linearly can produce these IMs. These results indicate that IM components in EEG provide a neural signature of Gestalt formation.

[Supported by Research Foundation Flanders(FWO)]

## AUTHOR INDEX

- Actis-Grosso R 143  
 Adeli H 142  
 Admard M 49  
 Aedo-Jury F 77  
 Agostini T 48, 85, 91, 140, 164  
 Aguilar G 50  
 Ahmed A 50  
 Akamatsu S 127  
 Akshoomoff N 60  
 Alais D 64, 118  
 Albertazzi L 33, 160  
 Alberte L 38  
 Albonico A 75, 138  
 Albrecht S 154  
 Albucher J 147  
 Ales J M 122  
 Allison R 2, 3  
 Allred S 6  
 Almaas A N 62  
 Alp N 176  
 Alvarez G A 97  
 Anderson A J 121  
 Andrew M 38, 125  
 Angelaki D E 136  
 Angelon G 91, 164  
 Anker S 61  
 Annoni J M 70  
 Anobile G 169  
 Ansoerge U 7, 26, 56, 108  
 Anstis S 4  
 Arai Y 127  
 Arató J 54  
 Arboleda A M 108  
 ArceLopera C 108  
 Arend I 82  
 Armann R G M 100  
 Arnold D H 118  
 Arranz-Paraíso S 41  
 Asai T 90  
 Asher M F 161  
 Ashida H 10, 65, 106, 136  
 Aso R 132  
 Atkinson A P 123  
 Atkinson J 38, 60, 60, 60, 61, 63, 125, 137  
 Attard J 154  
 Austin E 67  
 Azzopardi G 163  
 Babenko V V 76  
 Bach M 110  
 Baddeley A 101  
 Baddeley R J 64, 161, 161  
 Bajšanski I 154  
 Bakshi A 131  
 Banissy M J 16  
 Banks J 145  
 Bao Y 37  
 Baranowski A M 160  
 Barbeau E J 147  
 Barbur J L 98, 132  
 Bardi L 105  
 Barrett D J K 94, 98  
 Baruch O 27  
 Barzut V 157  
 Bate S 16  
 Battaglini L 39  
 Beaudot W 35  
 Beck T F 29  
 Bell J 49  
 Bennetts R J 16  
 Ben-Shahar O 6  
 Ben-Zion I 172  
 Bergmann Tiest W M 118, 174  
 Bernardis P 25  
 Bertamini M 9, 173  
 Betz T 164  
 Beuth F 22  
 Bidet-Ildei C 71  
 Bidula S P 28, 29  
 Biehl S C 104  
 Billard A 107  
 Billino J 84  
 Bimler D L 68  
 Bindemann M 130, 153, 154  
 Birtles D B 61  
 Black R H 48  
 Blakstad E W 62  
 Blanuša J D 133  
 Blazhenkova O 22  
 Bled C 147  
 Bliumas R 32  
 Bocheva N B 41, 86  
 Bodrogi P 84  
 Bogacz R 31  
 Bolshakov A 165  
 Bona S 137  
 Bonneh Y 147  
 Boschetti G 140  
 Bossi M 43  
 Bowns L 35  
 Braddick O 38, 60, 60, 60, 61, 63, 125, 137  
 Brady N 50  
 Brække K 62  
 Brainard D H 5  
 Brascamp J W 139  
 Brass M 105  
 Braun D I 88  
 Braun J 79, 101  
 Brenner E 28, 31, 66  
 Bricolo E 138  
 Brignani D 125  
 Brinkhuis M A B 139  
 Brooks A 103  
 Brotchie P 121  
 Bruno N 173  
 Brusaferrero A 140  
 Bülthoff H H 71, 103  
 Bülthoff I 76, 103  
 Bulut T 157  
 Burn J 85  
 Burnett K E 82  
 Burr D C 166, 169  
 Burton A M 100, 102  
 Busigny T 147  
 Cai X 107  
 Caldara R 70, 73, 74, 94, 123, 126, 143  
 Camilleri R 121  
 Camors D 97  
 Camp S 84  
 Campana G 121  
 Cao R 24, 79  
 Carbon C C 9, 10, 17, 18, 128, 154, 156, 159, 159  
 Carpenter R H S 121  
 Carrasco M 8, 8  
 Casco C 91  
 Cass J R 139  
 Castet E 146  
 Cattaneo Z 137  
 Čeněk J 156  
 Cerdá X 106  
 Chakravarthi R 67  
 Chamberlain R 159, 175  
 Chambers A L 42  
 Chang D 103  
 Chapman A 151  
 Chassy P 90, 135  
 Chauhan T 152  
 Chen C 167, 175  
 Chen P L 37  
 Chetverikov A 120  
 Chiovetto E 107  
 Chipi E 157  
 Chollet F 147  
 Chotsrisuparat C 149  
 Choudhary A 171  
 Chow H M 124  
 Christensen J H 24  
 Chubb C 6  
 Ciardha C Ó 154

- 
- Cicchini G M 169  
 Clark R 31  
 Clarke A D F 56, 80, 95  
 Clifford A 151  
 Clifford C W G 75, 76, 169  
 Cole G G 174  
 Colombo F 70  
 Colvin T 35  
 Committeri G 105  
 Contemori G 91  
 Cooney S M 50, 51  
 Cooper B M 134  
 Cormenzana Méndez I 146  
 Cormiea S M 97  
 Cornelissen F W 11, 80  
 Costa M F 111  
 Cottureau B R 77, 81  
 Courrèges S 130  
 Cowan F 61  
 Creissac J 35  
 Cristino F 107  
 Cropper S J 89  
 Ćurčić-Blake B 80  
 Cuthill I C 39, 64, 161, 161  
  
 Daini R 75, 138  
 Dakin S C 43, 62, 76  
 Daktariūnas A 109  
 Dale A 60  
 Damm I 33  
 Daneyko O 13, 133  
 Daniel F 9  
 Daniels K 85  
 Danilova M 68  
 Danz A D 136  
 Date M 36  
 Daugirdiene A 32  
 Davidson E 128  
 Davies N 170  
 Davis J 122  
 DeAngelis G C 136  
 Dechtereņko F 87  
 de Heering A 125, 127  
 Deiana K 21, 78  
 Dekker T M 124  
 de la Malla C 28, 174  
 de la Rosa S 71, 103, 103  
 Delicato L S 75  
 Delord S 9, 155  
 Demeyer M 44, 46  
 Derrington A M 41  
 De Sá Teixeira N A 151  
 De Tommaso M 91, 140, 164  
 de-Wit L 7, 45, 159, 175  
 Doerschner K 6  
 Domijan D 154, 160  
 Doneva S P 174  
  
 Dong J 19, 107  
 Dorman R 44  
 Dovencioglu D 6  
 Dresp-Langley B 43  
 Drevon C 62  
 Drewes J 81  
 Dryden A R 167  
 Du X 80  
 Duchaine B 122  
 Duijnhouwer J 44  
 Dujmović M 78  
 Duke P A 27, 52  
 Dumoulin S O 80  
 Durand J B 77, 81, 97  
 D'Uva M 166  
 Dzhelyova M 74  
  
 Eckstein M P 123  
 Economou E 13, 164  
 Edwards D 61  
 Edwards M 49  
 Eimer M 7, 17, 72, 73  
 Einhäuser W 11, 117  
 Ekroll V 113, 114  
 Endo M 18  
 Endres D 29  
 Ennis R J 146  
 Eom J 158  
 Erb M 70  
 Ernst U A 176  
 Estudillo A J 153  
 Evans K K 101  
  
 Fademrecht L 103  
 Fait E 125  
 Fantoni C 173  
 Faraj S 11  
 Farini A 166  
 Fawcett M 39  
 Fedorov L A 69, 104  
 Feldman J 45, 175  
 Felisberti F M 157  
 Fennell J G 173  
 Fific M M 130  
 Fini C 105  
 Finn J 75  
 Fiori F 79  
 Fiser J 24, 54, 54  
 Fisher K 17, 73  
 Fleming R W 141  
 Florey J A 76  
 Flowe H D 98  
 Fomins S 38  
 Forder L 33  
 Fougny D 97  
 Fracasso A 12  
 Frackowiak R S J 70  
  
 Frank S M 120  
 Franklin A 33, 145, 151  
 French G 151  
 French J 38  
 Frijia F 166  
 Frosst N M W 106  
 Froyen V 45, 175  
 Fujita I 134  
 Fukuda K 89  
 Fumarola A 140, 164  
 Furlan M 87  
  
 Gamberini L 151  
 Ganis G 39  
 García Calvo I 66  
 Garrido L 81, 92  
 Garrod O G B 123  
 Gartus A 158  
 Gautier J 86, 135  
 Gawryszewski M 137  
 Gegenfurtner K R 14, 27, 84, 88,  
 113, 141, 145, 146  
 Geier J 20, 165  
 Genova B 41  
 Gepshtein S 44  
 Gerasimenko N Y U 110  
 Gerbino W 25, 114, 173  
 Geyer T 95  
 Gheorghes T N 20, 21  
 Gheorghiu E 51, 59  
 Ghin F 121  
 Ghose T 46, 129  
 Ghosh K 131  
 Giese M A 29, 69, 104, 107  
 Gilchrist A L 1, 13, 13  
 Gilchrist I D 31, 98, 161  
 Gillam B 115  
 Gillespie-Gallery H C R 132  
 Girard H 60  
 Goffaux V 15, 16  
 Gokcay D 23, 126  
 Gokce A 95  
 Goldbach L 156  
 Goldsmith M 27  
 Goller F 56  
 Gong M 55  
 Gong X 97  
 González E G 2  
 Goodale M A 141  
 Gorjup R 25  
 Gracheva M 34, 165, 166  
 Granrud C E 48, 94  
 Grassi M 25  
 Gravel N 80  
 Greco V 166  
 Green D 62  
 Greenlee M W 120

- 
- Greenwood A 83  
Greenwood J A 15  
Gregory N J 12  
Grieco A 55, 151  
Grimsen C 176  
Griscom W S 119  
Grodd W 70  
Grønn M 62  
Grosso M 61  
Grubert A 7  
Grün S 134  
Grundler W 37  
Grzeczowski L 120  
Grzymisch A 176  
Güçlütürk Y 82, 158  
Guest D 99  
Guest H J 26  
Guicciardi M 85  
Guiney H 37  
Gulan T 78  
Gunatillake I 139  
Guo K 71  
Gurčinienė O 109  
Gusev A 138  
Gvozdenović V 96  
Haak K V 80  
Hacker G A 103  
Hairol M I 86, 135  
Haladjian H H 101  
Hallum L E 58  
Hamker F H 22  
Han H 130  
Hansmann-Roth S 53  
Harauzov A K 136  
Hardiess G 96  
Harmeling S 162  
Harrison N R 135  
Harsányi G 128  
Harvey B 80  
Havermann K 144  
Hayn-Leichsenring G U 15  
Hayward W G 128  
Hazenberg S J 47, 82  
He L 73  
He X 33  
Heard P 128  
Hecht H 160  
Heinrich S P 110  
Heise N 108  
Heller J 4  
Helmert J R 144  
Henik A 82  
Hepsomali P 126  
Herzog M H 58, 59, 66, 120  
Hesselmann G 112, 116  
Hesslinger V M 9, 156  
Hickey C M 100, 143  
Hickey J D 98  
Hicks S L 166  
Hidaka S 36  
Higashiyama A 92  
Hilano T 132  
Hine K 56  
Hiramatsu C 40  
Hochstein S 147  
Hodson R 151  
Hodzhev Y K 148  
Hoehl S 127  
Höfler M 32, 98  
Hogan B G 39  
Hohmann M 71  
Holmes A J 81  
Honda Y 36  
Horowitz T S 26, 63  
Howard C J 99  
Hsu S 126  
Huber-Huber C 26  
Hudák M 20, 165  
Hughes A E 39  
Hulleman J 97, 171  
Hunt A R 30, 95  
Hussain Z 110  
Ichikawa M 20, 85  
Idesawa M 21  
Ikaunieks G 91  
Ikeda H 104  
Imaizumi S 90  
Imura T 37  
Inaba Y 127  
Infanti E 100  
Ingvarsdóttir K Ó 54  
Isaacs B R 39  
Isherwood Z 10  
Islam R 109  
Itamoto S 96  
Ito J 134  
Itoh Y 56  
Ivanov I V 33  
Iversen P O 62  
Iwasaki K 47  
Izyurov I V 110  
Jack R E 123  
Jacobs R H A H 82, 82, 158  
Jakovljević I 145  
James K H 152  
Janković D 150  
Jansen S E M 118  
Janssen D H J 162  
Javitt D C 171  
Jellinek S 54  
Jennings B J 67  
Jernigan T 60  
Jochen B 24  
Jóhannesson Ó I 64, 139  
Johnston S J 38, 102, 107  
Jones P R 124, 124  
Jouffrais C 97  
Jovanović L M 93  
Jung W H 78, 79, 158  
Jurica P 23  
Kadota H 150  
Kafaligonul H 36  
Kalogeropoulou Z 140  
Kalpadakis-Smith A V 15  
Kalwarowsky S 34, 124  
Kanayama N 90  
Kaneko H 3, 49, 142  
Kao S 88  
Kappers A M L 118, 174  
Karatzas D 152  
Kashino M 30  
Kassaliete E 155  
Kato N 30  
Kato T 18  
Kavšek M 48, 94  
Kawamura M 90  
Kawamura T 150  
Keane B 118  
Kennett M J 65  
Khanh T Q 84  
Khansari-Zadeh M S 107  
Kiiski H S M 74  
Kim M 5  
Kimchi R 27, 176  
Kingdom F A A 51, 58, 59, 68  
Kiorpes L 8, 8  
Kirita T 15  
Kistler W 54, 66  
Kitaoka A 10, 20, 65  
Kiyama S 151  
Klemer N 158  
Klimova O A 105  
Klink P C 44  
Kluth T 163  
Knoblauch K 9  
Knops A 112  
Kobanbay B 24  
Koenderink J J 53, 160  
Kogo N 44, 115, 176  
Kohl C 16  
Kojima A 36  
Kojima H 147  
Kong G 64  
Koning A R 29, 149  
Körner C 32, 98  
Korolkova O A 129  
Kovács G 72, 72

- 
- Kovács P 72, 72  
 Kovalev A I 105  
 Koyama S 90  
 Krastina I 91  
 Kristjánsson Á 64, 120, 139, 139  
 Kroliczak G 28, 29  
 Krumina G 38, 91, 155  
 Krylova M A 110  
 Kubíček P 156  
 Kuhn L K 92  
 Kulbokaite V 32  
 Kulke L V 38, 63, 137  
 Kunimi M 151  
 Kurokawa Y 36  
 Kuwamura K 25  
  
 Lacis I 155  
 Laguesse R 17, 73, 167  
 Lamas J 92  
 Lambert A J 83  
 Lancier S 49  
 Lander K 122  
 Langlois T 119  
 Langner O 15  
 Lao J 70, 73, 74, 126, 143  
 Lappe M 172  
 Lebedev D 34  
 Leder H 158  
 Lee B B 134  
 Lee J 125  
 Leek E C 107  
 Leenders M 29  
 Lengyel M 24  
 Leonards U 173  
 Libenson L 68  
 Likova L T 22  
 Lindner A 29  
 Link A 49  
 Lisboa I C 108, 152  
 Little D R 130, 89  
 Liu J 107  
 Liu L D 59  
 Liu Y 143  
 Liu Z 13  
 Liu-Shuang J 122  
 Lochy A 137, 167  
 Loegel A 130  
 Logvinenko A D 14  
 Longo M R 79, 149, 153  
 Lopez B 12  
 López-Moliner J 28, 174  
 Lourenco S F 153  
 Lovett V E 38  
 Lu H 52  
 Lukavsky J 26, 87  
 Luniakova E G 30  
  
 Ma L 45  
 Ma Y 80  
 Ma Y K 124  
 Machado L 37  
 Machilsen B 44, 46  
 MacInnes J 83  
 Macke J H 162  
 MacLeod M J 171  
 Macrae C N 30  
 Maertens M 4, 5, 50, 164  
 Maguinness C 93  
 Maiorana N V 143  
 Makin A D J 67  
 Maksimova V A 111  
 Malaspina M 75, 138  
 Malfatti M 33  
 Malisano C 48, 132  
 Mallick A 131  
 Mallot H A 49, 96  
 Maloney R T 169  
 Mamassian P 53  
 Manahilov V 148  
 Mandal S 46  
 Mangel S C 13  
 Maniglia M 43, 91  
 Manning C 62  
 Manson A 49  
 Manzini M 173  
 Maravita A 133  
 Marchenko O P 155  
 Mareschal I 50, 75, 76  
 Marichal L 17  
 Marino B F M 143  
 Marković S 150, 157, 157  
 Martelli M 138  
 Martín A 146  
 Martinovic J 67  
 Masakura Y 20  
 Mast F W 120  
 Mather G 65  
 Mathey S 155  
 Matthews O E 64, 161  
 Mattia M 79  
 Matziridi M 31  
 Mauger E 127, 130  
 Maule J J 145  
 Maurizio M 24  
 May K A 170  
 Mazza V 99, 125  
 McGovern D P 40  
 McGraw P V 42, 45, 110  
 McIntosh R D 25  
 McKechnie A 83  
 McKyton A 172  
 Meghanathan R N 95  
 Meinhardt G 63, 111, 168  
  
 Meinhardt-Injac B 93  
 Melcher D 12, 81  
 Menshikova G Y A 105, 140  
 Menzel C 15  
 Meyer G 48  
 Miellet S 70, 74, 126, 143  
 Mihaylova M S 148  
 Mikellidou K 166  
 Mikhailova E S 110  
 Mikhaylova O 138  
 Milisavljević M 96  
 Milojevic Z 146  
 Mizokami Y 89  
 Mollon J D 19, 68  
 Molloy C 170  
 Moltu S 62  
 Monno Y 142  
 Montague-Johnson C 38, 125  
 Montanaro D 166  
 Montaut E 147  
 Monti A 125  
 Moors P 45, 116  
 Moreira S M C F 111  
 Morizot F 127, 130  
 Morris J 75  
 Morrone M C 61, 166  
 Motokawa M 32  
 Mounier A 9  
 Mouta S 35, 92  
 Movshon J A 58  
 Mueller A S 41  
 Mukaida S 18  
 Mukovskiy A 107  
 Müller H J 8, 95  
 Mullins K 89  
 Munesue T 147  
 Muravyova S V 148  
 Murgia M 85, 164  
 Muroi A F 85  
 Murray R F 5, 53  
 Muschter E 12  
 Muth C 10, 159  
  
 Nagata S 127  
 Nakai T 151  
 Nakashima Y 51  
 Nakatani C 23  
 Nakayama K 81  
 Nakstad B 62  
 Nardini M 34, 124, 124  
 Naumenko O V 170  
 Nedimović P 165  
 Németh K 72, 72  
 Newell F N 40, 74, 93  
 Newman E 60  
 Nicholas S 22  
 Nikitina E A 16

- 
- Nikolaev A R 23, 95  
Nishina S 83  
Noceti N 102  
Norcia A 122  
Nordheim T 62  
Nordhjem B 80  
Note H 147  
Novikova K 172  
Nowakowska A 95  
Nummenmaa L 52  
Nuthmann A 11, 144  
Nyström P 62  
O'Connor A R 47  
Odone F 102  
O'Donnell B 146  
Ogawa H 138  
Ogawa M 40  
Ögmen H 66  
O'Hare L 80  
Ohl S 11, 140  
Ohta A 96  
Ohtsu K 101  
Ohtsuka S 156  
Okajima K 108, 119, 150  
Okuda S 150  
Oldmeadow J A 131  
Oliveira A M 55, 151  
Olkkonen M 6  
Oluk C 36  
Olzak L A 55  
Onwuegbusi T O 98  
Or C C - F 123  
Orchard-Mills E 118  
O'Regan J K 67  
Ortlieb S A 159  
Ostendorf F 172  
Otazu X 106  
Ouyang X 126  
Overgaard M 116  
Oxner M 128  
Pack C C 59  
Pagano S 99, 125  
Pagès B 147  
Palmer S E 33, 46, 119  
Palmisano S 2, 2  
Palumbo L 9  
Panas O'Brien S 170  
Panis S 142  
Papatomas T V 160  
Papinutto M 74, 143  
Paramei G V 90  
Pariante J 147  
Park J 78  
Parkes L 171  
Parketny J 72  
Parr J 38, 125  
Parraga C A 106  
Parwaga S 52  
Pascalis O 127  
Pasqualotto A 22, 24  
Pastukhov A 24, 101  
Patching G R 54  
Patrick J A 42  
Pauen S 127  
Paulun V C 141  
Pavan A 43, 121  
Pavlov Y G 155  
Pavlova M A 70, 71, 153  
Pavlovskaya M 147  
Pawlak M 28, 29  
Pedmanson P 102  
Peirce J W 45  
Pellicano E 62  
Penton T 16  
Pereira A F 108, 152  
Persike M 63, 111, 168  
Pertoldi S 85  
Pertzov Y 40  
Pestun M V 140  
Peterson M F 123  
Peterzell D H 90  
Petkov N 59, 163  
Peykarjou S 127  
Pfeffer F 168  
Pham A 8  
Piater J 163  
Pilling M 84, 99  
Pilz K S 70, 104  
Pinna B 21, 78  
Pitcher D D 122  
Pladere T 38  
Pleskačiauskas A 109  
Plomp G 23, 66  
Ploner C J 172  
Pobric G 171  
Podvigina D N 111, 136  
Poggi P 166  
Polin D 84  
Pollux P 80  
Poncin A 16  
Pongakkasira K 17  
Pöppel E 37  
Porcheron A 127, 130  
Powell J 171  
Poyarekar S 122  
Proulx M J 24  
Prpic V 140, 164  
Przybylski L 28, 29  
Pucci M 166  
Qi L 19, 107  
Qiu J 82  
Raab M H 10, 154, 159  
Radonjić A 4, 5  
Rangelov D 8  
Raposo N 147  
Rashal E 176  
Rea F 102  
Reavis E A 120  
Redies C 15  
Redmill D W 173  
Reeves A 43  
Reichel C 110  
Reidy J 20, 21  
Reinhard J 33  
Reinhart F 107  
Renken R 80  
Ricarrere P 9  
Ricciardelli P 143  
Rich A N 69  
Richoza A 123  
Riga A 164  
Rigutti S 173  
Ripamonti C 34  
Ritchie K L 102  
Roach N W 42, 42  
Roberts M 8  
Roberts M V 38  
Rodger H 94  
Rodriguez-Carmona M 98  
Rodriguez Sanchez A 163  
Roeloffs H 128  
Rogers B J 2, 2, 170  
Rolf's M 11, 140, 146  
Rønnestad A E 62  
Rose-Henig A 66  
Rossion B 17, 73, 74, 122, 125,  
127, 137, 167, 176  
Roth Z N 141  
Rothkirch M 116  
Roy S 131  
Rozhkova G 34, 165, 166  
Rudd M E 14  
Ruffieux N 70  
Rushton S K 27  
Russ A J 130  
Rutherford K R 30  
Rutherford M 61  
Rychkova S 34, 166  
Ryckman N 83  
Saarela T 6  
Sadakari T 47  
Sadibolova R 149  
Saegusa C 128  
Sahraie A 30, 95, 171  
Saiki J 100  
Sakaibara S 89  
Sakajiri M 96



- 
- Sakurai K 131  
Sandini G 102  
Sandoval Similä S J 25  
Santoro I 91  
Santos J A 35, 92, 108, 152  
Sasaki M 34, 84  
Šašinka Č 156  
Sato M 25, 32, 47  
Sato Y 84  
Sayim B 7  
Schelske Y T H 129  
Schiller F 88  
Schira M 10  
Schloss K B 33, 119  
Schmidt F 46, 142  
Schmidt T 117, 142  
Schneider T M 17  
Schubert T 87  
Schulz J 144  
Schütt H H 162  
Schütz A C 84  
Schweinberger S 129  
Schyns P G 123  
Sciutti A 102  
Scott-Brown K C 12  
Scott-Samuel N E 39, 64, 161, 161, 170  
Seidel Malkinson T 40  
Seno T 40  
Serrano-Pedraza I 41  
Seya Y 42, 163  
Seymour K 69  
Shapiro A G 66  
Shapley R 164  
Sharifian F 52  
Sharman R J 45, 65  
Shaw H 71  
Shelepin Y 172  
Shigemasa H 150  
Shiina K 77, 78  
Shinoda H 42, 163  
Shirai N 37  
Shirama A 30  
Shoshina I 172  
Siderov J 86, 135  
Sikl R 49  
Silva C C L 35  
Silva R M 92  
Silvanto J 137  
Simecek M 49  
Simmons D R 62  
Singh M 45, 115, 175  
Skelton A 151  
Slavutskaya A V 110  
Smeets J B J 28, 31, 66  
Smith A T 87  
Smith B 75  
Smith K 141  
Smith L B 152  
Smithson H E 123  
Sokolov A A 70  
Sokolov A N 71, 153  
Šoliūnas A 109  
Solomon J A 58, 170  
Song J S 79  
Soppelsa F 127  
Soranzo A 13, 20, 21  
Sordini A 166  
Sorokey N 147  
Sors F 85, 91  
Sousa E 108, 152  
Souto D 109  
Souza G S 146  
Spehar B 10  
Sperling G 6  
Spotorno S 83  
Srismith D 128  
Stachoň Z 156  
Stainer M J 12, 121  
Stanikunas R 32  
Steedman R 151  
Steer J 35  
Stefanov S 86  
Stefanova M 41, 86  
Steil J S 107  
Stepanenko M 134  
Štěrba Z 156  
Sterzer P 112  
Stevanov J 10, 19  
Stevanov Z 19  
Strand-Brodd K 62  
Strasburger H 37  
Strømmen K 62  
Sugita Y 51  
Sullivan P 38, 125  
Sun P 6  
Sunaga S 32  
Surre F 135  
Sutherland C A M 131  
Suzuki M 77  
Svezgda A 32  
Szczepanowski R 117  
Takada H 36  
Takahashi A 15  
Takahashi K 152  
Takaoka M A 106  
Takebe S 36  
Takemura A 150  
Talas L 161  
Tamada Y 47  
Tamm S 156  
Tamura H 134  
Tanaka R 163  
Tandonnet C 23  
Tanrikulu Ö D 45  
Tartaglia E M 120  
Tatagiba M S 70  
Tatler B W 12, 56, 83  
Taya S 167  
Taylor P C J 8  
Teramoto W 36  
Tetereva A O 140  
Thornton I M 26, 64, 102, 128  
Thunell E 66  
Tibber M S 62  
Tidbury L P 47  
Timney B 41  
Timotijević Đ 150  
Timrote I 38  
To A 170  
Todorović D 19, 169  
Tolhurst D J 39, 161  
Torii S 34, 84  
Toscani M 14  
Tošković O M 93, 119  
Towler J 17, 72, 73  
Trauzettel-Klosinski S 33  
Tredoux C 128  
Trevethan C T 171  
Troje N F 105  
Trotter Y 43, 77, 81  
Trueman J 157  
Truksa R 91  
Tsattalios K 67  
Tse P U 120  
Tseng C H 124  
Tsotsos J 106  
Tsuda H 100  
Tsui A S M 124  
Tsuji M 85  
Tsukanova I B 133  
Tsushima Y 105  
Tudge L 87  
Turatto M 100  
Tyler C W 170, 175  
Uchikawa K 25, 89, 130  
Ueda J 119  
Ueda T 77, 78  
Uesaki M 10, 136  
Umbach N 4  
Umemura H 86  
Urquhart J 171  
Utz S 18  
Uusküla M 68  
Vagnoni E 153  
Vahine T 9, 155  
Vaitkus T 104

- 
- Vakli P 72, 72  
Valerjev P 78  
Valsecchi M 27  
Valuch C 56  
Van Belle G 17, 73, 125, 137, 176  
van Boxtel J J A 52  
Vancleef K 46  
Van de Cruys S 175  
van der Burg E 64, 118, 139  
Van der Hallen R 175  
van der Zwaag W 66  
van der Zwan R 103  
van Doorn A J 53, 160  
van Ee R 121  
Vangeneugden J 69, 104  
van Hofsten C 62  
van Koningsbruggen M 12  
van Leeuwen C 23, 44, 95  
van Lier R 29, 47, 82, 82, 113, 114, 149, 158  
Vanmarcke S 109  
Vanni S 52  
van Rheede J J 166  
van Wezel R J A 44  
van Zoest W 143  
Vasilyeva A 149  
Vasilyeva N N 148  
Vayssière N 81  
Veierød M B 62  
Velichkovsky B M 144  
Vergeer M 121  
Verhallen R J 19  
Verri A 102  
Vigano G J 169  
Volonakis T N 64, 161  
Voudouris D 28  
Vul E 141  
Vuong Q C 167  
Wade N 3  
Wagemans J 7, 45, 53, 109, 114, 121, 159, 160, 175, 176  
Wahl S 144  
Wake T 96  
Walker R 87  
Wallis G 65  
Walsh V 122  
Walshe R C 144  
Wang D 68  
Wang S 19  
Wang T 19  
Watanabe K 104, 128, 152  
Watson T L 31, 50  
Wattam-Bell J 38, 60, 61, 62, 63, 125, 137  
Waugh S J 86, 135  
Weaver M 143  
Webb B S 110  
Weber A 142  
Weiskrantz L 171  
Weiß D 145  
Werner A 58  
Westerberg A C 62  
White A L 11  
Whiteford K L 119  
Wichmann F A 50, 162, 162, 164  
Wijtjes M 6  
Willenbockel V 167  
Williams M A 69  
Wilson I 166  
Wirth B E 73  
Witzel C 33, 67, 145, 151  
Wloka C 106  
Wolfe J M 97  
Wolk C 29  
Woods A T 74  
Wright C E 6  
Wuerger S 47, 48, 152, 171  
Wutz A 12  
Wyatt N 37  
Wydell T N 92  
Xiao B 54  
Xiao K 152  
Yaguchi H 89  
Yamane Y 134  
Yamauchi Y 32  
Yamazaki T 92  
Yanaka K 77  
Yarrow K 118  
Yasuda T 77, 78  
Yat D 124  
Yavna D V 76  
Yeshurun Y 176  
Yildirim F 11, 23  
Yildirim G 23  
Yoshida T 96  
Yoshikai R 49  
Young A W 131  
Yu W 167  
Yun X 82  
Zakharkin D 138  
Zakharov I 134  
Zanker J M 162  
Zanuttini L 132  
Žauhar V 154  
Zavagno D 13, 133  
Zdravković S 13, 14, 133, 145, 165  
Zeil J 162  
Zelinsky G J 142  
Zetzsche C 163  
Zhang J 97  
Zhang S 19  
Zhao L 56  
Zhao M 76  
Zhaoping L 65, 95  
Zharikova A 44  
Zhu W 80  
Zimmer M 72, 72  
Zimmermann E 172  
Živković J 165  
Zohary E 40, 141, 172