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Biomedical Center of Saints Pères, Paris Descartes University

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Centre Biomédical des Saints Pères, Université Paris Descartes

PROGRAM AND GENERAL INFORMATION

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PROGRAMME ET INFORMATIONS GÉNÉR

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We thank for her precious help / Nous remercions pour son aide précieuse

Zoe Ogeret

Program #	TALKS	Session
1	**Case reports of the effect of the spectral power distribution of metamer lights on pupil aperture** *Françoise Viénot*, (Museum national d'histoire naturelle Centre de recherche sur la conservation des collections, Paris, France; email: vienot@mnhn.fr) *Jean Le Rohellec*, (Museum national d'histoire naturelle - Centre de Recherche sur la Conservation des Collections, Paris, France; email: jean.lerohellec@free.fr) *Laura Zouaoui*, (Université Paris-Sud, Centre Universitaire d'Application Optométrique, Orsay, France; email: laurazouaoui@hotmail.fr) Whereas metamer lights generate the same signals in the cones, they may generate different signals in rods and in ipRGCs which are candidates to control pupil aperture. The aim of the study was to assess whether the long term pupillary reflex varies with the spectral power distribution of metamer lights and, further, to investigate whether melanopsin or rod response contribute to pupil aperture. We took advantage of illumination using multi colour LEDs to profile the spectrum of the light. Precisely, we generated pairs of spectral power distributions the substitution of which drives one class of photoreceptors while leaving the other classes not stimulated. Previous results did show pupil constriction after a one minute stimulation period with contrasts of 1.128 and 1.148 entailing melanopsin and rods adaptation, respectively, but no such pupil constriction was observed with a stimulation contrast of 1.034 that entailed a melanopsin depletion only (Viénot, Bailacq, Le Rohellec, 2010). In the present experiments run at a photopic level (25 cd.m-2), no pupil modification was observed even after 10 min adaptation to a 1.07 melanopsin contrast or to a 1.05 rod contrast. At a mesopic level (5 cd.m-2), 10 min adaptation to a 1.09 melanopsin contrast did not entail pupil modification either, but adaptation to a 1.05 rod contrast did. Whether the cases where we failed to drive the pupil aperture are due to suboptimal receptor contrast stimulation or due to inappropriate time adaptation remains to be solved.	Color
2	**Colorimetric Observer Classification Using the New Observer Calibrator Prototype** *Abhijit Sarkar*, (Technicolor Research & Innovation, Rennes, France IRCCyN-IVC, Polytech' Nantes, University of Nantes, France; email: abhijit.sarkar@technicolor.com) *Laurent Blondé*, (Technicolor Research & Innovation, Rennes, France; email: laurent.blonde@technicolor.com) *Patrick Le Callet*, (IRCCyN-IVC, Polytech' Nantes, University of	Color

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In our ongoing work, a method for deriving seven distinct colorimetric observer categories has been developed, as well as a method for classifying individual observers as belonging to one of these seven categories (Sarkar et al, *Final Program and Proceedings, CIC 2010*). Five representative L, M and S cone fundamentals were derived through a cluster analysis on the combined set of 47-observer data from 1959 Stiles-Burch study, and 61 color matching functions derived from the CIE 2006 model corresponding to 20-80 age parameter range. From these, a reduced set of seven representative observers was derived through an iterative algorithm, using several predefined criteria on perceptual color differences. An observer classification method was then implemented in a visual experiment, using two displays with different spectral characteristics. The results showed that the CIE 10° standard observer was not a preferred category for any of the 30 observers tested. Very recently, an LED-based portable "Observer Calibrator" prototype has been developed. This proof-of-concept prototype, to be demonstrated at the 2010 GDR-Vision/AVA Christmas meeting, is based on the same observer classification method, and is principally aimed at certain color-critical industrial applications. The "Observer Calibrator" prototype can also be highly useful in fundamental color vision and color science research, allowing pre-sorting of human subjects into different categories based on their color vision. Such pre-sorting can add value to various scientific studies by making the process of color observer selection more comprehensive.

Colour appearance mechanisms are not affected by age-related sensitivity changes

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The purpose of this study was to assess in a large sample of colour-normal observers of a wide age group (n=185; age range: 18-75) whether age-related sensitivity changes are associated with corresponding changes in hue perception. We therefore obtained the following data in the same set of observers: thresholds along the protan, deutan and tritan line (using the Cambridge Colour Test), settings for the four unique hues (red, yellow,

blue, green), and neutral grey settings. We found a significant decrease in chromatic sensitivity with increasing age, in particular along the tritan line. Neither the unique hues nor the neutral grey settings change significantly with age. Hue settings predictionsd based on the known age-related changes in the ocular media show a pronounced dependency on age, which is at odds with the observed invariant hue settings. In conclusion, chromatic discrimination sensitivity declines with age, whereas suprathreshold colour perception is constant. This is consistent with adaptive cone weightings of supra-threshold colour appearance mechanisms. Possible mechanisms underlying this colour constancy across the life span will be discussed.

Modelling the quantitative effects of colour vision applied to a foraging honey bee

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Color

Colour is an important signal for pollinating bees to discriminate food sources. The ability of bees to correctly identify flowers by colour hinges on their colour constancy, the ability to perceive colours as unchanging despite changes in the spectrum of ambient light. One simple mechanism of colour constancy is achieved by von Kries adaptation, the ability of photoreceptors to shelf-shunt their sensitivity so as to provide maximum information at various ambient intensity levels. We do not yet understand the quantitative effects of a failure of colour constancy under biologically realistic conditions. The effect of von Kries-mediated colour constancy is simulated in an agent-based environment where different bee colour vision variants are tested, including; a) a 'Colour blind' bee with no colour discrimination, b) Von Kries bee, and the c) 'Perfect' bee with the ability to discriminate the slightest difference in reflectance spectra. Performance is measured by nectar accumulation. the bee model captures the matching and maximizing colour choice behaviour over several surface spectra of flowers known to co-occur in a natural meadow setting. These model flowers secrete nectar reward recorded from nectar standing crop data and provide an associated colour signal. The amount of nectar collected in the Perfect bee model is significantly better compared to the von Kries model. It is observed that nectar accumulation in the 'non Kries bee' model varies significantly when bees forage in three different natural light conditions and an increase in nectar collection is observed with improved colour discrimination.

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The role of the posterior parietal cortex in visual perception and action

INVITED

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Lesions of the dorsal posterior parietal cortex typically result in optic ataxia (OA) – a disorder in which patients have difficulty reaching toward and grasping objects in the absence of primary sensory or motor deficits. It has been described clinically as part of the Balint-Holmes syndrome for nearly 80 years before it became a cornerstone of the most popular dual stream theory of the visual brain (Milner and Goodale, 1995). OA has then been used over the last 15 years to argue in favour of dissociable perception and action functions (Jeannerod and Rossetti 1993; Milner and Goodale 1995; Rossetti and Pisella 2002). In these contexts, research on OA has focused primarily on visuo-motor functions ("How") versus object identification ("what") and has largely ignored visuo-spatial functions ("Where"). We will first review recent accounts on the nature of the well-established visuo-motor deficits in OA. In absence of concomitant clinical symptoms, we review evidence that misreaching errors in central vision result from the "hand effect": an erroneous dynamic spatial processing of proprioceptive information from the hand. When visual feedback of the hand is provided (closed-loop condition), pure optic ataxia is restricted to peripheral vision. This central versus peripheral vision distinction is repeatedly used to argue that action and perception are not unique and dissociated systems. Subsequently, we will present original data revealing visuo-perceptual deficits in patients with OA. The possibility of a functional relationship between the visuo-motor deficits of OA patients and their perceptual deficits will be put forward and discussed.

Noise and correlations in parallel visual decision making

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Noise, Channels & Oscillations

Parallel processing is a basic organization principle of the visual system. For example, features like motion or color are processed in separate, highly specialized brain areas. For perceptual decision making, this suggests that multiple decisions can be made simultaneously. Each decision is based on noisy evidence for a feature accumulating over time until a criterion is reached. Critically, evidence accumulation is also subject to internal noise which is, however, difficult to measure directly. Here, we investigate internal noise in parallel perceptual decision making by asking human participants to perform simple decisions on color and motion stimuli that are presented in a random order. We first show that latencies

to motion and color features are negatively correlated depending on the features presented on previous trials. Second, with the knowledge of this negative correlation, we can derive an exact prediction of the latency distribution in a dual-decision condition, in which color and motion features are coupled by a logical OR. By comparing the empirical latency distribution with this prediction, we conclude that the internal noise is increased in dual-decision conditions. These findings imply that a significant fraction of the internal noise is produced by decision processes themselves, which sets a fundamental capacity limit for parallel perceptual decision making.

Visual observers compensate for their internal noise

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We have previously suggested (Morgan, Chubb & Solomon http://www.journalofvision.org/content/8/11/9) that observers avoid representing their own internal noise in their percepts. I shall review the evidence from two kinds of variance discrimination tasks (orientation and position). A further test will be described in which observers have to choose between a high-noise and low-noise task. The experiment uses the fact that thresholds for 3-dot bisection are higher than for 3-dot Vernier. Observers saw a horizontal 3 dot array and had to decide on each trial whether the centre dot was displaced upwards, downwards, left, or right. Vernier (up/down) and bisection (left/right) trials were interleaved with two independent, adaptive staircases (Watt & Andrew's APE). We also measured bisection and Vernier thresholds separately and found the former to be ~1.5 x higher. In the mixed task, bisection thresholds were again higher, but not as high as predicted from a simple MAX model in which observers chose the largest internal signal. Data were significantly better fit by a model in which the target displacement was transduced into a smaller bisection signal. Data were even better fit by a Bayesian model in which observers reduced the amplitude of the noisier (i.e. the bisection) signal and noise. In other words, they compensated for their own internal noise. Similar results will be reported using shape and density discriminations. Incidentally, the latter gives no support to the suggestion that there is a 'direct' perception of numerosity.

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Narrow Range of Local Spatial Channels at Each Eccentricity

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8 Noise, Channels & Oscillations

The structure of the spatial channels forming the front end of human visual processing, though a long-standing question, has never been fully resolved. In particular, there are few studies of the channel structure that have restricted local processing regions or assessed the variation in this

structure with distance from the fovea. A new evaluation of the local structure of spatial channels with local stimuli in peripheral retina employed the masking sensitivity approach to minimize the analytic assumptions in the inference of channel structure. The test stimuli were slowly size varying Gaussians and frequency varying Gabors, designed to address the range of channel tunings of the predominantly sustained response system in the near periphery. Under these sustained conditions, the channel bandwidths were ± 1 to ± 0.5 octaves from low to high spatial frequencies. However, the range of identifiable channels spanned a narrow range of peak spatial frequencies, from roughly 2 – 8 c/deg at 2 deg eccentricity to 1-4 c/deg at 8 deg eccentricity. This two-octave range of channel tunings within each local region is much narrower than is conventionally assumed. Since there are no sustained channels tuned below 2 cy/deg for the central visual field, human peripheral spatial processing appears to be based on a simpler channel structure than is often supposed. The results indicate a high degree of efficiency in the organization of early visual processing and account for the encoding of a large number of feature dimensions with the relatively few (~2^16) neurons available within each local cortical processing unit.

A flicker illusion with a static stimulus

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It is widely accepted that oscillations of brain activity play an important role in sensory perception. Yet the perceptual world does not appear to oscillate, at least not visibly: our brains must have developed strategies to cope with the phenomenological consequences of neural oscillations under most common situations. In theory however, it may be possible to reveal these perceptual oscillations in appropriately designed experimental situations. Here we report a novel illusion whereby the center of a static wheel with 30 to 40 alternating black and white spokes is perceived to flicker when viewed in the periphery. Although this flickering phenomenon is so far unexplored, the illusion is a variant of the "MacKay rays", a well-known class of illusory effects (MacKay, D.M., 1957, Nature, 180, 849). The flicker is amplified by eye movements, such as those occurring during reading or smooth pursuit. Yet, we show that the relative motion of the stimulus on the retina is not strictly necessary for the flicker illusion: a similarly powerful flickering effect is perceived on the afterimage of the wheel, produced after a few seconds' exposure followed by instant removal. Finally, electro-encephalography allowed us to identify neural correlates of the perceptual flicker with oscillatory activity in the alpha (8-14Hz) band. We propose that this new flickering illusion is a unique way to visualize the alpha rhythms that constantly occur in the

brain, but normally remain unnoticed.

Orientation anisotropies in human visual cortex complement those in natural scenes

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Signals from our eyes are transmitted to the visual cortex topographically, preserving the spatial layout of the retinal image. Representing the orientation of image features is a fundamental operation of the visual cortex as early as V1. fMRI BOLD responses evoked by different orientations are anisotropic (Mannion et al, 2010, J Neurophysiol, 103, 3465-3471). Obliques evoke greater activity than horizontals and, to a lesser extent, verticals. Furthermore, orientations radial to the point of fixation evoke greater activity than tangential. To investigate the relationship between cortical response anisotropies and the spatial structure of the natural environment, we analysed a sequence of natural images aligned to the gaze of a freely-moving human observer (Schumann et al, 2008, J Vis, 8(14):12). We found an over-representation of horizontals (and, to a lesser extent, verticals) and an over-representation of orientations tangential to the point of fixation. Overall, the prevalence of orientations in the natural environment is highly anti-correlated with V1 activity. This relationship between visual ecology and visual sensitivity suggests that processing in V1 anticipates a diet of retinal image structure characteristic of free-viewing of the natural environment. We speculate that V1 might serve as a topographic map of surprising deviations from predicted image structure.

Noise, Channels & Oscillations

The quest for BOLD fusion

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Humans exploit a range of visual depth cues to estimate depth; for example, the slant of a nearby tabletop can be judged by combining information from binocular disparity, texture and perspective. Behavioural tests show humans combine cues near-optimally, a feat that could depend on: (i) discriminating the outputs from cue-specific mechanisms, or (ii) fusing signals into a common representation. Here I report experiments that test for cortical brain areas that respond on the basis of fused depth signals (binocular disparity and motion parallax). We measured high-resolution fMRI responses in the visual cortex and used

INVITED

multivoxel pattern analysis methods to assess the information contained in different cortical areas. We show that information content (prediction accuracy of a linear classifier) increases in a number of areas when two depth cues concurrently signal depth. However, only in area V3B/KO was this increase compatible with a fusion of depth signals. Moreover, this increase in accuracy was specific to pairs of cues that congruently signalled depth. Finally, we tested for transfer between cues, showing that fMRI responses in V3B/KO evoked by one cue were diagnostic of depth indicated by the other. Together with a number of control experiments, these results provide evidence for a cortical area that represents 3D structure by fusing different depth signals.

Motion camouflage and high-contrast skin patterns in Zebras

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In many animals, ranging from insects, fish and snakes to tigers and zebras, we find high-contrast skin patterns that make them highly visible. The potential adaptive value of such a conspicuous appearance has puzzled evolutionary biologists and visual ecologists, giving rise to speculations about a wide range of mechanisms that could add fitness benefits, including individual identification, thermoregulation, protection against parasites, or predator avoidance. We used computer simulations of a biologically motivated motion detection algorithm (the '2DMD' model) to analyse the motion signals generated by different areas on particular animals' bodies, such as the zebra, to investigate the possible 'dazzle' effect of such patterns, which has been suggested as a means of camouflage. The resulting distributions of motion signals resemble those available to a predator observing their moving prey, or those produced by predator eye movements such as saccades. Simple displacements of pictures of these animals generate strong but incoherent patterns of local motion signals, varying with the tuning parameters of the motion detectors, which do not provide unambiguous information about the movement direction of the whole animal, and which would make it difficult to track such targets on the basis of motion information.

Grouping & Perceptual organization

Motion rules in perceptual organization

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When a stimulus contains multiple local motion cues that move in different directions, the visual system has to decide whether to integrate the motion signals into a coherent object or segment them into several objects. A still influential paper proposed a two-stage model (Adelson & Movshon, 1982, Nature, 300, 523-525), where motion information is first segmented and then integrated. Perceptual organization of moving objects

Grouping & Perceptual organization

does not rely only on motion cues, but also on static cues: another seminal study showed that the choice between integration and segmentation of moving stimuli relied on the 'tacit knowledge' of the physics of transparency' (Stoner, Albright & Ramachandran, 1990, Nature, 344, 153-155) – meaning that the motion system was fed by the form system. Here I present data obtained with plaid stimuli (also used in the studies cited above) that seriously question these two dogmas. Subjects viewed static plaids with unambiguous segmentation cues (occlusion or stereo), leading to the unambiguous percept of two segmented surfaces. When set in motion, plaids were however mostly perceived as single coherent surfaces, even though they underwent later perceptual alternations between coherency and transparency. Such a result reveals (1) a relative independence of motion and form cues, with a primacy of motion cues (see also Hupé & Rubin, 2000, IOVS, 41 (Suppl.), 721, and Hupé & Rubin 2003, Vision Res, 43, 531-548); (2) a preference for motion integration over motion segmentation at motion onset, implying a reverse hierarchy between the two global processes.

Does target-flanker grouping alleviate crowding?

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In peripheral vision, target perception is impaired by elements flanking the target, an interference that is called crowding. For example, discriminating the orientation of a rotated target letter T is compromised when the target is flanked by other Ts. Usually, crowding is stronger when the target and the flankers perceptually group compared to similar conditions in which target and flankers do not group. Here, we investigate whether target-flanker grouping can alleviate crowding. A peripheral target letter T had two sets of flankers making a cross shape with the target in the center. The first set consisted of "crowding-flankers" with two Ts of varying orientations placed to the left and right side of the target. This configuration degraded the recognition of the target. The second set consisted of "grouping-flankers" of the same orientation placed above and below the target. In the grouped condition, the target had the same orientation as the grouping-flankers whereas in the ungrouped condition, the target had a different orientation from the grouping-flankers. Observers reported the orientation of the target. The proportion correct was higher in the grouped compared to the ungrouped condition indicating that grouping-flankers may counteract crowding to some degree. Control experiments showed that in the grouped condition, both hits and false alarms increased showing a bias to reporting the target as having the same orientation as the grouping flankers. Future experiments will show whether this effect of grouping is a perceptual bias or a response bias.

How real is it? The effect of edits on presence during movie viewing

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The act of viewing a movie involves the illusion of immersion or presence – the viewer is transported into the story of the movie from the cinema seat. We have previously developed a measure of *momentary presence* during movie viewing, and established that it correlates with the degree of arousal. Here, we investigate the relationship between presence and another illusory aspect of movie viewing – the fact that we see a continuous narrative in spite of the presence of edits occurring every few seconds. It is often assumed that visual cognition does not store a detailed representation of the world in memory because it assumes that the world is stable. This "stable world assumption" (SWA) is clearly violated in cinema viewing as a result of frequent edits. Their statistics have been extensively investigated, but less attention has been paid to the effect that these unnatural stimuli have on the viewing experience. Our experiment seeks to understand how the illusion of presence is affected by the local time statistics of the movie. Using a variety of obscure Westerns as stimuli, our results show that local mean shot length and the variability in local mean shot length, both correlate with presence. We conclude that progressive violation of SWA increases presence and, by implication, arousal.

Grouping & Perceptual organization

Combination of left and right eye information for texture/density perception

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For binocular depth perception, right and left eye information must be compared, and the difference taken. When presented with anticorrelated displays (elements in one eye match those of opposite contrast polarity in the other eye) there is little or no consistent depth perception. Here we studied a situation where information from the two eyes would ideally be averaged for subsequent visual processing. Texture/density perception was explored using a relative numerosity task. Stimuli were composed of black and white dots, presented for 400 ms. We compared relative numerosity judgements for two conditions: (1) binocular and (2) binocularly anticorrelated stimuli. First, we compared performance for discrimination where both test and comparison stimuli were either

3D & Binocular vision

binocular or anticorrelated. We hypothesized that precision using the anticorrelated stimuli could be compromised by binocular rivalry. The JNDs for the binocular comparison were significantly lower than for the anticorrelated ones. Second, we compared performance where standard and test were presented under the two different conditions. We expected that a rivalrous percept could lead to perceiving up to twice as many dots in the anticorrelated condition. This did not occur (there was no significant bias), suggesting that observers saw the same number of dots in both conditions. For the numerosity task, binocularly anticorrelated and correlated dots appear to be combined between the eyes in a similar fashion. For binocular disparity tasks, depth perception is not achieved for anticorrelated stimuli. We find here that performance in a relative numerosity task is not adversely affected by anticorrelation between right and left eye.

Eye movements patterns during object recognition using stereo stimuli

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Eye movement research has been a wide and popular field of study over the last 30 years. One limiting aspect of many previous eye movement studies is the use of two dimensional (2D) stimulus displays. In the present work, we present a novel way of using eye movements to examine how the visual system performs three-dimensional (3D) object recognition from stereo image displays. A set of novel objects was created with these objects rendered in 3D from different viewpoints to create anaglyph images. Participants first memorised a sub-set of these stimuli, and then completed a recognition memory task under either stereo or mono-viewing conditions. Eye movements were recorded during both the memorisation (Learning) and recognition (Test) phases and compared against three theoretical models of shape analysis (Saliency, Curvature Maxima/Convexity, Curvature Minima/Concavity). The curvature models were computed directly from the 3D mesh objects. Eye movements in the 3D condition were mapped onto the 3D objects allowing us to analyse their spatial distributions in three dimensions. The results showed that the distribution of eye movements in object recognition is: (i) structured and consistent across observers. (ii) similar between the Learning and Test phases and (iii) best accounted for by the surface curvature models. Indeed, the Saliency model performed no better than chance in predicting the spatial distribution of eye movement patterns.

3D & Binocular vision

From sensory signals to perceptual decisions: Decoding the flow of visual information through the human brain

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Recently, the combination of statistical pattern classification and fMRI has emerged as a novel powerful approach to study content-based processing in the human visual system. Pattern classification can be used to investigate the signal flow through the early visual system. Specifically we developed a novel method of "Cortico-cortical receptive fields" that reveals that fMRI background signal fluctuations between V1 and V3 exhibit a precise, topographically specific functional mapping, even in complete darkness. Thus, also noise fluctuations in the visual system exhibit precise retinotopy. We also compared the perceptual information available to human observers to the information in fMRI signals from their visual brain. We found residual processing of invisible features at the early stages of cortical processing (V1), but not at higher stages of processing. For binocular rivalry stimuli we were able to track the dominant conscious percept in rivalry from all early visual areas, between V1 and V3, thus supporting psychophysical results that rivalry already affects early, eye-specific stages of the visual processing hierarchy. In another experiment we aimed to disentangle the stage at which sensory information gives way to decision-related signals. We found that visibility had a strong effect on the signals that predict subjects' perceptual choices. For highly visible stimuli choices were best predicted from sensory regions, but under low visibility, perceptual guesses were predicted not by noise fluctuations in the sensory system, but by a guessing-related network in parietal cortex. Taken together these findings clarify the link between ongoing activity fluctuations and visual decision making.

INVITED

Computational mechanisms of predictive remapping and visual stability

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Cells in many visual areas are retinotopically organized. Thus their input changes with each eye movement, posing the question of how we construct our subjective experience of a stable world. It has been proposed that predictive remapping could provide a potential solution (Duhamel et al., Science, 255, 90-92 1992; Melcher & Colby, Trends in Cog. Sci., 12, 466-473, 2008; Wurtz, Vis. Res., 48, 2070-2089, 2008). Recent evidence from investigations in the frontal eye fields suggests that the anticipatory updating is brought about by the corollary discharge (CD) associated withthe eye movements (Sommer & Wurtz, Nature, 444, 374-377, 2006). However, at present it is unclear how CD could alter the RF profile. Moreover, there exists no clear theory let alone a computational

Perceptual invariance, Perceptual constancy & Recognition

model of how predictive remapping contributes to the subjective experience of visual stability. We show that predictive remapping emerges within a model of coordinate transformation using CD of eye displacement and proprioceptive eye position. Moreover, we demonstrate the influence of predictive remapping on visual stability as objectified by a suppression of saccadic displacement task (Deubel et al., Vis Res, 36, 985-996, 1996). The model predicts that without the predictive remapping behavior the perceptual decision in the SSD paradigm would be biased towards a misslocalization in the saccade direction. This misperception is predicted to be even stronger in case of an absent CD signal.

Suppressing saccadic suppression

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The displacement of a target during saccades is very difficult to detect compared to the same displacement during fixation, a phenomenon called saccadic suppression of displacement. Displacements parallel to the saccade are harder to detect than perpendicular ones. Here we report a surprising interaction. Subjects made horizontal saccades and reported the direction, left or right, of any horizontal displacement. Thresholds for displacements made during the saccade were, as expected, quite high, but adding a task-irrelevant vertical offset lowered thresholds for the horizontal displacement by a factor of two or three. The same horizontal displacement that was undetected when presented alone was accurately reported when coupled to a vertical displacement. Moreover, the mere post-saccadic presence of a target on the saccadic axis (despite an additional vertically-displaced target) seems to be enough to raise the thresholds back up again. These results are a spatial equivalent to the temporal gap effect of Deubel et al. (Vis. Res., 1996) and suggest that, following a saccade, there is a spatial window elongated along the saccade direction, in addition to the temporal window of Deubel et al. If the target is discovered within that spatiotemporal zone, spatial coordinates are calibrated to its new location and no displacement is seen. If a suitable target is not present in this region, trans-saccadic apparent motion is perceived in head-centric coordinates, revealing the accuracy of remapping.

Perceptual invariance, Perceptual constancy & Recognition

Similar things look similar

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A Bag-of-Textons (BoT) is a histogram of patch types occurring in an image. It can be used to infer semantic identity ('it's a cat'). We have assessed its usefulness for inferring semantic relatedness ('it's something like a cat'). We gathered 50 images for each of 348 object categories; encoded them using BoTs based on local symmetry type and orientation (Griffin et al., 2009, LNCS, 5567, 343-355); and computed BoT-distances using the Bhattacharyya distance. As preliminary, we quantify the semantic-identity power of such BoTs using a task where the odd-one-out of three images taken from two categories must be identified based on the three BoT-distances (Griffin et al., 2009, Interface, 3(6), 71-85). Our approach scores 47%; chance is 33%. For our main analysis, we define two distance measures between categories. First, an image-based distance defined as the mean BoT-distance between images from the categories. Second, a semantic distance between the category labels. This is computed from word co-occurrence statistics, and correlates (ρ=0.62) with judgments of semantic relatedness (Gracia & Mena, 2008, LNCS 5175, 136-150). For each 'base' category, we find the 100 semantically-closest categories, and compute the Pearson correlation of the two distances measures between the base and the 100. The correlation, averaged across bases, is 0.14; and is positive for 86% of bases. Thus, to a limited extent, semantic relatedness can be inferred from similarity of appearance, and vice versa. This may be useful in machine co-learning of concept meaning and appearance, and could be exploited in human learning.

Perceptual invariance, Perceptual constancy & Recognition

Mellin-Riesz Transforms and Linear Summation Across Scale and Orientation

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How the visual system combines the responses of its orientation and spatial frequency tuned filters is a fundamental issue. Starting with the 3-D Newtonian potential, defined by the original image coordinates and a 'dummy' scale variable, we Taylor expand this 3-D holomorphic function using cascades of first-order constraints along the direction of the maximum local gradient. In collapsing this 3-D signal representation using a 2-D Fourier transform, the resulting operator delivers the Riesz transform and also provides rules by which filters tuned to different scale and orientation may be combined. Unlike the visual system, filters derived from a Taylor series expansion are neither distributed nor efficient. We

Perceptual invariance, Perceptual constancy & Recognition

show how Taylor's expansion may be embedded in a polar decomposition of the image signal from which both distributed and efficient signal representations can be encoded across scale and orientation by 'steering'. Radial (scale) computations are, however, largely unconstrained in our approach, which allows us to introduce a radial Mellin-like transform via complex log-exponential filters to facilitate scale-invariant computations. We implement the Mellin-Riesz transform using a distributed signal representation, after which we linearly compress across scale and orientation. Image features are then detected using Bayesian methods for model selection. We show: (i) that the inclusion of an image signal's mean reduces noise when identifying image features; and (ii) that higher-order image features (e.g. saddle points) can also be identified. We predict that the power invariance afforded by the compressed Mellin-Riesz transform may help to explain fundamental mechanisms that drive visual adaptation.

23	**Invariant Representations for Visual Perception** *Joan Bruna*, (Ecole Polytechnique, Paris, France; email: joan.bruna@gmail.fr) *Stephane Mallat*, (Ecole Polytechnique; email: mallat@cmap.polytechnique.fr) Visual perception is partly invariant to groups of transformations such as translations, rotations and scaling. It is stable to local deformations, while relying strongly on high frequency information. Finding metrics having similar properties is a mathematical challenge, and standard representations such as Fourier or wavelets are not appropriate. We introduce a class of non-linear unitary representations, providing invariant metrics to any prescribed affine group, and which are Lipschitz continuous to deformations. Such representations are implemented with convolution neural networks, which transform high frequencies into invariant interference coefficients. This transform produces inhibitory and masking effects similar to the ones observed in perception. State of the art results are obtained when classifying patterns and textures with a limited number of training samples. The learning and classification stages have a linear computational complexity. The relevance of this model to the analysis of non-linearities of complex cells in V1 will be discussed.	Perceptual invariance, Perceptual constancy & Recognition

Pro-gram #	**POSTERS**	Session
1	**Detecting changes to the Amplitude and Phase Spectra of Textured Stimuli: Effects of Display Time and Retinal Eccentricity** *Alasdair Clarke*, (Heriot Watt University Edinburgh, Edinburgh, UK;	Basic Psychophysics

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The Discrete Fast Fourier Transform allows us to easily extract an image's amplitude and phase spectra. The extent to which the early visual system codes image properties in terms of parameters of these spectra has been an active research topic for a number of years. Both parameters have been shown to contain important information regarding the appearance of an image [Tadmor and Tolhurst, Vis. Res., 33:141-145, 1993] and a large body of work investigated the effects of manipulating these spectra on the recognition or classification of image content. Here, we use a novel means of investigating sensitivity to amplitude and phase spectra properties, by using synthetic images of textured surfaces that are broadband in the frequency domain, and by testing the ability of observers to detect degradations of their spectral content (smoothing of the amplitude spectrum, or randomisation of the phase spectrum). We directly compare the effects of display time and retinal eccentricity on detection of these two manipulations, by using stimuli matched for difficulty of detection. We find no difference between the time-courses for the detection of degradation in the two spectra; in both cases, accuracy rises above chance with display times greater than 80 ms. Increasing retinal eccentricity to 9 deg, however, has a significantly stronger effect on the accuracy of detecting degradations of the amplitude spectrum than of the phase spectrum.

Short-term colour discrimination: appearance and cognitive approach

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2 Basic Psychophysics

In a driving situation, colours are used to provide real time information to the driver. Assuming that the driver is allowed to view the colour display from time to time to acquire such information, the question arises whether colour discrimination is limited by the duration of the driver's short glimpses, by his/her short term memory and also as a result of the highly demanding driving task. We conducted an experiment to measure the minimum perceived colour difference between two 5 deg green colour patches displayed for either 250 ms or 1 s with an inter-stimuli interval (ISI) of 2s. This was achieved in the presence of a distracting task where subjects had to indicate (by pressing one of two keys) the pointing direction of an arrow presented during the ISI. Discrimination thresholds were assessed by means of an adaptive double staircase method with a similar/different response choice. Thirty-two paid colour normal observers (16 aged 20 to 30 and 16 aged 60-70) took part in the

	experiment. Results don't show a significant effect of stimulus duration (paired t-student test) on short-term colour discrimination. There are two possible interpretations of the results. Either 250 ms are sufficient to allow subjects to memorise the colour appearance of the first stimulus, or the cognitive storage effort needed during the ISI cancels out any putative differential effect of stimulus duration. As a consequence, disentangling short-term memory and temporal integration effects in such colour discrimination tasks requires further investigations.	
3	**Retinal inhomogeneity and the witch's hat: Contrast sensitivity declines as a bi-linear function of eccentricity in each direction** *Alex Baldwin*, (Aston University, Birmingham, UK; email: baldwias@aston.ac.uk) *Tim Meese*, (Aston University, Birmingham; email: t.s.meese@aston.ac.uk) *Daniel Baker*, (Aston University, Birmingham; email: d.h.baker1@aston.ac.uk) The logarithm of contrast sensitivity has been described as a linear function of retinal eccentricity for a visual field of 120 deg (Pointer & Hess, 1989, Vis Res, 29, 1133-). Here we ask whether this is a suitable account for the central 9 deg of the visual field where most contrast sensitivity experiments are performed. We measured contrast detection thresholds for oriented cosine-phase log-Gabor stimuli with a spatial frequency of 4 c/deg and bandwidths of 1.6 octaves and ±25°. Four meridians were tested (-45°, 0°, 45° and 90°), each with four stimulus orientations (-45°, 0°, 45° and 90°). Eccentricity was sampled in steps of 6 cycles, and 1.5 cycles in a subsample of conditions. In almost every case, we found that the initial sensitivity loss with eccentricity was steep (average = 1.1 dB/cycle), becoming shallower (average = 0.4 dB/cycle, similar to previous reports) after a critical point: a behaviour that was nicely described by a bi-linear equation. This equation also improved the fit to the Pointer and Hess results. Sensitivity to the entire central visual field was estimated by elliptical interpolation between bi-linear fits to each of the four cardinal half-meridians. This produced a sensitivity surface shaped like a "witch's hat", and made good predictions for the results for the oblique meridians. By testing other spatial frequencies, we aim to determine whether the location of the hat's brim is a fixed visual angle (as might be expected on anatomical grounds) or a fixed number of stimulus cycles.	Basic Psychophysics
4	**Varying extrinsic uncertainty affects the slope and position of the psychometric function for contrast detection and contrast discrimination** *Daniel Baker*, (School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET UK; email: d.h.baker1@aston.ac.uk)	Basic Psychophysics

Tim Meese, (School of Life & Health Sciences, Aston University, Aston Triangle, Birmingham, B4 7ET UK; email: t.s.meese@aston.ac.uk)

The slope of the psychometric function for contrast detection is controlled by nonlinear contrast transduction or uncertainty, or a combination of the two. For contrast discrimination, the pedestal removes intrinsic uncertainty, and contrast gain control reduces the effective exponent; both processes result in a shallower slope of the psychometric function. Manipulating extrinsic uncertainty experimentally should affect both threshold and slope but, despite its theoretical importance, this test has not been performed previously at both detection threshold and above. Here we manipulated spatial uncertainty for detection and discrimination of a pair of horizontal 4c/deg Gabor patches placed equidistant from a central fixation point on the circumference of a virtual circle. In a temporal 2AFC paradigm, there were 1, 2, 4 or 8 possible locations for the target pairs, indicated by low contrast rings. The level of uncertainty was fixed within a block of trials, with target contrast levels determined by the method of constant stimuli. For contrast discrimination, the experiment was identical except that pedestals were presented in all locations on every trial. Thresholds and slopes increased with extrinsic uncertainty for both detection and discrimination. However, the threshold effect was greater for discrimination than for detection, confirming our prediction that intrinsic uncertainty is greater at threshold than above. We report estimated levels of intrinsic uncertainty for a range of transducer exponents (1:3). A detailed understanding of the effects of intrinsic and extrinsic uncertainty are critical for examining effects such as collinear facilitation, for which uncertainty reduction is a common explanation.

Does the Visual System Employ a Distributed Representation in Radial Scale-Space?

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5 Basic Psychophysics

Distributed signal representations may be regarded as fault-tolerant and in scale-space characterized by a diagonally dominant auto-correlation function. We ask whether the visual system employs a distributed representation when processing image signals at different spatial-scales. We do so by assessing threshold elevations, defined as the ratio of the contrast threshold of a test in a masking condition to a baseline (no mask), at the very low spatial frequencies. Using a 2AFC paradigm, participants were required to detect a band-limited spatially isotropic test signal superimposed upon a similarly defined band-limited mask. The peak spatial frequency tuning of both the mask and test signals were varied

	from 0.5-32.0 cycles per degree (cpd) across trials and sessions. The root mean square contrast of the masks was fixed at 0.15, while threshold contrasts were obtained by varying the contrast of the tests. Mask and test temporal frequencies were either static (0Hz) or modulated at 8 Hz. The masking functions could be broadly explained by fitting four shifted radial (plus constant) log-exponential functions whose center frequency tunings lay in the region of 0.5, 2, 6 and 8 cpd. An examination of the individual radial filter transfer functions and the estimated masking noise variances at the lowest spatial frequency suggests that radial filter contrast sensitivity progressively declined as radial filter shift (in the frequency domain) increased, which is consistent with the predictions made by distributed signal representations.	
6	**A Phoenix Aftereffect** *Veronique Lefebvre*, (Division of Psychology and Language Sciences, University College London, 26 Bedford Way, London WC1H 0AP, UK; email: v.lefebvre@ucl.ac.uk) *Joshua A. Solomon*, (Department of Optometry and Visual Science, City University, London EC1V 0HB; email: J.A.Solomon@city.ac.uk) *Keith Langley*, (Division of Psychology and Language Sciences, University College London, 26 Bedford Way, London WC1H 0AP; email: ucjtskl@ucl.ac.uk) After adapting to a one dimensional image signal and testing with another whose orientation is slightly different, the perceived orientation of the test is shifted away from the orientation of the adapter. The recovery of the visual system to this tilt-after effect (TAE) follows an exponential law whose time constant in the presence of a test, is about one hundredth of a second, but with a blank field interval several minutes. Subjects were adapted to a single orientation which was followed by three intermittent tests using similar spatial patterns at a nearby orientation. In each test phase, the time constant of the decay in TAEs was of the order of 100 ms, as expected. At the onset of each intermittent test, however, we find that the magnitude of TAEs exceeded the magnitude of TAEs at the offset of the previous test. The re-bound in TAEs, the time constant of which we find to be much slower, we believe to be the actual recovery from adaptation. If so, the rapid reductions in TAEs reflect a temporary but nonetheless apparent recovery from adaptation that we attribute to the differential adaptability of the visual system to visual stimuli of different temporal frequencies.	Basic Psychophysics
7	**Psychophysical evaluation and modelisation of contrast sensitivity thresholds for Perlin noise** *Alexandre Coninx*, (LPPA - CNRS - Collège de France, LJK - Grenoble University - INRIA, EDF R&D, France; email: alexandre.coninx@college-de-france.fr) *Georges-Pierre Bonneau*, (LJK - Grenoble University - INRIA; email: georges-pierre.bonneau@inria.fr)	Basic Psychophysics

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Perlin noise (Perlin 1985, Proc ACM SIGGRAPH '85, 287-296) is a procedurally generated texture widely used in computer graphics. Its visual and spectral characteristics can easily be modulated using two computational parameters, the base frequency and persistence. Its smooth and "natural" appearance is particularly useful in simulating natural phenomena for applications such as image synthesis or video gaming. Our work in the field of scientific visualization led us to explore the potential of Perlin noise to convey scalar information (such as a physical value) when visualizing a 3D scientific data set. In order to evaluate the conditions under which this visual pattern can efficiently be perceived by the visual system, we evaluated the contrast sensitivity thresholds of Perlin noise stimuli for 16 different parameter values using a 2IFC psychophysical task and the Psi method (Kontsevich & Tyler 1999, Vis Res, 39, 2729-2737) to accelerate threshold assessment. The measured thresholds were found to be highly compliant with the values predicted by an existing computational contrast sensitivity model (Watson & Ahumada 2005, JoV, 5, 717-740) validating both the model and our results. They are also close to the values measured for natural images, as could be expected for textures used in image synthesis. We then used the model to predict sensitivity thresholds for other parameter values. In future work, we will propose new scientific visualization techniques based on the insight we have acquired in the visual perception of procedural textures.

Speed-dependent motion processing deficits in aging: The role of spatial integration

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Evidence suggests that some aspects of global motion perception can be adversely affected by the normal aging process. However, the specificity and onset of age-related changes remain unclear. The current study investigated the relative effects of dot speed and dot spatial displacement on global motion processing as a function of age. Coherence thresholds (corresponding to 79 % correct) were measured for direction judgments of translational (up vs. down) RDK motion in participants from across the adult lifespan (20–79 years). In agreement with previous studies, we found an age-related impairment at low (0.625 deg/sec) and high speeds (10 deg/sec). However, performance was more markedly affected by dot spatial displacement (when dot speed was kept constant) than by dot speed (when dot displacement was kept constant), particularly when dots were displaced over a large spatial distance (≥0.5 deg/frame).

Motion

	Furthermore, age-related impairments only became apparent in participants aged 70-79 years. These findings suggest a prominent role of spatial information (specifically, spatial integration) in global motion processing, especially in old age. They also indicate that, at least where speed-dependent deficits are concerned, global motion perception is relatively unaffected by the aging process until around 70 years of age.	
9	**Does the human visual system average local speed information?** *Francesca Rocchi*, (Nottingham Visual Neuroscience School of Psychology University of Nottingham, Nottingham, UK; email: lpxfr@nottingham.ac.uk) *Ben Webb*, (Nottingham Visual Neuroscience School of Psychology University of Nottingham; email: bsw@psychology.nottingham.ac.uk) *Timothy Ledgeway*, (Nottingham Visual Neuroscience School of Psychology University of Nottingham; email: timothy.ledgeway@nottingham.ac.uk) Global motion perception requires integration of local motion samples across space and over time. Yet the strategies deployed for combining disparate local speed vectors into a coherent percept are unresolved. A common assumption is that 'pooling' is synonymous with averaging, but does perceived global speed actually coincide with the mean of the local speeds present? Research using random-dot-kinematograms (RDKs), in which dots take a random-walk in speed, shows that speed-discrimination is governed by changes in the mean dot speed but not the mode (Watamaniuk & Duchon, 1992, Vision Research, 32, 931-41). However, other measures of central tendency (e.g. median) were not considered and perceived global speed was not explicitly measured. To address these issues we measured the point of subjective equality between pairs of RDKs: in one (standard) all dots moved at the same speed and in the other (comparison) dot speeds were drawn from a distribution with distinct measures of central tendency. Results showed that, in general, perceived global speed is better characterised by the median of the local physical speeds rather than by the mean, or any by other motion statistic. However, when dot speeds were drawn from rectangular distributions, the results were equivocal and coincided with observers perceiving transparency when the comparison dots moved much slower than the standard. This transparency effect decreased at either high dot densities or short stimulus durations, suggesting that perceived global speed depends on both the amount of information pooled across space and the time over which speed signals are processed.	Motion
10	**When older is better: Superior global motion perception in the elderly** *Claire Hutchinson*, (University of Leicester, Leicester, UK; email: ch190@le.ac.uk) *Harriet Allen*, (University of Birmingham; email:	Motion

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The current study assessed the effects of stimulus area and local element (dot) density on global motion perception in the elderly. Coherence thresholds (79% correct) were measured for discriminating the direction of random-dot-kinematograms depicting translational (up vs down) global motion in 18 younger (20-30 years) and 11 older (65+ years) participants. Younger participants were much more susceptible to changes in stimulus area and local element density than older participants, whose performance was largely unaffected. With relatively large stimulus areas and low dot densities, younger and older participants' performance was equivalent. However, as stimulus area decreased and/or dot density increased, younger participants' performance became markedly worse (coherence thresholds were higher) than older participants' performance. Our findings suggest that, in some instances, aging may lead to superior global motion processing. One distinct feature of the data is that younger participants' performance deteriorated as aperture area decreased and/or dot density increased, whereas older participants' performance remained relatively unaffected by changes in these parameters. This pattern of results may support the notion that there is less cortical inhibition in 'older' visual systems, leaving older observers less susceptible to crowding effects caused by small displays containing a high number of 'elements'.

Multivariate classification of motion direction using high field fMRI

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11 Motion

Previous studies have demonstrated that the perceived direction of motion of a visual stimulus can be decoded from the pattern of fMRI responses in occipital cortex (Kamitani and Tong, 2006 Current Biology 16 1096-1102). One possible mechanism for this is a difference in the sampling of direction selective columns between voxels, implying that sub-voxel information may be accessible with fMRI. To assess the possible sources of this direction-selectivity, we tested how classification accuracy varied across different visual areas and subsets of voxels for 8-way direction classification. Functional imaging data were collected using 3d-gradient-echo EPI at 7T (Achieva, Philips; SPMMR Center Nottingham) using 1.5mm isotropic voxels, (volume TR 2s). In one set of analyses we tested how classification accuracy varied with the number of voxels used; we used a 'searchlight' technique that performs classification based on a

spherically defined subsets of voxels (Kriegeskorte et al, 2006 PNAS 103 3863-3868) and found classification performance above chance across several visual areas (V1-V4, V5/hMT+) and in areas of the intraparietal sulcus, with a range of searchlight sizes (radius 4.5-10.5 mm). In the second set of analyses, we looked at classification performance after combining data across different voxels within visual areas (with similar visual angle preference from retinotopy) before classifier training. Preserved classification accuracy when averaging in this way, compared to random averaging of voxels, suggests that there may be large-scale biases at the level of retinotopic maps underlying some part of our results (see also Freeman et al, 2010 SFN Abstract 483.17).

The scale dependence of binocular fusion, suppression and diplopia

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When disparate images are shown to the two eyes, the perceived outcome may be fusion (single vision), suppression of one eye's view, or diplopia (double vision). We have re-examined the way in which these perceptions depend on binocular disparity and spatial scale (e.g. Schor *et al*, 1984 *Vision Research* **24**(7) 661-665) in an attempt to understand better the underlying spatial mechanisms and their interocular interactions. We used a novel 3-choice method to distinguish fusion, suppression and diplopia more clearly. Single, Gaussian-blurred, horizontal edges were presented to each eye (30% contrast, 0.2s) at various vertical disparities and with blurs B=1-32 minarc. Observers indicated '1 central edge', '1 offset edge' or '2 edges'. As disparity increased (from 0 to 8B), the proportion of fusion responses ('1 central edge') fell monotonically, and the fusional disparity range was nearly proportional to edge blur. The other responses did not scale with blur: at large disparities (>4B), suppression was much more likely for small blurs, while diplopia dominated at large blurs. Data were fitted with a descriptive model in which the disparity range for fusion was ~2.5B, while the disparity range for suppression was more than 10B at small blurs, falling to about 2.5B at large blurs. Thus, the range of fusion increases in proportion to the spatial scale of image features, but the range of suppression may be closer to being a constant disparity. Diplopia occurs - especially at large disparities and large blurs - when both fusion and suppression fail.

3D Perception, Binocular Vision and Space perception

A Probabilistic Model of Binocular Fixation and Correspondence

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The posterior distribution of binocular disparity has been investigated

3D Perception, Binocular Vision and Space perception

previously, using both physical and empirical models of the visual world (Yang & Purves 2003, Nat. Neurosci. 6(6), 632-640; Hibbard 2007, Vis. Cog. 15, 149-165; Liu, Bovik & Cormack 2008, JOV 8(11)). The present work emphasizes the importance of the prior distribution, as determined by the binocular geometry. In particular, the following question is investigated: Given the location of an image-feature in one retina, where is it most likely to appear in the other? The analysis is simplified by restricting fixation to the plane of zero ocular elevation. A fixation density is defined in this plane which, together with the known point in the first retina, determines an envelope of possible epipolar lines in the second. Furthermore, each candidate projection in the second retina, together with the rest of the configuration, defines a candidate 3D point. The probability of this point is evaluated using a local model of the scene. Specifically, in the neighbourhood of the fixation point, it is assumed that the visible surface is orthogonal to the cyclopean viewing direction. The scene and epipolar densities are now combined so that, given a point in the first retina, it is possible to evaluate the probability of each possible correspondence in the second. This density is discussed in relation to the range of disparity-sensitive mechanisms in the primate visual system.

The Vertical-horizontal and the Oppel-Kundt illusions: how our visual perception changes

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In the Vertical-Horizontal illusion a horizontal line bisected by a single vertical of equal length appears perceptually shorter than the vertical. Mamassian & Montalembert (2010) have identified two components of this effect: a vertical-horizontal anisotropy and an effect of bisection. However in the Oppel Kundt illusion, a horizontal line segment with small and regular vertical line segments along it appears longer than a horizontal line without such vertical 'ticks'. By manipulating the number of vertical line segments (0, 1, 5 & 9) and their position relative to the horizontal (crossing, touching) we have investigated when the addition of vertical line segments increases the perceived length of a horizontal line and when it decreases it. Our results show that the perceived length of a bisected horizontal line with a single central vertical tick is decreased by 5-10%, an effect somewhat smaller than Mamassian's. However, in an inverted 'T' configuration where the vertical line is equal to the horizontal, we observed no change in the perception of the horizontal line segment. Additionally, increasing the number of small ticks reverses the effect with the Oppel-Kundt arrangement with 9 vertical ticks producing an increase in perceived size by 5-6%. Our results suggest that 4-5 ticks should produce no illusion at all. We shall discuss these results in the light of previous research.

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16 **Object location and landmark use** 3D

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Perception, Binocular Vision and Space perception

When finding our way in the world, humans use objects as landmarks. To allow us to retrace a previously learnt route, landmark objects are stored in memory and associated with a navigational action.
Objects occurring around route nodes are most likely to become landmarks. It is known for example that objects at decision points (route locations where a change in direction is possible) are more often used as landmarks than those at non-decision points. In previous experiments the non-decision points used were locations along a route where the only possible action was to continue in the same direction. Decision points contain compelling elements that draw attention. When a turn is taken at a decision point there is a physical rotation that draws attention. When the turn is not taken the sight of a possible turn is capable of drawing attention.
Here we explore the impact of the compelling events at decision points on object recognition. We compare four different location types in an effort to extend our understanding of landmark memory beyond the common decision point versus non-decision point distinction. The results reveal an advantage for decision points where a turn occurs and for simple turns where no alternative is possible over decision points where a turn is not taken. This unique finding informs our knowledge of visual learning during navigation.

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Privileged processing of the straight-ahead direction: behavioural evidence in human

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3D Perception, Binocular Vision and Space perception

In macaque primary visual area, neurons coding the peripheral visual field show increasing level of activity as their receptive fields are brought closer to the straight-ahead direction by changing the direction of gaze (Durand et al, 2010 Neuron 66 126-137). Such mechanism might ensure that straight-ahead objects still receive a privileged processing in peripheral vision when the gaze is not directed toward them. In the present study, we tested this hypothesis in human subjects involved in visual reaction time tasks (button press in response to the appearance of peripheral visual targets). The egocentric location of the visual targets was varied (either

straight-ahead or eccentric with respect to the body midline), while their retinal images were kept constant by manipulating the gaze direction. Our results show that straight-ahead targets evoke significantly shorter reaction times than eccentric targets, although both types of targets form similar images on the retinas. Eye movement recordings allow ruling out an explanation based on fixation quality. Moreover, additional experiments show that neither binocular visual cues nor visual attention can explain the shorter reaction times observed for straight-ahead targets. These behavioural results in humans are reminiscent to those obtained at the neuronal level in macaques. We conclude that a neuronal mechanism leading to a privileged visual processing of the straight-ahead direction is shared by both primate species and that it can be revealed behaviourally.

18	**3D Object Recognition in Bees** *Annette Werner*, (Institut for Ophthalmic Research Centre for Opthalmology Tübingen University, Tübingen, Germany; email: annette.werner@uni-tuebingen.de) *Jochen Wagner*, (Institut for Neurobiology, University of Tübingen; email: annette.werner@uni-tuebingen.de) Insects' abilities to solve high level visual tasks by relatively simple neuronal hardware has been successfully implemented in robotics, for example using motion parallax to navigate in three-dimensional space (reviewed in Francescini, 2009, Acta Futura, 3, 15-34). Object recognition is another visual task which is important for biological as well as artificial visual systems. Bees, like most other insects, lack stereo vision, but can recognize other abstract features of objects, such as colour, size, shape and patterns (reviewed in Srinivasan, 2010, Annual Review in Entomology, 55, 267 - 284). Furthermore, bees have been shown to discriminate images of human faces, even if taken from different viewpoints (Dyer et al., 2005, Journal of Experimental Biology, 208, 4709-4714; Dyer & Vuong, 2008, PloSone, 3, e4086). But how do bees see and discriminate real three-dimensional objects? In order to find out, we trained and tested altogether 46 individual bees (apis mellifera) to discriminate between various real 3D objects (balls, cubes, disks and squares (diameter 28 mm), plane, concave or convex folded cards (25 x 60 mm) as well as their two-dimensional images (computational simulations or photos). The surface of all stimuli was an achromatic random-noise-pattern. We found excellent discrimination by bees of the 3D objects ($p < 0.01$). Real 3D objects were never confused with their 2D images ($p > 0.1$). Possible mechanisms underlying 3D object recognition in bees are discussed.	3D Perception, Binocular Vision and Space perception
19	**VSTM for convexities and concavities along a single contour** *Mai Mohamed Helmy*, (School of Psychology, University of Liverpool, Liverpool, UK; email: maisalah@liverpool.ac.uk) *Marco Bertamini*, (chool of Psychology, University of Liverpool, Liverpool, UK; email: m.bertamini@liv.ac.uk)	Grouping, & Perceptual Organization

The capacity of visual short-term memory is approximately four units (Cowan, 2001 Behav. and Brain Sciences 24 87-114). In our studies the units were segments along a contour and retention interval was 1000ms. As reported at a previous meeting (Helmy, Bertamini, 2010) when the contour was in isolation (therefore ambiguous with respect to convexity/concavity) performance was worse (as measured by d') compared to when the contour was closed, even though convexity/ concavity were irrelevant for the task of detecting a local change in shape. Moreover, the advantage for closed contours was only present when the segments were 4 (as opposed to 3 in a separate experiment) presumably because the effect is only visible when the task is near the limit of VSTM. For closed objects there was no difference in sensitivity for segments perceived as convex compared to concave. This suggests that the memory for convexities (arguably perceived as parts) is not fundamentally different form the memory for concavities (not perceived as parts). In a new experiment we tested whether changing convexity into concavity (or vice versa) from the first interval to the second would affect the detection of a change in the local shape of the segments. However, the trend for better performance when convexity coding was fixed (convex or concave in both intervals) was not significant. We also analysed bias and found that when the coding (convex or concave) changed between intervals there was a bias to report a change in the shape of the segments.

Local curvature detectors and global shape processing

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Subjects perform in the hyperacuity range when discriminating circles from contours containing radial sinusoidal modulations (Radial Frequency Patterns; RF). High RF sensitivity results from integrating information across the entire contour. Points of maximum curvature have been implicated as a key feature in this integration process. We aimed to investigate the role of local curvature in RF discrimination and how this information is integrated globally. RF discrimination data (RF3, 5, 8; curvature=2deg-1) were compared to curvature discrimination data using either circular segments with varying angular extent (22.5°-360°) or segments containing single RF lobes.
Curvature increment thresholds for discriminating circular segments (of half the angular extent of a single RF cycle) were comparable to those observed with complete RF contours. However, sensitivity for single RF

cycles was significantly poorer than for complete RF patterns or circular segments. Given that curvature thresholds for entire RF contours do not significantly exceed those for circular segments, one might speculate that RF computation is limited by detecting points of maximum curvature. This is, however, inconsistent with the substantially reduced sensitivity for isolated RF cycles. Instead, results suggest that the signal of local curvature units elicited by RF patterns is degraded compared to circular segments and that global pooling of such sub-ideal local signals is required to explain the hyperacuity performance for these shapes. This reconciles the apparent paradox that RF sensitivity can be similar to that of isolated circular arcs and yet RF contours are being processed by global pooling of local information.

Is visual search influenced by lightness information?

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C M Moore, A Gilchrist

Moore and Brown (2001, JEP:HPP, 27, 178-194) reported that visual search is influenced by raw luminance rather than just lightness information, suggesting that search processes are engaged before lightness constancy (i.e., the discounting of spurious luminance differences such as cast shadows or the specific illumination conditions) is fully established. They presented a transparent filter in front of half of a search display and used luminance values such that the target was either luminance-matched with the distractors behind the filter or not. If search was based entirely on lightness-constancy resolved representations, then search performance should have been identical in the luminance-matched and unmatched conditions. If, however, search was influenced by raw luminance, then search should have been more difficult in the luminance-matched condition. Search times were longer in the luminance-matched condition than in the luminance-unmatched condition, indicating an influence of raw luminance because the luminance match introduced ambiguity. It is possible, however, that this difference was due to incomplete lightness constancy. If lightness constancy was incomplete, then the perceived similarity of the target and distractors would have been greater in the luminance-matched condition than in the luminance-unmatched condition, leading to the observed difference. To test this hypothesis we matched lightness for each participant and used the adjusted values. This reduced the difference between luminance-matched and luminance-unmatched condition, suggesting that the apparent influence of raw luminance on search was probably due to incomplete lightness constancy, rather than search processes being engaged prior to the resolution of lightness constancy processes.

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Perceptual rather than motor limitations constrain temporal-range estimation of multiple objects

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When making dual time-to-contact (TTC) estimates of two approaching objects, the two estimates interfere in an asymmetric fashion: the TTC of the later-arriving object is systematically overestimated. This asymmetric interference points to a processing bottleneck that could be caused by perceptual or by motor processing constraints. We used a Sperling-like prediction-motion task to differentiate between these two possibilities. Participants produced an absolute estimate of the TTC of only one of two objects approaching a target line. The target object whose TTC had to be estimated was indicated by an auditory cue that occurred either at the motion onset or at the instant at which the two objects disappeared from the screen (occlusion onset). The cue at motion onset should disengage visual processing of the irrelevant stimulus. The cue at occlusion onset, in contrast, requires visual processing of both relevant and irrelevant stimuli until occlusion. A single-object condition was used as a control. Results show symmetric interference in the motion onset condition. In the occlusion onset condition, however, the results were congruent with asymmetric interference. Thus, the processing bottleneck in TTC estimation is originating at the perceptual rather than at the motor level.

Coordinated smooth pursuit eye movements under artificial control-target mappings

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Hand-eye coordination optimises oculomotor control in many natural tasks. For example, smooth pursuit of a moving target (initiation and maintenance) is most accurate when the target is under the active manual control of an observer (Steinbach & Held, 1968, Science, 161, 187-8; Gauthier et al., 1988, Exp. Brain. Res., 73, 127-37). We investigated how artificial alterations of the control-target mapping, typical of computer input devices, affect the performance of coordinated smooth pursuit eye movements. Observers tracked a Gaussian blob target on a CRT monitor that they moved back and forth (horizontally) with a digitizer pen in a sinusoidal motion (horizontal digitizer range 23 cm, maximum target displacement about 20°). Eye movements were recorded with the Eyelink 1000 video tracker. We varied control-target gain (1:1, 1:2, 1:4, reverse 1:1), speed (0.5-1.5 hz) and target visibility (in half the trials the target disappeared intermittently behind invisible occluders). Performance was evaluated by smooth pursuit gain and saccade count. The largest

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	advantage for active tracking was observed for the 1:1 mapping in the visible condition, suggesting that optimal smooth pursuit occurs for natural control-target mappings. But performance was better in active control than in passive tracking for all conditions, with the smallest performance advantage in the critical reverse condition. This pattern of results suggests that the oculomotor system has access to the kinematic properties of the control-target relationship, even without directed training prior to the task.	
24	**Short-Term Experience in a Wheelchair Affects the Perception of Distance** *James Rose*, (American University of Kuwait, Kuwait; email: jrose@auk.edu.kw) *Noura Al Sabah*, (American University of Kuwait; email: S00001689@auk.edu.kw) *Shoug Al Sabah*, (American University of Kuwait; email: s00003738@auk.edu.kw) *Mariam Al Awadhi*, (American University of Kuwait; email: s00011692@auk.edu.kw) *Alia Aref*, (American University of Kuwait; email: s00010173@auk.edu.kw) The visual perception of distance depends in part on the anticipated costs and benefits of traversing the distance. For example, distances appear greater when observers wear a heavy backpack or suffer from chronic pain, and objects are perceived as closer when they are desirable. Here, we report that perceived distance is affected by short-term experience in a wheelchair. Observers sat in a wheelchair and propelled themselves a distance of 32m, or were passively pushed the same distance. Observers then provided verbal estimates of the distance to targets located at 6m, 8m, and 16m. Both conditions resulted in greater perceived distance compared to a control condition in which observers sat in a stationary wheelchair. These results add to a growing body of research which shows that physical and goal states unique to the observer affect the perception of spatial layout.	Perception & Action
25	**Adaptation of reactive and voluntary saccades in normal children** *Karine Doré-Mazars*, (Paris Descartes University LPNCog Laboratoire de Psychologie et Neuropsychologie Cognitives FRE 3292 CNRS IUPDP Institut Universitaire de France ; email: karine.dore@parisdescartes.fr) *Dorine Vergilino-Perez*, (Paris Descartes University LPNCog Laboratoire de Psychologie et Neuropsychologie Cognitives FRE 3292 CNRS IUPDP ; email: dorine.vergilino-perez@parisdescartes.fr) *Christelle Lemoine*, (Paris Descartes University LPNCog Laboratoire de Psychologie et Neuropsychologie Cognitives FRE 3292 CNRS	Eye-Movements & Perception

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Saccadic adaptation was induced by a classical double-step target to elicit saccade gain shortening in response to a 2° backward step (20% of target eccentricity) in 9 adults (23-36 years old) and 9 children (11-13 years old). In two separate sessions, reactive and voluntary saccades (RS and VS) were elicited by gap-0ms and overlap-600ms paradigms. To assess the retention and the extinction of saccadic adaptation, two conditions were run in pre- and post-adaptation phases without and with postsaccadic visual feedback. Three main results: (1) The intrasaccadic target step induced the adaptation of both saccade types given that children as well as adults showed a progressive saccade gain shortening. Thus, cerebral structures involved in backward adaptation of both saccades are functional at 11 years old. (2) The retention was good for both saccade types in adults but only for RS in children: adaptive modifications of VS were not retained during trials without feedback of the target, suggesting that adaptive mechanisms sustaining the saccade gain shortening differ from those subserving retention and are not mature and functional at the same time. (3) Finally, post-adaptation trials with feedback of the target at the original location (no step) allowed the examination of adaptation extinction, i.e. return to gain baseline. The speed of extinction for RS was slower in children than in adults, suggesting that saccade gain lengthening is not yet well established in children of 11 years old and hence, that mechanisms responsible for backward adaptation mature before those for forward adaptation.

The role of saccade preparation in lateralized word recognition: evidence for the attentional bias theory

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Words presented to the right visual field (RVF) are recognized more readily than those presented in the left visual field (LVF). This RVF superiority could be the result of an attentional imbalance due to the selective activation of the left hemisphere with verbal tasks (attentional bias theory). Alternatively, the left hemisphere may process verbal material by using less attention than the right hemisphere (attentional advantage theory). Hyönä and Koivisto (2006, Laterality, 11:2, 155-169) manipulated the orientation of attention by asking their subjects to make a saccade towards a brief lateral verbal stimulus. Compared to a fixation condition, they showed that the saccade preparation improved word recognition only in the LVF, cancelling the RVF superiority. In our study, we used similar move and fixate conditions with young and old participants (Experiment 1). The RVF superiority was shown for fixate and move conditions with only a small benefit from saccade preparation. Elderly subjects had poorer performance than younger for both LVF and RVF in accordance with the attentional bias theory. In Experiment 2, young subjects had to saccade to the same or to the opposite side of the stimulus. We were particularly interested in the condition in which the stimuli were presented to the RVF and the saccade executed toward it or on the opposite side. The decrease in performance in the latter condition compared to the former argues again in favour of the attentional bias theory.

Saccadic adaptation: different neural networks for reactive and voluntary saccades

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Moving the fovea to a target of interest requires rapid eye movements (saccades). The amplitude of saccades is maintained over the long-term despite changing conditions (e.g., growth, aging, lesions). This saccadic adaptation process can also be elicited experimentally using the so-called double-step target paradigm in which a saccadic error is produced by shifting the visual target during the on-going saccade. Our knowledge of the neural networks involved in saccadic adaptation is still fragmented for reactive saccades (target step task) and virtually null for voluntary saccades (scanning task) Recent behavioural studies suggest that the neural substrates are different for the two saccade types (see for review Pélisson et al., 2010). In this study, we used blocked fMRI design to examine brain activation in humans engaged in a reactive and in a voluntary saccade task. The classical double-step target paradigm was used with two delay conditions (Fujita et al., 2002): 50ms after the end of the primary saccade to induce saccadic adaptation, or 500ms to considerably reduce adaptation. Each subject was tested in two separate sessions for reactive and voluntary saccades. fMRI measurements coupled with multi-voxel pattern analyses in 6 subjects revealed that saccadic adaptation is related to metabolic activations in the cerebellum and in the parietal and frontal cortices. In addition, this network differed between the reactive and the voluntary saccade adaptation tasks. In conclusion, these data demonstrate for the first time the metabolic activation of cerebellar and cerebral oculomotor centers related to saccadic adaptation in humans.

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Peri-saccadic compression in saccades sequences

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Peri-saccadic compression refers to the mislocalization of stimuli flashed around saccade onset towards the saccade target. Such phenomenon is well-documented from studies in which a small single target elicits a "targeting saccade". Previous studies have shown the existence of another saccade type, namely "exploring saccades". This distinction is based on the action goal (aiming for or exploring an extended object), with the two saccade types programming based on different information, object spatial position for the former and object size for the latter.
Here, we investigate if peri-saccadic compression occurs for successive saccades executed toward: two isolated small targets (2 crosses), two spatially-extended short objects (2 short X-Strings), one spatially-extended long object (1 long X-String). Additional trials with single targets served as control conditions. A vertical bar was flashed for 5 ms around the 1st or the 2nd saccade, at four possible locations so that the bar could be inside or outside the objects and rightward or leftward relatively to the saccade landing position.
Preliminary results show that compression occurs for the 1st and the 2nd saccades in the sequence as for single targeting saccades, whatever the action goal and the spatial structure of the visual stimuli. Recent computational models (e.g. Hamker et al., 2008, Plos Computational Biology, 4:2, 1-15) proposed that signals responsible for the compression effect come from the motor feedback (e.g. corollary discharge) of the upcoming saccade. This would imply that, despite their separate coding, targeting and exploring saccades share the same final common motor pathway.

Lateral interactions influence WHERE but not WHEN the eyes move

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Several models assume that lateral interactions between neurons of the Superior Colliculus determine both when and where the eyes move in two-stimulus visual displays [Trappenberg, Dorris, Munoz & Klein, 2001, Journal of Cognitive Neuroscience, 13(2), 256-271]. When a target is presented with a remote distractor, saccade onset is delayed due to long-distance inhibitory connections, but saccade accuracy remains unaffected. Reversely, when two stimuli are displayed in close proximity, short-distance excitatory connections speed up saccade initiation and deviate the eyes towards an intermediate location between the stimuli (i.e. the Global Effect). The present study was an attempt to estimate the threshold

distance at which the distractor effect on saccade latency supposedly reverses and the global effect disappears. A peripheral target stimulus (singleton) was presented either in isolation or simultaneously with a distractor on the ipsilateral target axis. Both the eccentricity of the distractor and the angular separation between distractor and target were manipulated. Results confirmed a distractor effect on saccade accuracy, but mainly for angular separations less than 5-7° depending on stimulus eccentricity, or short collicular distances. However, the direction and the magnitude of the distractor effect on saccade latency were only slightly affected by distance. Thus, as predicted by the lateral-interaction hypothesis, there is indeed a collicular threshold distance at which the global effect vanishes. However, in contradiction with this assumption, stimulus eccentricity, more than distance, determines saccade latency.

Are letters the correct unit to measure eye behaviour in reading? Testing the effect of character size on the launch site effect

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In reading, saccadic eye-movements are traditionally measured in letter units. This approach is supported by several empirical findings showing that the mean length of saccades, when measured in letters, does not vary as a function of viewing distance and character size. However, it remains undetermined whether the lack of an effect of character size stands at a more fine-grained level of analysis. In the present study, we investigated whether character size influences a robust reading phenomenon, the launch-site effect; this reveals that the eyes land further into a word as the distance of the eyes to the beginning of the word decreases. The eye movements of five participants were recorded while they read lines of words in an animal-name search task. Words were presented in two different font sizes (.2° and .4°); the launch site was varied by manipulating the eccentricity of the first target word (1-9 character spaces). Results showed a stronger launch-site effect for small-printed words; as the launch-site distance became smaller, the eyes tended to land closer to the end of small- compared to large-printed words. This trend was supported by a greater likelihood of skipping small- compared to large-printed words at close launch sites. Inconsistent with classical accounts of the launch site effect, the present findings provide new benchmark data for models of eye-movement control in reading. They also suggest that we may need to reconsider the use of letters as a metric to measure eye behaviour in reading.

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Does a Gabor patch flashed at a saccade start modify the visual exploration of a scene?

Eye-Movements

	Hélène Queste, (Gipsa lab département Images et Signaux, Grenoble, France; email: helene.queste@gipsa-lab.grenoble-inp.fr) *Nathalie Guyader*, (Gipsa lab département Images et Signaux; email: nathalie.guyader@gipsa-lab.grenoble-inp.fr) *Anne Guérin Dugué*, (; email: anne.guerin@gipsa-lab.grenoble-inp.fr) Many studies having examined the kind of visual information perceived during saccades established the well known phenomenon of saccadic suppression, namely the invisibility of targets flashed just before and during a saccade [Diamond et al., 2000, J. of Neurosci., 20(9):3449-3455]. This phenomenon starts before the saccade, is maximal at the saccade start and decreases during the saccade. While these studies have been concerned with artificial scenes, here we examine saccadic suppression during free viewing of natural scenes. 20 observers freely explored 200 natural scene images (40° x 30° of visual angle; control condition) and 16 other observers explored the same scenes with a Gabor patch flashed at the start of their second saccade (test condition). The experimental design was such as to maximize the probability to obtain a second fixation at the center of the scene. When the second saccade was detected, the Gabor patch was flashed in a random location, 4° from the center. The Gabor patch contrast was adjusted according to the local image statistics at the flash location. Preliminary results show that even though observers did not report the presence of the patch (saccadic suppression), their second saccades had shorter amplitudes and smaller curvatures compared to the control experiment, thereby suggesting that saccades computation is based on a signal prior to its processing for conscious vision.	& Perception
32	**The role of vergence in the multisensory construction of the 3D percept in humans** *alexandra séverac cauquil*, (Centre de Recherche Cerveau et Cognition CerCo UMR 5549 CNRS/ Université Paul Sabatier Toulouse, France; email: alexandra.severac-cauquil@cerco.ups-tlse.fr) *Christophe Maggia*, (Centre de Recherche Cerveau et Cognition CerCo UMR 5549 CNRS/ Université Paul Sabatier Toulouse; email: christophe.maggia@cerco.ups-tlse.fr) *Carine Dournes*, (Centre de Recherche Cerveau et Cognition CerCo UMR 5549 CNRS/ Université Paul Sabatier Toulouse; email: dournes.carine@gmail.com) *Simona Celebrini*, (Centre de Recherche Cerveau et Cognition CerCo UMR 5549 CNRS/ Université Paul Sabatier Toulouse; email: simona.celebrini@cerco.ups-tlse.fr) As optical flow in the peripheral field of view changes the assessment of distances (Watanabe et al., 2004, Systems and Computers in Japan, 35(8), 107-116), we studied the contribution of extra-foveal visual motion input to foveal 3D perception. Peripheral motion influenced the foveal 3D	Eye-Movements & Perception

percept: divergent flow improved 3D performance when convergent flow impaired it, or conversely according to subjects' reference frame (Maggia et al, 2009, 3rd Med Conf of Neuroscience. doi 10.3389/conf.neuro. 01.2009.16.112). However, as a fixation point restrained vergence eye movements during the stimuli presentation, we hypothesized that the effect could be even stronger without any fixation point. 10 healthy subjects with normal stereoscopic vision were asked to indicate via a joystick the depth of circular random dot stereograms presented in the centre of a PC monitor while dots scrolled on two, lateral monitors. 3 types of movement were used: convergent, prone to induce backward vection; divergent, prone to induce forward vection, and Brownian, as a control. Binocular eye movements were measured as well as reaction time and success rate. In our conditions, the absence of a fixation point did enhance the effect of optical flow on the central 3D percept (χ^2, p=0.015). More surprisingly, the optic flow induced a vergence movement, but its direction did not depend on the flow direction, i.e. either divergent, convergent or even Brownian flow induced convergence. This suggests that even though vergence participates to 3D percept construction, it is not the direct cause of the peripheral flow effect and deserves further investigation.

The effect of left-right reversal on film: Watching Kurosawa reversed

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The mirror reversal of an image is subtly different from the original image. Often such change goes unnoticed although it can affect aesthetic judgments. For the first time we extended the study of mirror reversal to feature films. People were invited to a cinema for free screenings of Yojimbo (1961) and Sanjuro (1962), both classic films by the renowned Japanese director Akira Kurosawa (1910-1998). Viewers (N=172) knew that this was part of a study and filled out a questionnaire afterwards. One in five had seen the film before and almost half (47%) considered themselves fans of Kurosawa. On one day Yojimbo was shown in its original orientation, on another day the entire film was mirror reversed. The same was done for Sanjuro. With just one exception, none of the viewers noticed the reversal, even when they had seen the film before and considered themselves fans of Kurosawa. In terms of rating of the quality of the film there were higher scores from people who had seen the film before but no overall effect of reversal. However, the question about the quality of the scenography (defined as the use of space, set, costume and lighting) revealed that although people who had seen the film before gave higher ratings, this was only true when the film had not been reversed. Though these findings support an effect of prior exposure in aesthetics, they also suggest that mirror reversal of films may disrupt the exposure effect.

Beauty and the Beholder: The role of spatial structure in visual preference

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Aesthetic appreciation is an area of considerable potential impact and interest, extending to a wide range of natural and everyday objects. Despite a rich set of experimental findings suggesting that certain stimulus qualities, such as symmetry, proportion, or complexity, are related to aesthetic appeal, the exact functional relationship between aesthetic experience and any of these stimulus qualities remains unknown. Motivated by our previous findings that humans display a consistent preference for a certain range of fractal dimension across fractal images of various types (Spehar et al., 2003, Computer & Graphics, 27, 813-820), we turn to visual mechanisms involved in the processing of visual information at different spatial scales to understand this relationship. Our hypothesis is that the preference for certain spatial structures, including fractals, can be partially accounted for by the visual system's general sensitivity for spatial variations at the spatial scales that most closely approximate given spatial structures. In the same group of observers, we measure sensitivity to a range of simple visual patterns (sine-wave gratings varying in spatial frequency and random textures with varying fractal exponent) and find that they are highly correlated with visual preferences for those images exhibited by the same observers. Although we do not offer a comprehensive model of aesthetic experience, we demonstrate a strong relationship between visual preference for simple visual patterns and visual sensitivity. Our results support assertions that there is a close relationship between aesthetic experience and the coding of natural stimuli (Graham and Redies, 2010, Vis Res, 50, 11503-1509).

Visual esthetics

Relative contributions of luminance contrast and emotionality to visual pleasure assessed using conjoint measurement

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Visual esthetics

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Previous studies indicate that emotion can modulate early processing, but also that modulating low-level visual characteristics of an emotional image influences its emotional processing (Biederman et.al , 2006, American Scientist, 94, 247-253;Rey et al. 2010, Psychiatry Research, 176, 155-160). We explored the interaction between pleasure intensity and image contrast using conjoint measurement (Ho et al., 2008, Psych. Science, 19, 196-204). A set of grey-scale images for which the level of pleasurable response (4-point scale) had been pre-determined on a normative sample was used. In a session, an image pair was presented, each with a randomly chosen pleasure level and at one of 4 randomly chosen contrasts. Images were presented for 1.5sec, intercalated between 2sec blank screens of same mean luminance as the images. In a session, the observers judged either which image was of higher contrast or of higher pleasure intensity. Two types of images were used: social scenes (social pleasure) or outdoor scenes (physical pleasure). Judgments were analyzed using Maximum Likelihood Conjoint Measurement. The results show reciprocal effects of pleasure and contrast for physical images, but no effect of contrast on the pleasure of social images. The results support the hypothesis that the pleasure evoked by social images depends on a high-level interpretation of the images and thereby not on contrast, whereas the pleasure of the physical images depends on the physical distribution of contrast in the images, revealing a dependence on low-level contrast coding.

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Characteristics of saccades in the blind visual field of hemianopic patients and implications for blindsight

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Homonymous hemianopia refers to the permanent loss of the visual field

contralateral to a retrochiasmatic (in general occipital) lesion. The present study examined the saccadic eye movements, made by 3 right and 5 left hemianopic and 8 healthy participants, towards visual targets located at different eccentricities (5° and 8°from screen centre), in the left and right fields. In two separate sessions, reactive and voluntary saccades were elicited by gap-0ms and overlap-600ms paradigms. Blank trials were interleaved with target trials to assess the ability to localize visual targets in the blind visual field and to prevent any response bias especially in patients. Results showed that targets in the blind hemifield evoked saccadic responses. Saccade latencies were longer in hemianopic patients than in control participants whatever the conditions. As expected, latencies in healthy controls were longer for voluntary than for reactive saccades. Yet, hemianopic patients did not show this difference, including in their intact ipsilesional visual field for half of them. In spite of that, saccade accuracy measured by gain, was relatively normal in both fields of patients. Here we provide further evidence that some visual information from the blind hemifield may still be processed in brain damaged patients with hemianopia. Such residual visual ability (blindsight) seems to allow target selection in the blind hemifield and saccade execution towards it. Temporal and decisional aspects of saccades seem more altered than spatial and motor selection in patients with retrochiasmatic lesions. Theoretical implications are discussed in regard to the underlying pathways in saccade generation.

Postural control in children with strabismus: effect of eye surgery

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We assessed the postural control in children with strabismus before and after eye surgery. Control of posture is a complex multi-sensorial performance based on visual, vestibular and proprioceptive systems. Reduced influence of one of such systems leads to postural adaptation due to a compensation of one of the other systems (Brandt, 2003).
Ten children with strabismus (4-9 years old) participated to the study. Ophthalmologic, orthoptic, vestibular and postural tests were done before and two weeks after eye surgery. Postural stability was assessed with a force platform in two conditions: eyes open and eyes closed. Two components of the optic flow were used for stimulation (contraction and expansion). The surface area of the centre of pressure (CoP), the variance of speed and the frequency spectrum of the platform oscillations were analysed via a fast Fourier transform.
Before surgery, similarly to normal children, the surface area and the variance of the speed of the CoP were smaller in the eyes open condition. The frequency analysis revealed more energy in the low-frequency band in the antero-posterior direction compared to the medio-lateral one, while the opposite occurred for the middle and the high-frequency bands. After surgery, the eye deviation was reduced significantly for all children; furthermore, the surface of the CoP increased significantly while the energy of the middle-frequency band was reduced significantly. These findings suggest that eye surgery influences somatosensory properties of extra-ocular muscles leading to poor postural control and that binocular visual perception could influence the whole body posture.

The occipital cortex in detection and categorization abilities: an fMRI study in hemianopia

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Previous studies have shown that the right and left hemispheres are predominant for detection and categorization tasks, respectively. This asymmetry appears to be instantiated at a processing stage as early as the occipital cortex. The present study was intended to assess the cerebral network responsible for natural scenes perception in hemianopic patients suffering from an occipital cortex lesion.
One Left and one Right hemianopic patient (LH or RH; respectively right and left occipital damage) were compared with 14 healthy controls in detection and categorisation tasks of natural scenes. Both tasks were performed in a 1.5T scanner to collect anatomical and functional data. In healthy controls, occipital activation was observed in the extra-striate areas of both hemispheres in the detection task but only of the left hemisphere in the categorization task. The LH (patient showed a bilateral occipital activation in both tasks. while, the RH patient showed unilateral right (intact) occipital activation in both tasks. These results highlight the importance of the perceptual task (detection vs. categorization) on the hemispheric asymmetry. They also suggest that different cortical reorganisations take place depending on the occipital lesion side.

'Welcome to the Tiger Spotting Game!': A psychophysical study of visual processing in Autism Spectrum Disorders

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Study of visual processing in Autism Spectrum Disorders (ASD) has produced a mixed picture, ranging from reports of strengths in simple visual search and local processing (Shah and Frith, 1983, Journal of Child Psychology and Psychiatry, 24, 613-620) to impairments of perceptual learning (Plaisted at el, 1998, Journal of Child Psychology and Psychiatry, 39, 765-775). While potentially valuable in helping determine the extent to which difficulties with face processing in ASD may be traceable to fundamental abnormalities of the visual system, it is difficult nevertheless to draw general conclusions as methodologies, stimuli and tasks vary greatly across studies. The Tiger Spotting Game is a novel computer game designed to use a single engaging game format to assess different levels of visual processing, whilst allowing systematic psychophysical measurement at different visual processing levels: from detecting the onset of a tiger stimulus to more cognitively demanding discrimination tasks requiring participants to identify the larger and faster of two tigers. Participants were 12 ASD and 12 typically developing age-matched controls, aged 11-12 years. ASD children were significantly slower to stop the faster of two 'looming' tigers compared to controls, while both clinical

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and control groups were comparable in a static size discrimination task using the same stimuli. The selective deficit is explicable in terms of aspects of executive control, including visual attention switching, and the study contributes to a small but growing body of research suggesting that autistic symptomatology can be traced in part to fundamental impairments of perceptual processing.

Dissociating implicit and explicit temporal event-coding in patients with schizophrenia

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A disturbance in the sense of time continuity has been reported in patients with schizophrenia. We used a simultaneity/asynchrony discrimination task to explore temporal event-coding in patients with schizophrenia and matched controls. In these tasks, two squares are presented left and right from the centre of the screen and subjects decide if squares appear simultaneously or asynchronously. Patients have a difficulty to consciously detect an asynchrony between stimuli, which can be dissociated from a bias effect (Giersch et al., 2009, Schizophrenia Bulletin, 35, 816-25). Despite this, we showed that patients' manual responses were biased to the side of the first square at very short SOAs that yield 'simultaneous' responses. In contrast, the responses of controls were biased to the side of the second square. These results suggest excessive fragmentation rather than fusion of events (Lalanne et al., in press, Schizophrenia Bulletin, doi: 10.1093/schbul/sbq107). Most recently, we dissociated fragmentation in time and in space by contrasting (1) divided vs focused attention (4 vs 2 locations for the target squares), and connected vs unconnected stimuli (squares). We replicated previous results with the responses of patients and controls being biased in opposite ways to the side of the first or second square. The bias to the side of the first appearing square in patients was most marked when the two squares were connected, i.e. when spatial difficulties were minimized. The results suggest that exploring time event coding in patients with schizophrenia could help to dissociating implicit and explicit time-specific mechanisms.

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Blur and Visual Discomfort

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Certain manipulations of the amplitude spectrum of images, such as changing the slope exponent (Juricevic et al, 2010, Journal of Vision, 10, (7), 405), or adding excess energy at different spatial frequencies

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(Fernandez and Wilkins, 2008), can result in visual discomfort. The manipulations that cause visual discomfort tend to increase the perceived blur of images (Webster et al, 2002, Nature Neuroscience, 5, (9), 839-840, Tolhurst and Tadmor, 1997, Vision Research, 37, (23), 3203-3215). Since visual discomfort is associated with difficulties in accommodation (Chase et al, 2009, Optometry and Vision Science, 86, (7), 883-889), it is plausible that perceived blur contributes to visual discomfort. Perceived blur could also arise from neural blurring, which might be indicative of inefficient processing. Inefficient coding could possibly lead to excessive metabolic expenditure, which has been suggested as a cause for visual discomfort (Juricevic et al, 2010, Journal of Vision, 10, (7), 405). The experiment investigated the relationship between visual discomfort and blur by manipulating the luminance profile of simple stimuli. The sharpness of edges in circular squarewave gratings was manipulated by either removing the higher-spatial-frequency harmonics, or by varying the relative phase of the components. The overall fundamental frequency was also manipulated. Both the presence of higher spatial frequencies, and phase information are known to affect perceived blur (Murray and Bex, 2010, Front. Psychology, 1:185). Results show that both increasing spatial frequency and increasing blur tend to entail an increase in estimated discomfort.

Real-time Video Mosaicking using Feature Point Correspondance

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We investigate the problem of real-time video mosaicking where the driving demand is to improve overall situational awareness of the viewer who is embodied within an environment via remote tele-presence using a real-time video mosaic - i.e. a panoramic image constructed in real-time from the incoming video frames captured from a remote vehicle/camera. Specifically, in this work we use a feature point based image alignment by combining a state of the art feature point detector (Bay et al., CVIU, 110(3):346-359, 2008) and a robust statistical selection methodology (Fischler/Bolles, Comms. ACM, 24(6):381-395, 1981). Image alignment is then performed by on-line bundle adjustment supported by hardware accelerated visualization with quality enhancements and explicit task parallelism on modern CPU hardware. The video mosaic output is constructed solely from the input video frames with no additional camera position information. Real-time performance is further supported by novel developments in the use of specific frame sieve in order to avoid high data redundancy which is associated with temporally dense input video frames having significant spatial overlap. An evaluation of our approach is presented to illustrate overall robustness in video mosaic construction under a diverse range of conditions including varying illumination and presence of motion within the scene.

Technical, Image processing, Computer vision

Looking, finding, and data in the eye

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As we move towards a model of human vision that can have practical applications for natural scene searching, for example during search and rescue or defence scenarios, the focus has been on how to extract feature information out of a scene; but in engineering, there has always been as much work on the camera as on the image processing software. As an integral and ultimately most important part of the visual system, the biological construction of the eye is sometimes overlooked in favour of mathematically efficient alternatives. I intend to show how replicating the behaviour of the eye more closely can have benefits for the processing capability of computer models, as well as empirical data to show an improvement in the correspondence of these models of saccadic search compared to human visual search patterns, by means of a saccade matching algorithm for a series of present/absent natural scene search tasks.

Technical, Image processing, Computer vision

Duration compression at low luminance contrast

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Apparent duration compression following temporal frequency adaptation disappears at isoluminance (Ayhan et al, 2010, VSS). However, this may be explained by the reduced visibility of isoluminant chromatic pattern. We therefore investigated duration compression at low luminance contrast. We first found the contrast threshold for 75% correct direction discrimination for chromatic stimuli defined along the equiluminant S-constant axis of the DKL space (Derrington et al, 1984, J Physiol, 357, 241-265) and, in addition, the threshold contrast for a chromatic stimulus with an additional luminance modulation. We matched the visibility of these two stimuli by presenting them at the same multiple of threshold contrast. The effect of adaptation on the perceived speed (of a 7 Hz test) was eliminated by interleaving high (20Hz) and low (5Hz) adaptors. In the duration experiment, the standard grating (600ms, 0.5cpd) was always displayed at the adapted location (either 5° above or 5° below fixation) and the comparison (0.5cpd), presented at the unadapted side, was varied over trials to generate a psychometric function. The PSE provided a measure of perceived duration. We found duration compression compared to baseline conditions for low contrast luminance variation matched to the isoluminance conditions, indicating compression can occur with low contrast adaptors and test patterns. In a second experiment, we also measured the effect of background chromaticity on duration and found that at isoluminance, duration compression is recovered for orange and green backgrounds reported to induce a luminance response to dynamic isoluminant stimuli (Smith et al, 1992, J Physiol, 458, 191-221).