

Body proportion as a cue for the perception of human stature

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ABSTRACTS

◆ **How the brain makes the world appear stable**

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All visual information arrives in the brain through the retinas, whose images are displaced with each eye movement, yet we perceive a stable visual world. How does the brain accomplish the stabilisation? Information about eye position comes from efference copy (a copy of the innervation to the muscles that move the eye) and from proprioception (in those muscles). Together these extraretinal signals indicate the position of the eye. By pressing on the eyelid of a viewing eye, the extraocular muscles can be activated to maintain a steady gaze position without rotation of the eye. This procedure decouples efference copy from gaze position, making it possible to measure the gain of the extraretinal signals. The gain is less than 1, leading to the conclusion that humans underestimate the deviations of their own eyes and that extraretinal signals cannot be the mechanisms underlying the perception that the world remains stable despite eye movements. The under-registration of eye deviation accounts quantitatively for a previously unexplained illusion of visual direction. Extraretinal signals are used in static conditions, especially for controlling motor behaviour. The role of extraretinal signals during a saccade, if any, is not to compensate the previous retinal position but to destroy it. Then perception can begin with a clean slate during the next fixation interval. Newer theories account for space constancy with current information only, not compensating for the effects of eye movements.

◆ **ScanMatch: A novel method for comparing saccade sequences**

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A significant challenge in eye-movement research is to quantitatively compare different sequences of eye movements. In such a comparison fixation location, fixation duration and fixation order are all important dimensions in determining how similar two sequences of eye movements are. Previous methods of comparing sequences of eye movements have tended to focus exclusively on one or other of these dimensions. We present a novel approach to compare saccade sequences based on a global DNA alignment method (Needleman–Wunsch algorithm). In the proposed method, the saccade sequence is spatially and temporally binning to create a chain of letters. This allows us to take into account not only the locations of the fixations, but also the fixation time and order. The comparison of two saccade sequences is made by maximising the similarity score computed from a substitution matrix (providing the score for a letter-pair substitution) and a penalty gap. The substitution matrix provides a meaningful link between each region of interest. This link could be distance, but could also be encoded in any dimension including perceptual or semantic space. We show, by using synthetic and behavioural data, the benefits of this method over other existing methods.

◆ **The influence of scene-viewing task on facilitation and inhibition of return**

- 3 Tim Smith (School of Psychology, University of Edinburgh; e-mail: tim.smith@ed.ac.uk)

Inhibition of return (IOR) is a difficulty in returning attention to recently attended locations and is widely believed to affect the probability of returning gaze in all tasks requiring serial inspection of a scene (Klein and MacInnes, 1999 *Psychological Science* **10** 346–352). However, a recent study has suggested that IOR may only delay return saccades when a scene is searched, not memorised or judged for preference (Dodd et al, 2009 *Psychological Science* **20** 333–339). In the present study we investigated whether the delay experienced by return saccades (temporal IOR) and the probability of returning to the previous and penultimate fixation locations (1-back and 2-back; spatial IOR) changed with viewing task: scene memorisation, preference judgment, and object search. Analysis of fixation durations indicated that temporal IOR is present across

all tasks but only affects saccades to the 1-back location, confirming our previous results (Smith and Henderson, 2009 *Visual Cognition* 17 1083–1108). IOR did not affect the likelihood of return saccades (spatial IOR) which occur as often as forward saccades in memorisation and preference and more often during search. Our results indicate that temporal IOR is independent of task but does not affect the probability of return. During all scene viewing tasks, the probability of returning gaze to a recently attended location is greater than at control locations, suggesting that facilitation of return may characterise the distribution of gaze during scene viewing better than IOR.

◆ **Statistical learning facilitates effective gaze allocation**

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Inhibition of (saccadic) return is often considered adaptive through implicit appeal to the temporal statistics of the visual world. Previous work has shown that in sequences of saccadic eye movements the inhibitory effect is highly flexible, and adjusts to the likelihood of return locations becoming behaviourally relevant. We examined how observers learn and keep track of these statistics. We distinguish two learning mechanisms: a local mechanism that keeps track of recent instances to prime current behaviour and a contextual mechanism that associates certain features of the environment with its statistical properties. Participants generated sequences of two saccades and we varied the probability that the second saccade was directed back to the previously fixated location from low (0.17) to high (0.50). In some conditions, the contingency was signalled by a contextual cue (the shape of the saccade trigger). Learning occurred in the absence of contextual signals, but also occurred when the different contingencies were randomly intermixed so that a local, sequential mechanism cannot be responsible for adaptation. The mapping between cues and statistics is acquired rapidly. We suggest that contextual cues are used to generate hypotheses about the statistical properties of the temporally local environment. Our results indicate that a context-selective tracking mechanism provides the data to test these hypotheses.

◆ **Yarbus and eye movement research**

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Yarbus's classic monograph, translated into English as *Eye Movements and Vision* in 1967, has profoundly influenced the direction of eye-movement research. Interest in his book has been rather different from that which Yarbus may himself have predicted. The emphasis in the book was very much placed upon stabilised retinal images and technical solutions for achieving and studying this. However, it is the later chapters of the book, concerning cognitive influences on scanning patterns, that have provided the lasting legacy of Yarbus's work. Despite Yarbus being amongst the most cited eye-movement researchers, the published material in English concerning Yarbus's life is scant. We present some new details about Yarbus's life and the impact of his research on contemporary approaches in the field. We also present findings from a study in which participants were asked to view a portrait of Yarbus under different instruction conditions. This homage to Yarbus broadly supports the results reported in the final chapter of *Eye Movements and Vision*.

◆ **Human monochromatic light discrimination explained by optimal signal decoding**

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Why does the minimum wavelength difference for humans to discriminate two monochromatic inputs (which could differ in input intensity) depend on the wavelength in a particular way, dipping near wavelengths 490 and 590 nm but rising steeply beyond 630 nm (Pokorny and Smith, 1970 *Journal of the Optical Society of America* 69 562–569)? We propose a computational explanation by maximum-likelihood decoding of the light's colour from the cone absorptions. The wavelength tuning curves of the three cone types reflect their average absorptions for any monochromatic input. However, owing to Poisson noise in the cones, the actual absorptions will deviate stochastically from the respective averages. The brain could decode the best estimates of the input wavelength and intensity responsible, and the noise-induced uncertainty about these estimates. Computationally [Dayan and Abbott, 2001 *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems* (Cambridge, MA: MIT Press)], these best estimates and their

uncertainties correspond to the peak location and the spread, in the input wavelength and intensity, of the conditional probability of the absorptions for the input. Experimentally, peak and spread should correspond to the perceived monochromatic input and the input discrimination threshold. We apply the computational decoding scheme to a wavelength discrimination procedure when subjects adjust the input wavelength and intensity of a comparison input field to match a standard monochromatic input field, and find a good agreement between the computationally predicted and experimentally observed wavelength discrimination thresholds as a function of the wavelength. Our findings suggest that retinal and cortical processes for colour decoding are optimal.

◆ **Binocular integration in human vision adapts quickly to maximize coding efficiency**

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The two eyes typically receive correlated inputs, from which one can derive the two decorrelated input channels: binocular summation, S+, and binocular difference, S-. S+ has greater power than S- in natural scenes, and the opposite occurs when the inputs to the two eyes are anticorrelated. To represent the input most efficiently, ie to maximise the information transmitted for a given energy budget, the visual system gives a higher gain to the weaker of the two decorrelated channels when the signal-to-noise ratio (SNR) is high [eg at low spatial frequencies (SFs), due to the 1/f spectrum], and gives a lower gain to the weaker channel when the SNR is low (eg at high SFs) to minimise energy wasted in transmitting noise (Li and Atick, 1994 *Network* 5 157–174). The gains are predicted to adapt to the interocular correlation. We assessed the relative gains to S+ and S- channels from observers' motion direction judgments using a cyclopean motion stimulus (Shadlen and Carney, 1986 *Science* 232 95–97; Hayashi et al, 2007 *Journal of Vision* 7(8):7, 1–10) in which the S+ signal had motion in the opposite direction to both S- and the monocular signals. As predicted, at low SFs, the ratio of S+ to S- gain was lower after adapting observers to positive ocular correlations (when both eyes saw identical natural images) than after adapting to anticorrelated ocular inputs (when one eye saw the photonegative of the other eye's input). The opposite occurred for high SFs. Adaptation occurred within a few seconds.

◆ **Difference between target and background luminance determines the rule for binocular combination**

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Binocular combination of luminance can be investigated by matching binocularly unequal target stimuli to binocularly equal standards. Such experiments typically produce quasi-linear equibrightness contours, which fold back at the extremes owing to Fechner's paradox (Levelt, 1965 *British Journal of Psychology* 56 1–13). For decrements against a bright background, however, Anstis and Ho (1998 *Vision Research* 38 523–539) reported highly nonlinear functions which imply a winner-take-all rule. Are these very different findings due to the sign of the contrast, the luminance of the target, the luminance of the background, or all three? We performed binocular matching experiments for increments on a black background ($< 0.01 \text{ cd m}^{-2}$), and either increments, decrements, or both (a light-dark edge) against a grey background ($\sim 10 \text{ cd m}^{-2}$). Stimuli were uniform or bipartite discs (diameter 1 deg) or a Gabor patch (1 cycle deg^{-1}), and matches were obtained by measuring the point of subjective equality with a 2IFC staircase procedure. Results showed that grey backgrounds were associated with nonlinear combination across eyes, which was particularly severe (close to winner-take-all) for high-contrast decrements, consistent with Anstis and Ho (1998). For increments on a black background, combination was nonlinear at low target luminances ($\leq 2 \text{ cd m}^{-2}$) but became increasingly linear towards higher luminances ($> 2 \text{ cd m}^{-2}$). Fitting a generic model of binocular combination reveals that the exponent governing summation is inversely related to the (signed) difference between the luminance of the target and that of the background.

◆ **Is visual search a high-level phenomenon? Evidence from structure perception in 3-D scatterplots**

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Increasing use of 3-D scatterplots for trend detection in visual analytics, raises the theoretical question: what constitutes an object in such a task? Previously (Shovman et al, 2008 *Perception* 37 79–80) we have shown that detection of a 3-D position of a single outlier point exhibits characteristics of serial visual search. According to feature integration theory (FIT) (Treisman and Gelade, 1980 *Cognitive Psychology* 12 97–136) that implies that every point is a complex perceptual object, and therefore detection of trends or patterns in a scatterplot will take longer

with increasing number of constituent points. Conversely, according to reverse hierarchy theory (RHT) (Hochstein and Ahissar, 2002 *Neuron* **36** 791–804) the object is the highest-level task-relevant arrangement of points. Therefore, RHT predicts that trend detection will take longer with more point groups. Participants identified (2–4AFC task) a group of points whose positioning exhibited a 3-D structure when actively rotated. Number of points per group (64, 100, 144, 196, 256) and the number of groups (2, 3, or 4) were manipulated independently. The dependent variable was the scene rotation duration, ie the time when the 3-D structure was potentially visible. Rotation times increased with number of point groups and decreased with number of points per group. This is consistent with RHT and contradicts FIT. In conjunction with previous experiments (Shovman et al, 2009 *IEEE Proceedings of International Conference Information Visualisation* pp 135–138), these data support connecting processes of visual search to task-relevant, high-level semantics of a scene rather than to its low-level visual features.

◆ **Pioneers of eye-movement research**

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Recent advances in the technology affording eye-movement recordings carry the risk of neglecting past achievements. Without this modern armoury, great strides were made in describing the ways the eyes move. Emphasis was initially placed on abnormalities of function (like strabismus) before normal features were considered. Thus, for Aristotle the fundamental features of eye movements were binocular and he described the combined functions of the eyes. This was later given support using simple procedures like placing a finger over the eyelid of the closed eye and culminated in Hering's principle of equal innervation. However, the overriding concern in the 19th century was with eye position rather than eye movements. Appreciating discontinuities of eye movements arose from studies of vertigo, particularly when generated by body rotation. Detailed experiments were conducted from the late 18th century that resulted, a century later, in examining discontinuous eye movements over scenes and when reading. The characteristics of nystagmus were recorded before those of saccades and fixations. Eye movements during reading were described by Hering and by Lamare in 1879; both used similar techniques of listening (with tubes placed over the eye lids) to the sounds made during contractions of the extraocular muscles. Photographic records of eye movements during reading were made by Dodge early in the 20th century; this stimulated research with a wider array of patterns. In mid-century attention shifted to the stability of the eyes during fixation, with the emphasis on involuntary movements. Yarbus developed a contact-lens device for stabilising images on the retina, but it is his work on cognitive components of oculomotor behaviour that now attracts interest. The contributions of pioneers of eye movement research from Aristotle to Yarbus are outlined.

◆ **Evidence that indirect inhibition of saccade initiation improves saccade accuracy**

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Saccade selection is the result of a competition between potential targets in our visual environment. When a target and distractor are close together then they compete to become the saccade target and the resulting movement lands between them. The addition of another distractor, farther away (a 'remote' distractor—RD) from this local target/distractor competition, increases the saccade latency and improves its accuracy. The accuracy benefit comes from accessing the target competition at a later, more developed, stage but it is unclear how this comes about. One explanation is that the RD slows saccade latency by directly competing with the other stimuli to become the target. This increase in competition improves final target localisation (a direct route). An alternative explanation is that the RD does not compete to become the target, but impairs the ability to disengage from fixation, thereby increasing saccade latency and improving accuracy (an indirect route). These explanations give different predictions about how the saccade competition develops. The direct route predicts that the addition of a RD impacts on the development of the saccade competition, while the indirect route predicts no change. To examine this, we measured saccade responses made to a target and local distractor compared with those made to the same stimuli with an additional RD. We found that the presence of the RD did not change the pattern of accuracy improvement, suggesting that the RD acts along the indirect route, promoting greater accuracy through accessing saccade competition later, when it is better developed.

- ◆ **The reduction of the effect of the Müller-Lyer illusion on saccade amplitude by classic adaptation**
 12 Paul Knox (Directorate of Orthoptics and Vision Science, University of Liverpool; e-mail: pcknox@liverpool.ac.uk)

The effect of Müller-Lyer stimuli on saccade amplitude varies across studies. With long stimulus presentation times, however, illusion effects might be counteracted by saccade amplitude adaptation. To investigate this, five adult subjects were exposed to 20 pre-adaptation saccade tasks (leftward and rightward point targets), followed by 5 blocks of 20 adaptation trials, in which the same leftward or rightward 'in' ($><$) or 'out' ($<>$) Müller-Lyer configuration was presented for 1 s after a variable fixation time, central vertex at fixation, eccentric vertex at 6° . Interblock probe trials (3 left, 3 right) consisted of point targets presented for 200 ms. Eye movements were recorded with infrared oculography. Primary saccade amplitude was measured offline for trials in which amplitude was $\geq 3^\circ$, and latency was >50 ms. Saccade amplitude was consistently larger to 'in' than 'out' configurations in the first adapting block. Effect size ('in' amp - 'out' amp / 'out' amp), collapsed across subjects and directions, was 10.3% for the first adapting block, reducing to 5.8% in the final block. Probe trial saccade amplitude increased in 'out' runs and decreased in 'in' runs. These effects were not present in a control experiment, in which stimulus display time was 200 ms. These results show that, with long target presentation times, the effects of Müller-Lyer stimuli may be adapted out, leading to an underestimate of the effect of this type of stimulus on saccade amplitude.

- ◆ **Body proportion as a cue for the perception of human stature**

13 George Mather (Sussex University, Brighton; e-mail: g.mather@sussex.ac.uk)
 Stature matters in sexual behaviour, even for humans, but what visual cues mediate stature judgments? Perceptual depth cues are of limited utility. Does internal body proportion offer a cue to stature? Cue validity was assessed by analysing normative data on human proportions in a large sample of 4789 males. The ratio of head height to body height (head:body ratio, HBR) was found to be highly correlated with stature ($r = -0.47$), offering a reliable (though not perfect) cue to human stature. A psychophysical experiment assessed whether humans actually use HBR as a cue to stature. Full-figure photographs of four males (all in their early twenties) were manipulated digitally to create three versions of each figure, depicting HBRs of 0.11, 0.13, and 0.15. Ten naive participants were shown all possible 54 pairs of the manipulated photographs, and asked to select the taller of the two. They reliably selected the figure with the smaller HBR as taller ($F_{2,18} = 55.7$; $p < 0.001$). Many classical statues depart from the ideal proportions defined in Leonardo's *Vitruvian Man* (eg Michelangelo's *David*). A second experiment with eighteen participants assessed whether height judgments in statues depend on HBR. Participants were asked: 'If these statues were real people, who would be taller?' Perceived stature depended on HBR. Calculations based on the normative data indicate that Michelangelo's *David* was created with the HBR of a man 165.3 cm tall. Thus, HBR is a valid and reliable cue to stature that may also have been exploited by classical sculptors.

- ◆ **Loss of contrast sensitivity at 4 cycles deg^{-1} depends on eccentricity and meridian but not grating orientation for the central 9 deg of the visual field**

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Surprisingly, there has been no detailed study of the relation between contrast sensitivity and stimulus orientation across the central visual field. Here we measured contrast detection thresholds for cosine-phase log-Gabor stimuli with a spatial frequency of 4 cycles deg^{-1} , duration of 100 ms and bandwidths of 1.6 octaves and 25 deg. There were 4 meridians (-45° , 0° , 45° , 90°), 4 stimulus orientations (-45° , 0° , 45° , 90°) and 4 eccentricities (0° , $\pm 1.5^\circ$, $\pm 3^\circ$, and $\pm 4.5^\circ$), giving a total of 100 conditions in a randomised blocked design. To reduce extrinsic uncertainty, a low contrast ring (diameter of 0.75 deg) was presented continuously at the appropriate position in the visual field, where it surrounded the stimulus. A similar ring in the centre of the display aided fixation. We found no evidence for the meridional resolution effect of Rovamo et al (1982 *Investigative Ophthalmology & Visual Science* 23 666-670) or the oblique effect. For two observers, ASB and DHB, the loss of sensitivity with eccentricity averaged 0.6 and 0.82 dB per cycle, respectively; a little more severe than previous reports. In general, sensitivity declined less rapidly for the horizontal meridian than for the vertical meridian for each stimulus orientation. The sensitivity functions were slightly concave on log-linear axes and preliminary analysis attributed the anisotropy to the initial slopes of bi-linear fits—the second parts of the slopes being fairly uniform. These results will help to constrain the interpretation of previous and future studies addressing the details of spatial integration of contrast in the central visual field.

◆ **Leg length and attractiveness in simplified stimuli (stick figures)**

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There are many examples of reference to female legs as a factor in sexual attraction. It is not surprising, therefore, that both males and females perceive female figures as more attractive as leg length increases, in proportion to torso or stature, and perhaps the opposite should be true for male figures. This was reported by Swami et al (2006 *Body Image* 3 317–323) but confirmed only for females by Sorokowski and Pawlowski (2008 *Evolution and Human Behavior* 29 86–91). Both evolutionary and cultural factors can play a role in the effect, such as the emphasis on longer legs in images of attractive women. To isolate leg length from other factors we conducted three studies using an extremely simplified type of stimulus: stick figures. Results with three different methodologies (a forced choice, a rating, and a production task) confirm a role for leg length in attractiveness judgments for females (as judged by both males and females), modulated also by level of estimated self-attractiveness. Independent of the issue of leg length, and equally important, is the demonstration that stick figures can serve as a novel and useful tool in the study of attractiveness. Their extreme simplicity is both their limitation and their strength. With extremely simplified stimuli the variables of interest are more clearly isolated, and the complexity of the large number of secondary sex characteristics could be effectively eliminated. In addition, novel tasks can be used: for instance participants can be asked to draw stick figures themselves.

◆ **The surprise advantage: Surprise events trigger increased detection of changes unrelated to the surprise**

16 Rob Child, Marco Bertamini§ (Department of Social and Psychological Sciences, Edge Hill University, Liverpool; e-mail: robert.child@liverpool.ac.uk; § School of Psychology, University of Liverpool; e-mail: m.bertamini@liverpool.ac.uk)

When people watch a dynamic event, they can fail to detect large changes. We asked the question of how the detection of one change would affect the detection of a secondary change. The idea of redirection would predict that changes far from the surprising event would be less likely to be reported, but the opposite prediction follows from the idea that a departure from what is expected increases attention to the whole event. In three studies, participants watched a video clip of a card game in which they were asked to follow one card (Queen) in a set of three (Jack, Queen, King). The movement of the cards was simple so that every observer could identify the correct location. The Queen was then revealed in either the correct (and therefore expected) location for one group or in the unexpected location for another group. In experiment 1 ($N = 120$) a feature was changed in the target card (Queen). In experiment 2 ($N = 180$) a feature was changed in a card peripheral to the task (Jack). Results show that detection rates were significantly higher when the Queen appeared in the unexpected location, and this was true for both the changes to the Queen and to the Jack. In experiment 3 ($N = 90$), this 'surprise' advantage extended to cases where more than one change was present, namely when both Queen and Jack changed suit.

◆ **The influence of attention on the negative compatibility effect**

17 Geoff Cole, Gustav Kuhn§ (Centre for Brain Science, Department of Psychology, University of Essex; e-mail: ggcole@essex.ac.uk; § Department of Psychology, Brunel University, Uxbridge; e-mail: gustav.kuhn@brunel.ac.uk)

Response time to determine the left–right orientation of an arrow is relatively slow if a subliminal prime is also an arrow whose direction corresponds with that of the target (Eimer and Schlaghecken, 1998 *Journal of Experimental Psychology: Human Perception and Performance* 24 1737–1747). When the direction of the arrow is opposite to that of the prime, response times are relatively fast. A number of explanations for this 'negative compatibility effect' have been posited, including accounts based on masking and inhibition. We examined the phenomenon and provide evidence that a shift in attention can create a negative compatibility-like effect. Observers responded to targets that were presented either at a location to which the prime points or in the opposite hemifield. Results revealed that the prime shifts attention to the corresponding location. The consequence of this attention movement is that the representation of direction is affected, resulting in shorter reaction times to process an arrow if the arrow's direction is compatible with the last shift of attention. Furthermore, this interference occurs at a conceptual level concerning the representation of left and right rather than at the motor planning level. We discuss these findings in the context of theories that argue for shared representations of perception and action.

◆ **Contextual modulation in face recognition**

18 Fatima Felisberti (Psychology Unit, Faculty of Art and Social Sciences, Kingston University, London; e-mail: f.felisberti@kingston.ac.uk)

Early studies showed that face recognition is susceptible to biases, but results were controversial, pointing to memory biases for faces of both cheaters and cooperators. Here, six studies involving 299 participants (204 females; 18–48 years old) reported how behavioural descriptions tagged to photographs of Caucasian faces with neutral expressions ($N = 36$; XMT2VS database) during memorisation affected recognition. A new vs old recognition task was used in three different scenarios (financial, friendship, and mixed). Each scenario contained three categories of behaviour (prosocial, antisocial, and neutral). In a financial scenario (studies 1–4) there was a recognition bias towards prosocial faces presented either individually or within a crowd of faces. This bias could be dampened if participants were explicitly asked to consider the importance of recognising cooperators and cheaters or if tags explicitly referred to such reputations. In the mixed scenario describing a wide range of prosocial (eg donated £10 000 to charity), antisocial (eg drove whilst disqualified), or neutral (eg likes shopping and swimming) behaviours, recognition of anti-social and prosocial faces was similar but significantly better than of neutral faces (study 5). Study 6 involved a friendship scenario and different occupations (27 students, 14 nurses, and 18 store assistants). Students were more accurate recognising prosocial faces than nurses and shop assistants, who showed a bias towards antisocial faces. Results indicate that face recognition biases are strongly affected by the social context during encoding and by the participant's working environment. They also highlight how face recognition biases may aid cooperative decision-making.

◆ **Convex and concave parts in visual short-term memory**

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Visual short-term memory is believed to be capacity-limited. The limit is approximately four units (Cowan, 2001 *Behavioral and Brain Sciences* **24** 87–114). Sakai and Inui (2002 *Perception* **31** 579–590) concluded that the same capacity limitation applies to convex parts (ie convex segments of a closed contour), but they did not test concave segments. Our stimuli were snake-like with a main vertical orientation. The segments on the left and on the right could vary in shape, and the task was to compare two stimuli before and after a 1000 ms retention interval. In the baseline condition the contour was in isolation. In the convex and concave conditions the closure of the contour made the features either convex (on the outside) or concave (on the inside). In experiment 1, conditions were randomly interleaved. This led to a trend for better performance (higher d' values) when the features were inside the object (concave features). A possible explanation for these results is an attentional shift towards the inside of a closed shape when the observer is unsure about target location. To control for this, left and right positions were not interleaved in experiment 2, ie the features to be tested were in a predictable location. In experiment 2 we found no difference between convex and concave conditions, but an advantage for closed contours over the baseline condition. We conclude that coding of features as convex or concave parts of an object improves performance, but without a difference between the two.

◆ **The effects of stimulus onsets and offsets on the global and the remote distractor effect**

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It is well known that an abrupt stimulus onset presented close to a saccade target can modulate saccade amplitude ('global effect'; Findlay, 1982 *Vision Research* **22** 1033–1045) while those remote from the target increase latency ('remote distractor effect'; Walker et al, 1997 *Journal of Neurophysiology* **78** 1108–1119). These effects are consistent with competitive processes operating in populations of neurons that encode potential saccade targets. It is also known that stimulus onsets at central fixation increase latency, while offsets reduce latency ('gap effect'; Saslow, 1967 *Journal of the Optical Society of America* **57** 1024–1029). The influence of visual offsets, remote from central fixation, is, however, less clear. Here we compare the effects of task-irrelevant stimulus onsets and offsets on saccade latency and amplitude. Participants were required to make saccades to a visual target while elsewhere in the display a distractor onset or offset occurred. An increase in latency was found for remote distractor onsets. Saccade amplitude was affected by stimuli appearing near the target. No such effects were found for distractors that were offset at the time of target appearance, which suggests that offsets at fixation influence saccade programming differently from offsets remote from fixation. Distractors presented long before the onset of the target also had no influence on either latency or amplitude. These results confirm the unique role of onsets in capturing the eyes.

◆ **Dichoptic direct-tilt aftereffects are lowpass functions of the adaptor temporal frequency**

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The perceived orientation of a 1-D test pattern can be distorted following adaptation to a tilted 1-D signal. The extent of the interocular transfer of this phenomenon (the tilt aftereffect, TAE) is examined as a function of the temporal frequency (TF) of the test and adapting signals under both dichoptic and monoptic test conditions. Subjects were adapted to 60% contrast 2.0 cycles deg⁻¹ sinusoidal gratings oriented 15° counterclockwise from vertical. Only the dominant eye's view was adapted. Test stimuli were also sinusoidal gratings whose contrast was fixed at 30%, and were presented randomly to either the adapted or the unadapted eye. The TFs of the adaptor and test patterns ranged between 0 and 25 Hz. The luminance of the monitor was also varied across experiments (40–400 cd m⁻²). Subjects reported whether the test grating was oriented clockwise or counterclockwise from vertical. A direct TAE was measured monoptically for all adaptor TFs and found to increase with the temporal frequency of the test signals. In the dichoptic conditions, TAEs were found to be lowpass functions of the adaptor TF. Our results suggest that the adaptor TF at which the TAE ceases to transfer may depend on the luminance.

◆ **Shadow processing in ageing and Alzheimer's disease**

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Participants show differences in processing speed between shadow-like image regions and equivalent regions which are not perceived as shadow-like (eg Rensink and Cavanagh, 2004 *Perception* 33 1339–1358). This indicates that visual processing mechanisms somehow make shadows difficult to perceive, presumably to help minimise light-related noise in visual inputs and facilitate object recognition. Here we examined whether such shadow-specific processing might be altered by ageing and particularly Alzheimer's disease (AD), reasoning that a declining ability to 'suppress' shadows would increase visual noise and thus potentially contribute to the visual confusion experienced by some AD patients. We used visual search for a discrepant target among items which appeared as posts with shadows cast by light-from-above when upright, but as angled objects when inverted. Young participants showed the classic effect of slower responses with upright than inverted displays, but only when the shadow-like part was dark, not white (control condition). Crucially, this interaction of shadow colour with item orientation was maintained in healthy older and AD groups, indicating that processing mechanisms specific to light-from-above shadows remain unaltered in healthy ageing and AD. Both older groups were, however, slower when discriminating dark as compared to white shadow-like regions regardless of orientation, in line with altered contrast perception in ageing. More interestingly, AD patients were slower at distinguishing any type of upright items, irrespective of 'shadow' colour, in keeping with specific deficits to lower visual field processing in AD. Overall, shadow visibility appears (if anything) reduced in older people owing to general, not shadow-specific, changes.

◆ **Age-related chromatic sensitivity decline is not associated with hue 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 whether age-related chromatic sensitivity changes are associated with corresponding changes in hue perception. We therefore obtained the following data in the same set of observers: the sensitivity along the protan, deutan, and tritan line, and unique hue settings. We find a significant decrease in chromatic sensitivity due to ageing, in particular along the tritan line; the cone weights associated with the unique hues settings, on the other hand, remain constant with age. Our results confirm previous findings and are consistent with the hypothesis that compensatory mechanisms exist to maintain hue constancy across the life span.

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