

Abstracts
Scottish Vision Group
Dundarach Hotel, Pitlochry 15-17 March 2008

David Perrett (University of St Andrews)

Seeing the future: Natural image sequences produce anticipatory neuronal activity

Sensory experience allows anticipation, yet one sensory stimulus also 'masks' perception and neural processing of subsequent stimuli. To understand this paradox we compared cell responses in monkey temporal cortex to body images presented individually, in pairs and in action sequences. Responses to one image suppressed responses to similar images for ~500ms. This suppression led to responses peaking 100ms earlier to image sequences than to isolated images (e.g., during head rotation, face-selective activity peaks before the face confronts the observer). Thus masking has unrecognized benefits for perception because it can transform neuronal activity to make it predictive during natural change.

Nicky Ridgway, Mary MacLeod, and Arash Sahraie (University of Aberdeen)

Chromatic processing in hemianopia

When observers have to respond to two simultaneously presented targets, their reaction times are significantly faster than responses to single targets. This is termed the Redundant Target Effect (RTE). In experiment 1, we demonstrated the presence of RTE in normal observers (n=10) using, luminance-defined, colour-defined and combined luminance-colour defined stimuli, even when targets were presented in different hemifields. For colour-defined targets, Random Luminance Modulation (RLM) technique was used to mask any luminance cues. In experiment two, we applied the same technique to investigate the extent of chromatic processing within the field defect of a group of cortically blind patients (n=5). Previously, RTE had only been consistently reported in 1 out of 20 cortically blind patients tested, using combined luminance-colour targets (Marzi, Tassinari, Aglioti & Lutzemberger, 1986). Here we show evidence for chromatic processing within the field defect in all five cortically blind patients tested. The reaction times to sighted field presentations are affected if a similar target is presented within the field defect. More specifically, depending on the stimulus conditions all five patients illustrated either facilitation (RTE, i.e. shorter reaction times) or inhibition (i.e. slower reaction times) of chromatic processing. Overall the pattern of facilitation and inhibition for luminance and colour defined targets are complex. However, S-cone sensitive stimuli led to an inhibitory effect in all five patients. This finding is significant as S-cone afferent signals reportedly, do not project to midbrain structures such as superior colliculus, often implicated in blindsight.

Lisa O'Kane and Paul Hibbard (University of St Andrews)

Contextual disparity variation does not influence distance scaling in a three-dimensional shape judgement task

Binocular disparity varies approximately inversely with the square of distance. This relationship could potentially be exploited by the visual system as a cue to viewing distance, which could be useful in the interpretation of the shape and size of objects. Previous work has suggested that the range of disparities presented to an observer might be used as a cue to distance, and therefore might influence the perception of three-dimensional shape (Glennerster et al, 1998). We extend this idea by examining the effect of the magnitudes of disparity information available in the surround on perceived depth from disparity. The stimulus consisted of three dots vertically aligned on the screen. The distance in depth of the central dot from the other two was defined by disparity, and was adjusted by the observer until it appeared equal in length to the base of the triangle. The triangle was surrounded by a surface that was sinusoidally modulated in depth. Shape settings were made for different magnitudes of disparity variation in the surround, over a range of viewing distances. Observers added more depth to the stimulus at further distances than at the closer distance. However, observers' settings did not change with the pattern of disparity present in the local reference surface. We conclude that the degree of disparity variation in a local reference frame, despite providing a potential source of statistical information to distance, does not affect settings of depth made by observers.

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Binocular depth perception in a human subject with bilateral lesions of the lateral occipital cortical area

The human ability to discriminate binocular depth is most acute when humans are set the task of comparing the relative depth between two nearby visual features, with current evidence indicating that the ventral visual form pathway is responsible when the task requires a comparison between adjacent depth planes. We tested this hypothesis by measuring sensitivity to relative depth in the visual agnostic subject DF, whose major anatomical lesions are bilateral losses of the Lateral Occipital (LO) areas. Depth perception in DF was measured with a forced-choice, front-back task with a circular field of stereoscopic random dots as a function of their disparity. This central field was surrounded by a background field of random dots, which were always at zero disparity. Relative depth perception in normal subjects declines in acuity when an annular featureless gap is introduced between centre and background dots. The bigger the gap, the greater is the loss in acuity. However, DF's acuity as a function of gap size showed essentially no change. DF's stereoscopic depth vision is in many respects similar to normal subjects: she responds reliably to the cue of binocular disparity in random dot stereograms, is able to use binocular disparity to resolve ambiguous structure- from-motion images and reports a clear perceptual difference between correlated and anticorrelated binocular random dot figures. Results from DF are consistent with the proposal that relative depth between

foreground and background visual features is processed through a pathway that passes through LO and forward to ventral visual areas.

Moreno I. Coco (University of Edinburgh)

Effects of prosodic cues on the resolution of syntactic ambiguity in a visual world study

The syntactic structure of sentences can be ambiguous, for example the sentence “put the apple on the towel in the box” is an instance of a so-called attachment ambiguity. The phrase *on the towel* can either refer to the apple (picking out one apple among several), or it can refer to the goal of the putting action. Such ambiguities can be investigated using eye-tracking experiments that present a visual scene and a spoken sentence at the same time (visual world experiment). Previous work found that different visual contexts lead to different scan paths for ambiguous sentences. It was also found that the intonation of the spoken stimulus can influence the resolution of the ambiguity. However, it is not yet clear how the information provided by the two modalities interacts, and how this help listeners converge on a unique final interpretation.

I will report a visual world eye-tracking experiment that addresses this question. In particular, I will focus on the role of prosody, i.e., the intonational structure of the speech stimulus. Two conditions were tested for the visual information: a one referent condition and a two referent condition (one or two apples in the example). This was crossed with two conditions for the linguistic information by introducing an intonational break either before or after the ambiguous phrase (*on the towel* in the example). If prosodic information can override visual contextual information, then we predict that scan paths will follow the constraints imposed by the prosody. Preliminary analysis do not confirm this prediction. Rather, we find an interaction between prosody and visual information: prosody only delays scan paths on objects according to intonational breaks.

**Rachel Bannerman, Maarten Milders, and Arash Sahraie
(University of Aberdeen)**

Processing emotional stimuli: Comparison of saccadic and manual choice reaction times

Most studies investigating reaction times to visual stimuli have used manual responses. A subject’s reaction time is a combination of time taken for both perceptual processes and motor preparation/execution. The latter component is shorter for saccadic eye movements than manual responses and therefore may be a more sensitive indicator of variations in perceptual processing times. Here we compared the speed of discrimination for emotional and neutral facial expressions in 3 experiments, using a forced-choice saccadic and manual reaction time task. The results show that unmasked, brief (20ms) bilateral presentation of an emotional / neutral pair of faces, can lead to a shorter discrimination of emotional stimuli in saccadic localisation task (Exp.1). The findings are replicated using schematic face stimuli (Exp.2). When the effect of interference from emotional stimuli is ruled out by showing a pairing of the emotional or neutral face with an outline face, faster saccadic discrimination was obtained for fearful facial expression only (Exp.3). The manual discrimination reaction time was not significantly different for emotional

versus neutral stimuli in any of the experiments. Overall, comparison of saccadic and manual responses show that faster discrimination of emotional / neutral stimuli can be carried out within the oculomotor system. In addition, emotional stimuli are processed preferentially than neutral face stimuli.

Rachael E. Jack and Roberto Caldara (Department of Psychology and Centre for Cognitive Neuroimaging, University of Glasgow, UK)

Culture is in the eye of the pupils

Face processing, amongst many basic visual skills, is thought to be invariant across all human beings. Since the seminal work of Yarbus (1965), studies of eye movements have consistently revealed systematic, analytical sequences of fixations over the eyes and the mouth during face processing. This triangular scanpath observed in Western Caucasian observers has long been assumed to represent a universal, biologically-determined information extraction pattern for faces. However, surprisingly, the role of culture in these studies has been neglected so far. To investigate this issue we monitored the eye movements of Western Caucasian and East Asian observers in diverse face processing tasks: upright and inverted face recognition, categorization by race and categorization of facial expressions. Contrary to intuition, we found consistent perceptual differences in eye movement scanpaths between Western Caucasian and East Asian observers across all the tasks. Our observations demonstrate that face processing can no longer be considered as arising from a universal series of perceptual events. Culture shapes perceptual mechanisms and the extraction of visual information from faces.

Nicholas J. Wade (University of Dundee)

The Thatcherisation of faces

Peter Thompson's delightful manipulation of a Conservative Party poster depicting a smiling Margaret Thatcher has spawned a mini-industry! Cutting out and inverting the eyes and mouth while maintaining the upright orientation of the head has a profound effect on the appearance of the face which is not matched by inverting the whole configuration. The disruptive effects of inverting a whole face had long been known, but this partial inversion was a novelty, and one that has been imposed on most heads of state since 1980! Margaret Thatcher was not the first politician to be warranted partial pictorial disfigurement. A Norwegian artist, Kjartan Slettermark, applied similar sleight of scissor to posters of Richard Nixon in the early 1970s. One inverted the eyes alone, but none inverted eyes and mouth in the manner of Thompson's Thatcher illusion, nor inverted the whole head. Some of Slettermark's Nixon pictures achieved particular notoriety after they had been purchased by the Norwegian Parliament and hung in the meeting room of the foreign affairs committee. In 2004 they were removed because they were considered to convey an inappropriate political message! This indicated the power of perception when confronted with politics. Thompson was following in a long tradition of conflating perception with political satire, and some of the precursors are discussed.

Martin Fischer and Nadja Tschentscher (University of Dundee)

Grasping joint attention

We studied how two different hand posture cues affect joint attention in normal observers. Visual targets appeared over lateralized objects, with different delays after centrally presented hand postures. Attention was cued by either hand direction or the congruency between hand aperture and object size. Participants pressed a button when they detected a target. Direction cues alone facilitated target detection following short delays but aperture cues alone were ineffective. In contrast, when hand postures combined both cues, aperture congruency effects without directional congruency effects emerged and persisted, but only for power grips. These results suggest that joint attention mechanisms are exquisitely sensitive to the timing and content of contextual cues.

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The effect of musical expertise on audiovisual integration of drumming actions as revealed in behavioral and brain imaging experiments

We investigated the effect of musical expertise on sensitivity to asynchrony for drumming point-light displays, which varied in their physical characteristics (Experiment 1) or in their degree of audiovisual congruency (Experiment 2 and 3). In Experiment 1, 21 repetitions of 81 point-light movies (3 tempos X 3 accents X 9 SOAs) were presented to 4 jazz drummer experts and 4 novices. In Experiment 2, 21 repetitions of 27 point-light movies (3 audiovisual incongruency conditions x 9 SOAs) were presented through headphones or loudspeakers to 3 jazz drummer experts and 3 novices. Finally in Experiment 3, 10 repetitions of 18 point-light movies (2 audiovisual incongruency conditions x 9 SOAs) were presented to 13 drummer experts and 13 novices. Participants gave forced-choice judgments of audiovisual synchrony. The results of Experiment 1 show a clear enhancement in experts' ability to detect asynchrony especially for slower drumming tempo. In Experiment 2 a consistent decrease of the Temporal Integration Window (TIW) width was found for incongruent stimuli, independently from the sound source. Finally, the results of Experiment 3 demonstrated a qualitative difference between drummers' and novices' sensitivity to asynchrony for incongruent stimuli with a significant decrease in TIW width only for the latter group. We will finish the presentation with discussion of fMRI experiments which examined how brain activity in groups of drummers and novices reflect these differences in perceptual abilities.

**Ken Scott-Brown, Andrea Szymkowiak, Pat Cronin, Anne Scrimgeour, and
Mathew Stainer (University of Abertay Dundee)**

To CCTV or not to see TV? Instinct blindness in surveillance technology

Psychology has contributed much to the development of policy procedure and practice in modern policing, for example in the development of collating witness testimony. Nevertheless the academic interest in the psychological foundations underpinning innovation in CCTV surveillance (aside from the pure technological developments) has been politely described as 'rather slight' (Williams and Johnstone, 2000). Certainly the prospect of continuously viewing up to 36 flickering video screens for 8 hours at a time would reasonably be expected to be a challenge to the average observer given what is known about the evolved psychological mechanisms of human visual system. To what extent, however, can technological solutions be described as 'instinct blind' (Scott-Brown and Cronin, 2007). We examine the role for vision science in a wider 'visual analytic' approach to the problems associated with decision making under uncertainty in CCTV observation contexts. In addition to the role of 'change blindness' and 'mindsight' (e.g. Rensink, 2004) we examine the potential for meta-cognitive errors to interfere with efficient implementation of surveillance policy, procedure and practice. The development of collaborative networks focused on the development of applied policing research in Scottish Universities in conjunction with Scottish Police present new opportunities for a science for surveillance. However, the integration of diverse methodologies and the dissemination of highly specialized results present a substantial challenge to the academic community in general, and the vision science community in particular.

Mark Shovman (University of Abertay)

Towards a cognitive model of data visualisation

The study of data visualisation – from simple, ubiquitous bar- and pie-charts to cutting-edge multimodal interactive animations – may offer valuable insights for theories of perception and cognition. Complex data visualisation tools are commonly justified as an aid in extracting relevant information from raw data. The exact usefulness of these tools, however, is arguable, partly because the concept of 'information', despite being intuitively clear, is hard to define. Abstract data visualisations are made up of a full spectrum of pictorial and symbolic elements, and the processes of data visualisations perception comprise elements of both natural scene perception and reading comprehension. Both visual perception and reading comprehension are well-researched topics. Juxtaposing them within the context of graph comprehension can enrich and creatively combine their respective research paradigms. It can also reveal assumptions these paradigms take for granted – such as the notion of 'object' in visual perception and 'meaning' in reading comprehension. This talk reviews and compares cognitive models and experimental methodologies from visual perception, attention, memory, reading comprehension and even child development, in light of their applicability to understanding the processes of visualisation comprehension. The resulting model explains several contradicting experimental findings, and establishes a framework in which concepts like 'information model' and 'inner mental representation' can be discussed and experimentally assessed.

Helen E. Ross (University of Stirling)

Frontal slope perception: Distance foreshortening and angle of regard

Proffitt and colleagues claim that downhill slopes appear steeper than uphill slopes. This is contrary to perspective theory, in which distance foreshortening makes uphill slopes appear steeper than they are, and downhill slopes flatter. I found no effect of viewing direction on numerical estimates of slope angle for observers standing on slopes of 2-23 deg. All slopes were overestimated. However, a downhill slope of 7 deg was estimated as significantly flatter (16 deg) when viewed from a height of 9 m and viewing distance of 38 m than when viewed from ground level at a distance of 20 m (23 deg). The high view also entails a steeper angle of regard, which may be a contributing factor. When viewed from a height of 100 m at the Wallace Monument, the flat carse of Stirling was estimated as sloping 6 deg uphill, the nearby hill of Drumbrae (5 deg) as 34 deg, and the distant mountain Ben Ledi (9 deg) as 59 deg. These estimates were significantly steeper than for similar slopes viewed at close distances, with a negligible change in the angle of regard. These results confirm the anecdotal reports of the effects of perspective on distant views of slopes. Further experiments will be carried out to examine the contribution of the angle of regard.

Martin Lages and Rob Jenkins (University of Glasgow)

Newtonian representation of falling objects?

If an object drops to the ground it accelerates according to the laws of physics. In a simple experiment with 15 naive observers we varied the speed of a 50 frame/s recording of a falling apple in 11 steps (range $\pm 20\%$) as well as display orientation (normal, inverted) and direction of replay (forward, backward). In each trial an observer judged whether a previously seen movie clip was faster or slower than real motion. Each observer attended a training block followed by ten test blocks each comprising 44 randomly intermixed trials. For each observer and condition we determined the point of subjective equality (PSE; 50% point) by fitting a Gaussian cdf to the data. The PSEs of 13 observers were entered into a analysis of variance (Estimates of two observers were excluded due to insufficient discrimination performance). Direction of replay and the interaction between replay and display turned out to be highly significant. A model selection test based on Bayesian Information Content (BIC) also favoured the interaction model over a simpler additive model. This interaction reveals that speed perception of a (de-)accelerating object is systematically altered if the object moves with or against gravity. We suggest that observers apply a vector representation of gravitational force to moving objects.