ABSTRACTS

♦ A template model predicts detection of sparse stimuli
1 Daniel Baker, Tim Meese (University of York & Aston University)
Contemporary models of contrast integration across space assume that pooling operates uniformly over the target region. For sparse stimuli, where high contrast regions are separated by areas containing no signal, this strategy may be sub-optimal because it pools more noise than signal as area increases. Little is known about the behaviour of human observers for detecting such stimuli. We performed an experiment in which three observers detected regular textures of various areas, and six levels of sparseness. Stimuli were regular grids of horizontal grating micropatches, each 1 cycle wide. We varied the ratio of signals (marks) to gaps (spaces), with mark:space ratios ranging from 1:0 (a dense texture with no spaces) to 1:24. To compensate for the decline in sensitivity with increasing distance from fixation, we adjusted the stimulus contrast as a function of eccentricity based on previous measurements [Baldwin, Meese & Baker, 2012, J Vis, 12(11):23]. We used the resulting area summation functions and psychometric slopes to test several filter-based models of signal combination. A MAX model failed to predict the thresholds, but did a good job on the slopes. Blanket summation of stimulus energy improved the threshold fit, but did not predict an observed slope increase with mark:space ratio. Our best model used a template matched to the sparseness of the stimulus, and pooled the squared contrast signal over space. Templates for regular patterns have also recently been proposed to explain the regular appearance of slightly irregular textures (Morgan et al, 2012, Proc R Soc B, 279, 2754–2760).

♦ Trypophobia: The fear of holes
2 Geoff Cole, Arnold Wilkins (University of Essex)
A phobia is often defined as an irrational fear of certain situations or objects, and identifying the cause of such aversion is difficult. We describe an unusual but common phobia (trypophobia), as yet unreported in the scientific literature, in which individuals are averse to images of holes. We performed a spectral analysis on a range of trypophobic images and found that the stimuli possess a particular visual characteristic. Specifically, they have high contrast energy at mid-range spatial frequencies. Importantly, we also found that poisonous animals also possess this spectral property. Thus, with respect to cause, we argue that the phobia arises because trypophobia-inducing images share a basic visual property with poisonous organisms, a property that is automatically computed and will therefore facilitate a rapid non-conscious response.

♦ Perception of volume via binocular disparity: effects of local spatial arrangement
3 Julie Harris (University of St Andrews)
Our brains are exquisitely sensitive to binocular disparity, the tiny angular differences between left and right eye views of the world. Disparity contributes to the impressive sense of depth and filled space that is perceived when we view complex scenes, with objects or elements at many depths. Yet perception of depth in such scenes is seldom studied. Here we explore how disparity contributes to the perception of depth volume. Stimuli were composed of line elements, which could be scattered through a volume in depth, or presented on a pair of planes with a depth separation between them. Observers were asked to perform a volume discrimination task: which of two volumes was the deeper in depth. Our key interest in this study was the local element layout. For isolated elements, there is a ‘disparity gradient limit’. Element pairs with large disparity gradients (disparity/spatial separation) become diplopic and depth perception is impaired. Here we manipulated element layout to vary local disparity gradients, and assessed the impact on depth volume perception. High local disparity gradients had a major effect on depth volume perception, reducing the perceived volume compared with scenes containing the same depth range, but fewer high disparity gradients. To perceive volume, the disparity of scene elements must be extracted, and then the distribution of those disparities must be used to estimate volume. This work has shown that the initial arrangement of scene elements can limit volume perception, likely at the stage where initial disparity extraction takes place.

Note: These abstracts have not been edited and are printed as submitted.
The stimulus to accommodation: reconciling theoretical and empirical accounts of the contributions of different spatial frequency components
Simon Watt, Kevin MacKenzie (Bangor University)

There have long been conflicting views over the role of different spatial frequency components in accommodation control. Fine-tuning models posit that accommodation is guided by increasingly high spatial frequencies—up to 20–30 cpd—as optimal focus is approached. This makes sense because signals from higher frequencies become available only as defocus decreases. However, empirical studies report a ‘roll-off’ in the contribution of higher spatial frequencies at just 6–8 cpd, arguing that the fine-tuning account is incorrect. Here we address shortcomings with both accounts, and find that they are in fact compatible. We used empirical measurements of retinal-image formation (rather than a diffraction-limited eye) to specify the fine-tuning model accurately. We found that previous models overestimated the signal from high spatial frequencies, and our revised model predicts the mid-range roll-off observed in empirical studies. We further tested the model using a method designed to overcome limitations of previous experiments. Specifically, we used a multi-focal-planes display to present different spatial frequency components at different focal distances, and relative contrasts, to determine the ‘weight’ given to each component in each stimulus context. We generated predictions for steady-state accommodation by considering overall changes in retinal contrast generated by accommodation. Responses were broadly predicted the model. Our findings suggest that the contribution of different spatial frequencies to accommodation control is not fixed, but is instead an emergent property of their contribution to overall changes in retinal contrast in a given stimulus. Our findings reconcile apparently contradictory theoretical and empirical accounts of the stimulus to accommodation.

Vision during navigation in mouse primary visual cortex
Aman B Saleem, Asli Ayaz, Kate Jeffery, Kenneth D Harris, Matteo Carandini (University College London)

Successful navigation through the world requires an accurate estimate of one’s own speed. Neural correlates of animal speed have been found in high-level brain structures such as the hippocampus (Geisler et al, 2007, PNAS, 104, 8149–8154). To estimate animal speed, the inputs to these structures must integrate visual speed inputs and run speed gauged from the locomotor systems (Jeffery, 2007, Curr Opin Neurobiol, 17, 684–691). Multimodal integration can occur within the visual system, eg in primate extrastriate cortex (Angelaki et al, 2009, Curr Opin Neurobiol, 19, 452–454). Measurements in rodents show that locomotion modulates responses even in primary visual cortex (V1) (Niell & Stryker, 2010, Neuron, 65, 472–479). However, the role of the visual system during navigation is unknown, because experiments measuring visual responses have not typically been performed during navigation.

Using a virtual reality environment, we asked what signals about navigation are present in responses of V1. We presented a virtual environment on three monitors surrounding mice that walked over an air-suspended spherical treadmill. The environment was a corridor with walls adorned with a white noise background and prominent landmarks. We recorded from a population of neurons in V1 using multi-site probes, while the animals navigated the virtual reality.

We find that, in mice, the integration of visual motion and locomotion signals occurs as early as primary visual cortex (V1). We find that the population of V1 neurons are driven by linear combinations of virtual room speed and run speed, with weights that varied between neurons. Most neurons gave equal weight to run speed and virtual room speed, and decoding the populations revealed that V1 encoded positively weighted combinations of speed better than virtual room or run speeds alone. These data suggest that V1 is the first stage in the multimodal processing circuit that supports self-localization and navigation.

Eye movements are an excellent probe of multi-stable motion direction perception
Andrew Meso, Guillaume Masson
CNRS/Aix-Marseille Université

Eye movements provide an informative window into cognitive and perceptual processes. We exploited this in psychophysical experiments with multi-stable motion stimuli in which perceived direction varied dynamically. Given a continuous space over which a percept varies ie from horizontal through diagonal to vertical directions, explicit perceptual reports are limited to instances in time and constrained by the context in which they are made, normally a discrete forced choice. To probe the relevant information within the eye movements, we used a slow moving barber pole stimulus (6 deg/s), with an obliquely oriented sinusoidal luminance grating presented behind a square aperture...
generating the multi-stability. First we sought to identify what component of the eye movements, was coupled with perception during both short presentations (<1 s) and extended trials over which switches occurred (15 s). We used acceleration and speed criteria to identify blinks, saccades and smooth components (containing both smooth pursuit and ocular following responses). We found these smooth components to be coupled to perceived directions at the end of short trials and also to the sparsely sampled transitions during the longer trials. Second, we found that the question of which precedes the other between the eyes and the reports showed individual differences probably due to transformations from neural representation to motor response. Third, the eyes provided a rich source of information in the estimated directions and their distributions over conditions, indicating where noise driven transitions were more likely. Eye movements are therefore a useful and so far underused probe of multi-stable perception.

♦ The effects of stroboscopic visual training on visual attention, motion perception and catching performance

Luke Wilkins, Rob Gray (University of Birmingham)

Stroboscopic visual training has recently been shown to improve several perceptual abilities including 2D motion sensitivity (Appelbaum et al, 2011, Front Psychol, 2, 276), visual memory [Appelbaum et al, 2012, Atten Percept & Psychophys, 74(8), 1681–1691] and anticipatory timing [Smith & Mitroff, 2012, International Journal of Exercise Science, 5(4) 344–353], but its effect on sports performance has not been investigated. In the present study, 17 participants were randomly assigned to a stroboscopic training group (n = 9) or a control training group (n = 8); both of which encompassed 7 × 20 minute sessions of various ball-catching drills occurring over a 6 week period. For the stroboscopic training group, the off-time of the glasses was systematically increased during training while for the control group the glasses were always set at the shortest off-time (ie, the easiest setting). Participants completed one-handed ball-catching, useful field of view test (UFOV) and motion-in-depth sensitivity (MIDS) tests pre- and post-training. There were no significant training group differences for either the catching or visual tests. For both training groups, catching performance changes pre–post training were significantly correlated with the changes in scores on the visual tests (UFOV: $r = 0.61$, MIDS: $r = 0.56$). These results provide further evidence that training with stroboscopic glasses can improve perceptual and attentional abilities, however, they suggest that adjusting strobe on-time may not be critical for this effect. Although we provide initial evidence of a possible link between stroboscopic training effects and sports performance, further research is needed to understand this relationship.

♦ Exploring the spatiotopic frame using motion after-effects

Brice Dassy, Simon Rushton, Rob Honey (Cardiff University)

Motion after-effects have been used to probe the existence of a spatiotopic map. Turi and Burr (2012) reported spatiotopic adaptation using a single adapting stimulus. If a true spatiotopic map exists then it should be possible to simultaneously adapt two points in separate locations within the putative map. Our preliminary work established that we could obtain adaptation to a single patch and separate patches that could be based on either a retinotopic or in a spatiotopic reference frame. We then tested whether we could obtain adaptation to two adapting patches positioned in different parts of the spatiotopic frame. The build up of motion adaptation was measured with a nulling procedure (staircase run over sessions following Bex et al, 1999) at 5 intervals during the adaptation (total adaptation period of 50 s). Participants adapted to a 5 deg stimulus composed of 300 dots moving radially inwards or outwards (median 3 deg/sec). In two adapting patches experiments the stimuli were separated by 20 deg and had opposite direction radial motion. We obtained adaptation to a single patch positioned in either a retinotopic and spatiotopic frame; and we obtained adaptation to two patches separated in a retinotopic frame. At a group level, there was evidence of adaptation to two separate patches in a spatiotopic frame; but the magnitude of this adaptation was relatively weak and there were notable individual differences.

♦ Modulation of visually evoked postural responses by contextual visual, haptic and auditory information: a ‘virtual reality check’

Georg Meyer, Kirsten Fien, Helen Mawson, Noreen O’Sullivan, Antony Robotham, Fei Shao (University of Liverpool)

Externally generated visual signals that are consistent with self-motion cause the illusion of motion in space (vection) and corresponding automatic postural responses that are not simple responses to optokinetic stimulation, but are modulated by the configuration of the environment. The aim of this paper is to explore what factors modulate postural responses to vection signals in a high quality virtual reality environment. We present data from four experiments on visually evoked postural responses to show that:
(1) visually evoked postural sway in the lateral direction is modulated by the presence of static anchor points that can be haptic, visual and auditory reference signals;
(2) real objects and their matching virtual reality representations as visual anchors have different effects on postural sway;
(3) visual motion in the anterior-posterior plane induces robust postural responses that are not modulated by the presence of reference signals or the reality of objects that can serve as visual anchors in the scene.

We conclude that automatic postural responses for laterally moving visual stimuli are strongly influenced by the configuration and interpretation of the environment and draw on multisensory representations. Different postural responses were observed for real and virtual visual reference objects. On the basis that automatic visually evoked postural responses in high fidelity virtual environments should mimic those seen in real situations we propose to use the observed effect as a robust objective test for presence and fidelity in VR.

♦ Clinical assessment of stereoacuity and the perception of stereoscopic entertainment media

Laurence Tidbury, Anna O’Connor (University of Liverpool)

There are anecdotal reports (Arnold et al, 2011, JPOS, 48, 4, 199–201) that patients who have no measurable stereoacuity on clinical testing comment that they are able to appreciate the stereoscopic effect of 3D entertainment media. To investigate this, 30 subjects with normal levels of stereoacuity were assessed under four levels of monocular blur ranging from nil to binocular suppression, to simulate reduced stereoacuity. The assessment consisted of a number of standard clinical tests of stereoacuity and two tasks employing the stereoscopic function of a passive 3DTV and a Nintendo 3DS. Subjects viewed five short video clips on the 3DTV (at 1.2 m) and were asked to rate how apparent the 3D effect appeared. A simple depth identification task was performed using static pictures on the Nintendo 3DS.

Qualitative perception of the 3D effect of the video clips remained highly evident until suppression of one eye occurred, although 73% (n = 22) of subjects still reported a ‘fairly evident’ or ‘very obvious’ 3D effect. On the Nintendo 3DS the median accuracy of object depth identification did not reduce below 100% until suppression of one eye occurred, with a significant reduction to ‘absent’ stereoacuity (ANOVA, p < 0.05). It appears that when stereoacuity is degraded, as measured by current clinical tests, a 3D effect can still be perceived on entertainment media devices. Therefore the absence of measurable stereoacuity may not mean the patient has no stereoacuity, but that current clinical tests provide limited information about stereoacuity. Further investigation of dynamic stereoacuity is required.

♦ Dissolution of agency to an external source: manipulations of body-sway in relation to depersonalization

Noreen O’Sullivan, Georg Meyer, Helen Mawson, Kirsten Fien, Richard Bentall, Tony Robotham, Fei Shao (University of Liverpool)

The capacity to demonstrate agency, the intentioned initiation of actions, is a by-product of goal-directed behaviour. However, agency has also been related to embodiment, the extent to which ongoing representations of the self embody all relevant aspects of the self. Conceivably, increased disembodiment would reduce the effectiveness of agency, acting as a force against the viability of current goals. The potential for this outcome is not only relevant in the context of normal functioning: it might also explain why individuals who suffer from depersonalization have a reduced sense of agency over their execution of actions. Depersonalization relates to chronic feelings of the self being less real, which develop as a consequence of traumatic experiences.

In this study, we explored agency and embodiment in relation to depersonalization in a 3D environment that availed of vision in influencing participants’ movement while standing—movement being one of the most basic products of agency. Participants’ goal was to stand in front of a 3D bar-coded visual array while completing a visual detection task. The array moved along x and z planes in separate conditions at a rate appropriate normal body-sway.

Results showed that fluctuation in body-sway became synchronized to the rate of the visual source. Depersonalization moderated the impact of the visual source on body-sway: increased depersonalization was related to increased synchronized sway. To our knowledge, the findings are the first to demonstrate that embodiment, agency, and their interaction, are potential mechanisms underlying depersonalization.
An adapted version of the crossmodal congruency task for measuring the limits of visual-tactile integration

Daniel Poole, Sam Couth, Ellen Poliakoff, Emma Gowen, Paul A Warren (University of Manchester)

When creating a coherent percept of our environment, information close in space and time tends to be integrated. However, due to varying transduction rates of our sensory organs, there is a degree of spatial and temporal discrepancy that can be tolerated. The crossmodal congruency task (Spence et al, JEPS, 26, 1298–1319) can be used to measure the influence of vision on touch. Typically participants judge the elevation of a tactile vibration while simultaneously receiving distracting light flashes at the same (congruent) or conflicting (incongruent) elevations. The difference in performance between congruent and incongruent conditions gives a measure of visual-tactile integration known as the congruency effect (CE).

We have developed a version of the task in which we control for the 3D location of visual distractors, presented at various positions and stimulus onset asynchronies (SOAs). Participants were instructed to discriminate between single and double tactile pulses presented at approximate threshold level. In Experiment 1 ipsilateral visual distractors were presented at 0 mm, 21 mm, 42 mm vertically from the target, and 42 mm in a symmetrical, contralateral position. In Experiment 2 visual distractors were presented at –30 ms, 100 ms, 200 ms and 400 ms SOAs. The distractors presented 0 mm and –30 ms from the target produced a significantly larger CE, becoming non significant when distractors were presented further from the target spatially and temporally. This methodology will be used to assess the limits of visual-tactile integration in groups that tend to produce variable reaction time data (eg autism and the elderly), whilst making task difficulty equivalent for each individual.

Multiple influences on direction encoding during occluded target motion

Anna Hughes, Kaustuv Joshi, Christian Jones, David Tolhurst (University of Cambridge)

Predictions of the speed and direction of a moving Gabor patch can be systematically biased by pattern motion within the patch [Hughes et al, 2012, Perception ECVP Supplement, 41, 118; Hughes & Tolhurst, 2012, Perception, 41(12), 1519]. Here, we extend this work to show that the orientation of the stripes within a Gabor patch can also affect direction perception. Observers viewed a Gabor target moving with a linear trajectory randomly chosen within 18 degrees of the horizontal. This target then became occluded, and observers were asked to judge where it would later have crossed a vertical line, using a numerical scale bar. As in our previous experiment, we found that the addition of pattern motion within the Gabor patch affected direction judgements. When the motion within the pattern was upwards relative to the overall direction of motion, observers tended to estimate that the patch would cross slightly above its veridical position, and vice versa when the within pattern motion was downwards. We also found an effect of stripe orientation irrespective of any local motion; patches with stripes that were pointing upwards relative to the direction of motion were perceived to be crossing above patches where the stripes were pointing downwards relative to the direction of motion. Thus, while subjects can normally make relatively accurate direction judgements in an occlusion paradigm, Gabor stripe orientation can bias these judgements. We discuss these findings in relation to current models of how the human brain makes motion direction judgements.

Measuring possible facilitation of a collinear axis of symmetry on element grouping

Giulia Rampone, Alexis Makin, Marco Bertamini (University of Liverpool)

Reflectional symmetry is detected quickly and efficiently. What still remains unclear is whether specific holistic effects might occur in the early perception of symmetry, facilitating its processing. Casco et al [2009, Vision research, 49(6), 583–593] presented participants a group of three-Gabors on a background of different orientated Gabors and asked a judgment of orientation for either the central patch (element task) or the group (group task). Performance was higher for collinear patches in both tasks. However, they found that the collinear facilitation was associated with a different ERP time-course. We tested whether axis of symmetry might work as collinearity in facilitating grouping. Observers had to judge axis of symmetry for a group of Gabors. Gabors orientation was either congruent or orthogonal to the symmetry axis. The effect of collinearity observed in Casco et al (2009) did not generalize to axis of symmetry and neither with the axis of elongation. When elements are separated along the axis of elongation, no significant effect of collinearity is observed. These results confirm that the presence of collinear flanks is a special factor in increasing grouping. Finally, estimates of perceptual sensitivity (d’) for global and local orientation suggest this paradigm is likely to produce
also significant response bias in the direction of the irrelevant orientation. A modification of this paradigm aimed to reduce response biases, would clarify how these perceptual mechanisms interact with parts and whole in holistic perception.

‡ Effects of anxiety on visual-motor behaviour during visual and instrument flight rules

15 Jonathan Allsop, Rob Gray (University of Birmingham)

Going beyond performance effects to understand the influence of anxiety on the underlying visual-motor behaviour is of significant interest from both a theoretical and practical point of view. The present study investigated this issue in an important, real-world task: landing an aircraft. Twelve participants first learnt how to complete landings in a flight simulator while having full vision of the outside world (visual flight rules, VFR) and during simulated low visibility conditions (instrument flight rules, IFR). Landings were then performed in anxiety-inducing conditions (involving evaluative pressure and monetary incentives) for both VFR and IFR. Overall, lateral control improved significantly whereas glide-slope (vertical) control was unaffected by anxiety. Interestingly however, individual changes in IFR glide slope performance from pre-test to anxiety conditions positively correlated with changes in pupil diameter over the same time span. In both the IFR and VFR conditions, the number of glances out the simulated cockpit window increased under anxiety. These results are indicative of anxiety-induced changes in gaze behaviour, mental workload and effort.

‡ The role of peripheral vision in flow parsing during rolling self-motion

16 Cass Rogers, Simon Rushton, Paul A Warren (Cardiff University & University of Manchester)

Rushton and Warren (2005, Curr Biol, 15, R542–R543) suggested that in order to assess scene-relative object movement the brain identifies and globally subtracts (parses) patterns of visual flow consistent with self-motion. Although this flow-parsing process has been studied in central vision (Warren & Rushton, 2009, Curr Biol, 19, 1555–1560), our recent results suggest that peripheral flow, a strong cue to self-motion, also permits the extraction of object motion during self-motion (Rogers et al, 2012, Perception, 41, 1524). Previously we simulated lateral translations of an observer to investigate the effects of peripheral flow on perceived object trajectory in central vision. Here we considered rotational movements of an observer. Using monitors placed to the side of the head, or a large ring of limited lifetime dots (50 degrees diameter), we introduced patterns of rotational flow into peripheral vision to simulate clockwise or anticlockwise roll of the observer about the line of sight (z-axis). Simultaneously a vertically moving probe was placed 2 degrees above or below a central fixation point. Observers orientated a line to indicate the perceived trajectory of the probe. We predicted that due to a global subtraction process, peripheral flow would bias perceived trajectory in the opposite direction to the presented motion; clockwise flow would produce an anticlockwise trajectory bias, and anticlockwise flow would bias responses clockwise. The results were in line with the flow-parsing hypothesis for the near and far peripheral self-motion stimuli. These findings suggest that peripheral vision also contributes to the flow-parsing process for rotational observer movements.

‡ Multiple target visual search during simulated observer movement

17 Daniel B Dodgson, Paul A Warren, Johan Hulleman (University of Manchester)

It is thought that visual search is made more efficient by inhibitory tagging of distractor items, thereby reducing the likelihood of re-inspection. However, for difficult dynamic display tasks, inhibitory tagging is thought to be less robust (Hulleman, 2010, Vis Res, 50, 2069–2079). Here we investigate inhibitory tagging when stimulus motion is consistent with simulated observer movement. In this case motion should be “parsed” or globally subtracted (eg Rushton & Warren, Curr Biol, 15, R542–R543) and observer performance should improve relative to the static search task. Participants undertook easy and hard visual search tasks comprising 3D displays of 12 or 18 items containing 3–6 targets, judging whether there were less than or at least 5 targets present. Search items were 3D polygons (targets had fewer faces than distractors) positioned in a 3D volume. Participants wore stereo shutter glasses which provided a compelling 3D percept. Onscreen movement was either: (i) Static (No motion); (ii) Simulated observer movement (lateral translation + counter rotation of the head); (iii) Random motion. We measured observer search performance in terms of reaction time and error rate. Preliminary results (n = 11) suggest that, similar to Hulleman (2010), there is no difference in performance across motion types for easy search tasks. When search was made difficult there was limited performance (error rates) improvement in the simulated observer motion condition relative to random motion. We discuss these results in the context of theories of inhibitory tagging and optic flow parsing.
Visual search task and moving peripheral noise

Ieva Timrote, Agnese Reinvalde, Madara Zirdzina, Tatjana Pladere, Gunta Krumina (University of Latvia)

There are disorders linked to M, P visual pathways that can be improved until certain age (Parrish et al, 2005, Vision Research, 45, 827–837). To investigate how central task is performed with distractors in peripheral visual field, we carried out a pilot experiment. Fourteen individuals (20–26 years old) participated in the experiment. They performed a type of visual search task, consisting of a set of ten Latin letters in ten rows (Arial, 11pt). Each set of letters occupied 24.7° of a projection screen (89.7° wide and 64.9° long). An individual had to memorize the first letter in the upper left row and count all these letters from the set of letters. All the individuals performed a visual search task with no peripheral noise for twenty consecutive times. Afterwards four individuals performed this central task in different peripheral conditions—with no noise, with moving noise and with stationary noise. Peripheral conditions were selected randomly, nine times each. From the results, visual search task is performed for a longer time when there is moving peripheral noise (p < 0.01, ANOVA). What is more, performing visual search task for twenty times is quite a difficult task for an individual—he/she has to overcome a fatigue for several times during the repeated task. This type of a visual search task demands immediate attention and concentration, therefore up to five visual search tasks are sufficient in cases where short period of time should be used to keep individual’s attention focused.

Subjective evaluation of presence and fidelity in a simulated multisensory flying task

Li T Wong, Daniel Young, Max Aldridge, Georg Meyer, Mark White, Philip Perfect (University of Liverpool)

Aviation training increasingly involves the use of virtual reality simulations. For effective training transfer, the simulation should afford high functional fidelity, which is the extent to which procedural skills in the virtual environment mimic those in the real environment (Ferwerda, 2003), and presence, which is the degree to which a person perceives a psychological sensation of being in a simulated environment (Scheunie, van der Straaten, Krijn, & van der Mast, 2001). The robustness and reliability of subjective measurement of these constructs has been debated in literature. In this study, participants were trained on a basic simulator to perform a hover-precision task, where they were required to keep a simulated helicopter in line with a target in resistance to turbulence applied along the yaw axis. Participants then completed 8 trials in a high-fidelity simulator, where visual, auditory and kinematic cues were manipulated to assess effects on fidelity and presence evaluation. Error measures were taken as an objective measure of performance to compare with Likert scale measures of presence and fidelity. We evaluate the correlation between subjective ratings of presence and fidelity with objective error measures while manipulating auditory, visual and motion cues. This work contributes to user evaluation of simulated environments, transfer of training research and study of cognitive–perceptual frameworks.

Regularity, symmetry, and perceived numerosity

Daniel I R Bates, Marco Bertamini (University of Liverpool)

The Regular-Random Numerosity Illusion has been cited in previous research as demonstrating that the configuration of a pattern of dots affects the ability to estimate the number of items in that array. Experiment 1 built upon work by Ginsburg (Ginsburg, 1980, J General Psychology, 103, 211–216) suggesting that regular patterns may lead to over-estimation. Using a magnitude estimation task participants were presented with and asked to judge the numerosness of random, reflectional, or rotational dot pattern arrays, ranging from 2–30 dots. No differences were found. Experiment 2 explored the possibility that the illusion is not based on regularity per se but on the level of cluster in a dot pattern array (Allik & Tuulmets, 1991, Perception & Psychophysics, 49, 303–314). Using the same methodology a range of 8–24 dots patterns with varying levels of cluster were presented to participants at either 100 or 500 ms. Clustering did affect perceived numerosity. Experiment 3 used a different methodology. For reflectional, rotational or translational pattern arrays the point of subjective equality (PSE) was computed using a 2 alternative forced choice paradigm whereby each pattern of 4–24 dots was judged against a random 14 dot pattern array. We conclude that, consistently with the literature, clustering affects perceived numerosity but when there is no difference in clustering the presence of different types of regularities (different symmetries) has no effect on perceived numerosity. The Regular-Random Numerosity Illusion therefore would be better renamed as the Spacing or Clustering Numerosity Illusion.
Augmenting visual and kinaesthetic signals with auditory heading cues in a simulated helicopter hover task

Daniel Young, Li T Wong, Mark White, Max Aldridge, Georg Meyer, Philip Perfect (University of Liverpool)

The quantification of simulation fidelity underpins the confidence required for the use of flight simulation in design, to reduce real life testing, and to provide a safe environment for pilot training. This aim of this study is to develop quantifiable human performance indicators to measure objective flight simulator fidelity (eg Padfield et al, 2010; Meyer et al, 2012).

Data is presented from two experiments: In an initial experiment, naive participants were presented with kinematic (physical motion of the flight simulator) and audio cues representing rotational movement to establish the unimodal and bimodal detection thresholds. It was found that all participants can detect both motion cues and that bimodal presentation leads to improved correct motion direction discrimination. In a second experiment, performance in a simulated helicopter hover task was evaluated whilst manipulating the availability of auditory, visual and kinematic motion cues. Participants were tested using a $2 \times 2 \times 2$ factorial design before and after training within a reduced fidelity environment. This study shows that training results in transferable learning that leads to objectively measurable improvements in flying performance.

AUTHOR INDEX

Aldridge, Max 19, 21
Allsop, Jonathan 15
Ayaz, Asli 5
Baker, Daniel 1
Bates, Daniel I R 20
Bentall, Richard 11
Bertamini, Marco 14, 20
Carandini, Matteo 5
Cole, Geoff 2
Couth, Sam 12
Dassy, Brice 8
Dodgson, Daniel B 17
Fien, Kirsten 9, 11
Gowen, Emma 12
Gray, Rob 7, 15
Harris, Julie 3
Harris, Kenneth D 5
Honey, Rob 8
Hughes, Anna 13
Hulleman, Johan 17
Jeffery, Kate 5
Jones, Christian 13
Joshi, Kaustuv 13
Krumina, Gunta 18
MacKenzie, Kevin 4
Makin, Alexis 14
Masson, Guillaume 6
Mawson, Helen 9, 11
Meese, Tim 1
Meso, Andrew 6
Meyer, Georg 9, 11, 19, 21
O’Connor, Anna 10
O’Sullivan, Noreen 9, 11
Perfect, Philip 19, 21
Pladere, Tatjana 18
Poliakoff, Ellen 12
Poole, Daniel 12
Rampone, Giulia 14
Reinvalde, Agnese 18
Robotham, Antony 9, 11
Rogers, Cass 16
Rushton, Simon 8, 16
Saleem, Aman B 5
Shao, Fei 9, 11
Tidbury, Laurence 10
Timrote, Ieva 18
Tolhurst, David 13
Warren, Paul A 12, 16, 17
Watt, Simon 4
White, Mark 19, 21
Wilkins, Arnold 2
Wilkins, Luke 7
Wong, Li T 19, 21
Young, Daniel 19, 21
Zirdzina, Madara 18