AVA 2020 Virtual Meeting
21st December 2020

ABSTRACTS

Talks

1st talk session, 10-11am

AVA Keynote

Deep neural networks: A new framework for understanding biological vision?

Charles Leek
University of Liverpool
Recent years have seen a massive surge of interest in the potential application of 'end-to-end' deep neural networks (DNNs) to a broad range of issues in understanding brain function – including human vision. Indeed, DNNs have been described by some as a new framework for vision research. These claims are, in part, based on work showing apparent human-level performance by DNNs in tasks such as image classification, and are supported by advances in techniques for comparing 'representational' structures computed by DNNs with behavioural and neuroimaging data. However, the suitability of DNNs as a theoretical framework for understanding biological vision remains unclear. In this talk, I will explore this question – and present a critical analysis of feedforward DNNs as models of human vision in the context of pattern classification and 3D object recognition. I ask several key questions: 'How should theoretically relevant and irrelevant parameters of DNNs be distinguished?', 'Can DNN states and outputs be rigorously and meaningfully compared to human performance?' 'What is the range of empirical phenomena that must be considered to evaluate DNN architecture and processing parameters?' I will illustrate these points with reference to recent work examining patterns of errors made by DNNs during image classification, visual illusions and the discrimination of possible and impossible objects. I argue that feed-forward, data-driven, deep learning approaches do not provide a sufficiently rich framework for elucidating the functional architecture of human vision in these domains.

The time-course of single-view depth discrimination for real-world scenes

Matt Anderson[1], James H. Elder[2], Wendy J. Adams[1], Erich W Graf[1]

1 -Centre for Perception and Cognition, Psychology, University of Southampton, UK

2 -Centre for Vision Research, Department of Psychology, Department of Electrical Engineering and Computer Science, York University, Canada

Accurate depth estimation is critical for recognizing and navigating real-world scenes. While stereopsis and motion parallax are important depth cues, humans also rely on single-view, monocular cues. We investigated the speed and accuracy of single-view depth perception for complex natural scenes. We sampled images of real-world scenes and co-registered range data from the SYNS database (Adams et al., 2016). On every trial, we cued observers to two probe locations in an image. Observers made two judgements: they indicated which location was more distant (ordinal depth), and judged the depth of the closer location, as a percentage of the depth of the further location. We ran two conditions. In the variable-elevation condition, the two probes differed in their vertical image locations. In the matched-elevation condition, the vertical coordinates were held constant, thus removing elevation in the image as a cue to depth. With the range data as ground-truth, we manipulated: (i) the mean depth of the probes, (ii) the depth difference, and (iii) the presentation duration of the image (17-267 msecs, with backward masking). Ordinal and quantitative depth discrimination exceeded chance within 33 msecs, even for the matched-elevation condition, and improved monotonically with presentation time. Elevation cues improved performance, and strongly predicted trial-by-trial depth judgements, but their influence attenuated at longer presentations, suggesting that elevation is used as an efficient route to depth discrimination during early visual processing, before other image cues are extracted. Our findings reveal that single-view depth estimation is accelerated by a 'higher is further' prior.

The influence of partial occlusion on shape recognition

Gunnar Schmidtmann

Eye & Vision Research Group, University of Plymouth

Humans are able to recognize objects from their outlines, largely irrespective of perspective, position and scale. Previous studies have drawn different conclusions regarding the importance of specific features such as curvature maxima in shape recognition. Schmidtmann et al. (2015) demonstrated that if observers were asked to match a segmented shape, which contained only either convex, concave curvature maxima or intermediate segments for varying lengths, to one of two subsequently presented re-scaled and re-positioned whole-contour shapes, they performed significantly better for convexities compared to the other shape features. Surprisingly, performance for convexities was independent of the length of the segments. These results implied that closed planar shapes are encoded using the positions of convexities, rather than concavities or intermediate regions, and that a simple shape-template model could explain performance (Schmidtmann et al., 2015, Scientific Reports, 5, 17142.). In natural viewing conditions, however, objects are often partially occluded. To investigate the effect of partial occlusion, I employed the same paradigm and stimuli as previously (Schmidtmann et al. 2015), but occluded either 16.7%, 33% or 50% of the shape (i.e., only half the shape was visible in the 50% condition). Results show that performance for convex features is superior to the other shape features and independent of segment length, replicating previous data. More importantly, however, recognition performance is only significantly impaired when 50% of the shape is occluded. These results demonstrate the importance of shape convexities for shape encoding, and the flexibility of the visual system to deal with partially occluded shapes.

2nd talk session, 11.15am-noon

Cortical responses to symmetry: source localisation of the sustained-posterior negativity

John Tyson-Carr, Marco Bertamini, Giulia Rampone, Alexis Makin

Department of Psychological Sciences, University of Liverpool, Liverpool, UK

Visual regularity activates a network of brain regions in the extrastriate cortex. Previous EEG studies have found that this response scales parametrically with proportion of symmetry in symmetry + noise displays. The parametric symmetry response happens in multiple tasks, but it is enhanced when the task requires active regularity discrimination. However, the origins and time course of this selective enhancement remain unclear. Here we answered remaining questions with new source dipole analysis in a reanalysis of the data originally reported by Makin et al. (2020). As assumed, the parametric symmetry response found at the sensor level was generated by a pair of dipoles in the left and right extrastriate cortex, a finding consistent with previous fMRI research. This bilateral activity was itself enhanced during regularity discrimination, in accordance with original findings. However, we identified a third, and later, symmetry response in the posterior cingulate during regularity discrimination. The spatial distribution of this component was characterised by a strong positive potential over the vertex of the scalp at approximately 580 ms. Unlike the extrastriate response, this previously unknown activation only indexes strong, task relevant regularity signals. This clarifies the neural circuits which mediate the perceptual and cognitive aspects of symmetry discrimination.

Investigating Sound Content in the Early Visual Cortex of Aphantasia Participants

Belén Montabes de la Cruz, Clement Abbatecola, Johanna Bergmann, Lucy Petro, Lars Muckli

School of Psychology, University of Glasgow

Sound content can be decoded from brain activity patterns in the early visual cortex of blindfolded participants, especially in its peripheral fields (Vetter et al. 2014; Current Biology, 24, 1256-1262), and of congenitally blind subjects (Vetter et al. (2020, Current Biology, 30(15), 3039-3044.e2). The question occurs of how aphantasics, who report to experience no visual imagery, respond to auditory stimuli. Auditory stimuli could elicit similar patterns of activation in early visual areas to the ones found in blindfolded and blind participants. Alternatively, these patterns could be altered in aphantasia, indicating underlying neurophysiological differences which may be related to aphantasia's lack of visual imagery. To address this question, we replicated Vetter et al.'s (2014:2020) experimental design on 5 blindfolded aphantasics who cannot voluntarily or spontaneously engage in visual imagery. At the individual level, our permutation analyses reported significant decoding in two participants. However, our group-level analyses rendered non-significant results in all retinotopic areas, indicating that sound content was not represented in our participants' early visual cortex. Since our participants scored low for spontaneous visual imagery,

and because Vetter et al.'s (2014) reported deactivation patterns and eccentricity differences do not fit a voluntary visual imagery account, we suggest that our lack of findings arose from our participants' inability to engage in involuntary imagery. Moreover, we propose that auditory feedback to early visual areas may stand as a form of involuntary imagery which does not necessitate awareness, being elicited through previously integrated multisensory associations.

Unpacking the photic sneeze reflex

Manuel Spitschan & Josh Shepherd-Smith

Department of Experimental Psychology, University of Oxford

Approximately 25% of people report sneezing in response to exposure to bright light (such as direct sunlight) or using light to induce a sneeze when feeling the need to do so. Despite photic sneezing being a widespread phenomenon, which poses some occupational hazards in safety-critical and healthcare contexts (e. g. ophthalmological examinations employing bright light), the retinal and neural mechanisms underlying it are not known. In the literature, there are very few studies that have attempted to induce photic sneezing using artificial stimuli, which could be manipulated parametrically to examine isolate the specific retinal mechanisms underlying this response. Here, we take the first steps at understanding the determinants of photic sneezing, focusing on large scale online surveys to inspire future laboratory experiments. Participants completed self-report two online surveys including questions on iris colour, time spent outdoors, sensitivity to light, chronotype, seasonality, allergies and nasal obstruction (n=1,854 participants), and about the lighting conditions that elicit a sneeze, time-of-day dependence, and agents other than light eliciting a sneeze (n=1,943). In addition, a self-report logging study is currently in progress (n=533). In future work, we will engineer a laboratory-based stimulus to examine which aspects of wavelength and intensity cause photic sneezing to hone in one the underlying retinal mechanisms.

3rd talk session, 2.30pm-3.45pm

GJ Burton Memorial Lecture

The Development of Colour Perception

Anna Franklin

The Sussex Colour Group, University of Sussex

Infants have trichromatic colour vision by at least 3 months old. Here, I will present a series of studies which investigate the development of perceptual mechanisms that enable infants and children to optimise their trichromatic colour vision for their environment and use colour to recognise and communicate about objects. Even in infants as young as 4-6 months old, visual sensitivity to different hues shows an asymmetry which relates to the statistical regularity of natural

scenes; infant looking time to hues relates to adult colour preferences; and infant categorisation of the hue spectrum into 5 discrete colour categories aligns strikingly well with those that are commonly made by the world's colour lexicons. Later, at 3-4 years, children are still learning the words for colour categories, and colour constancy is still developing. Colour term knowledge and colour constancy at this age also relate: children who know more colour terms are better at keeping an object colour perceptually constant under changing illumination. The findings identify rudimentary perceptual mechanisms in infancy and early childhood which provide insight into the nature of mature colour perception. I will discuss the implications of these findings for our understanding of perceptual development and the use of colour in perceiving and categorising objects and natural scenes.

Global motion evoked potentials in autistic and dyslexic children: a cross-syndrome approach

Lisa Toffoli[1], Gaia Scerif [2], Margaret J. Snowling [2], Anthony M. Norcia [3] & Catherine Manning [2]

1 Department of Developmental Psychology and Socialisation, University of Padua

2 Department of Experimental Psychology, University of Oxford

3 Department of Psychology, Stanford University

Atypicalities in psychophysical thresholds for global motion processing have been reported in many neurodevelopmental conditions, including autism and dyslexia. Cross-syndrome comparisons of neural dynamics may help determine whether altered motion processing is a general marker of atypical development or condition-specific. Here, we assessed group differences in N2 peak amplitude (previously proposed as a marker of motion-specific processing) in typically developing (n = 57), autistic (n = 29) and dyslexic children (n = 44) aged 6 to 14 years, in two global motion tasks. High-density EEG data were collected while children judged the direction of global motion stimuli as quickly and accurately as possible, following a period of random motion. Using a data-driven component decomposition technique, we identified a reliable component that was maximal over occipital electrodes and had an N2-like peak at ~160 ms. We found no group differences in N2 peak amplitude, in either task. However, for both autistic and dyslexic children, there was evidence of atypicalities in later stages of processing that require follow up in future research. Our results suggest that early sensory encoding of motion information is unimpaired in dyslexic and autistic children. Group differences in later processing stages could reflect sustained global motion responses, decision-making, metacognitive processes and/or response generation, which may also distinguish between autistic and dyslexic individuals.

The role of hue in the perception of object colours

Christoph Witzel

School of Psychology, University of Southampton

Every three-dimensional object produces a polychromatic colour distribution when the corresponding light stimulates the photoreceptors in the eye. Yet, we abstract from the variation along the three dimensions of colour perception when we describe objects, such as when we say, “a banana is yellow”. Here, we investigated how human observers abstract object colours from polychromatic colour distributions. In one experiment, we manipulated the colour distributions of images, and we asked observers to identify the manipulated image in a 4-alternative forced-choice task. Results showed that observers were slower and less accurate in detecting removal of colour variation beyond the main hue direction than in detecting small, but comparable changes of the main hue direction (e.g. the main yellow hue of the banana). These findings suggest that observers focus on the main hue direction and neglect other colour variation in the objects. In a series of additional experiments, we show that striking individual differences found with ambiguous images such as #theDress mainly depend on the main hue direction. We produced new images with an algorithm that projects object colour distributions onto the main hue direction of #theDress, and we measured how observers perceive the colours of those new images. Results showed that these new images yielded similar individual differences as #theDress, suggesting that the main hue direction is the basis for those striking individual differences in colour perception. Together, these findings indicate that the main hue direction, as identified through our algorithm, plays a predominant role in the identification of object colours.

Predicting visual discomfort from images

Olivier Penacchio[1], Sarah Haigh[2], Xortia Ross[2], Rebecca Ferguson[2], Arnold Wilkins[3]

1 School of Psychology and Neuroscience, University of St Andrews

2 Department of Psychology and Center for Integrative Neuroscience, University of Nevada, Reno, NV USA

3 Department of Psychology, University of Essex

Ratings of discomfort from a wide range of images can be predicted by a simple algorithm that has no free parameters. The algorithm fits a 1/f cone to the amplitude of the two-dimensional Fourier transform of the image luminance. The degree of fit is used to assess the extent to which the image departs from the characteristics of natural images, and this correlates with ratings of discomfort. We have extended the approach to include the colour in the image. In general, the discomfort from simple gratings increases with the difference in CIE UCS chromaticity between the bars. A new algorithm with no free parameters assesses the differences in chromaticity between neighbouring image pixels. This explains additional variance in ratings of discomfort.

4th talk session, 4pm-5pm

The effects of carrier spatial frequency and amplitude modulation signal on shape-from-shading depth judgements in older adults

Hannah E Broadbent[1], Andrew J Schofield[2], Harriet A Allen[1]

1 School of Psychology, University of Nottingham

2 School of Psychology, Aston University

The present study aims to assess the effects of age on second-order vision and how reduced carrier visibility in older adults, and subsequent threshold elevation for second-order signals, affects perceived depth from shape-from-shading. Modulations of luminance (LM) are characterised as first-order stimuli whereas contrast- and amplitude modulations (AM) of a carrier signal are characterised as second-order. Critically in-phase and anti-phase combinations of first- and second-order modulations convey different depth percepts via shape-from-shading (Schofield at al., 2006, Vision Research 46, 3462-3482). Twenty-two observers aged 18-25 and 18 observers ages 60+ years took part in a series of experiments. Observers completed a 2AFC task where they were asked to make judgements on which of two stimuli they perceived as more 'depthy'. These stimuli were combinations of LM and AM gratings. We also measured sensitivity for isotropic noise carriers and for AM signals in an orientation discrimination task. We found that stimuli containing LM-only and in-phase combinations of LM & AM components were consistently chosen as most 'depthy' by both age groups compared to AM-only and anti-phase combinations. An increase in carrier spatial frequency did not affect depth judgements in younger adults, whereas the older age group showed reduced ability to discriminate between stimuli when the carrier had high spatial frequency, consistent with reduced AM visibility[SA1] . Research into this field is important in understanding how age-related loss of high spatial frequency detail can alter the perceived depth via shape-from-shading in textured stimuli.

Effect of ageing of optical elements of the human visual system on its contrast sensitivity

Maliha Ashraf[1], Sophie Wuerger[1], Rafał Mantiuk[2], Jasna Martinovic[3,4]

1 Department of Psychological Sciences, University of Liverpool

2 Dept. of Computer Science and Technology, University of Cambridge

3 School of Philosophy, Psychology and Language Sciences, University of Edinburgh

4 School of Psychology, University of Aberdeen

Contrast sensitivity of human visual system declines as it ages even in the absence of any optical pathology (Owsley et al, 1983 Vision Research 23 689-699). This decline in contrast sensitivity results from various physiological changes that happen as humans age. The lens becomes yellower and denser, the pupil become smaller and becomes less flexible, etc. To test this, we collected spatio-chromatic contrast sensitivity data from both younger (mean age: 33, n = 20) and older (mean age: 65, n = 20) colour-normal observers across three colour directions (achromatic, red-green, yellowish-violet), and six luminance levels from 0.02 to 2000 cd/m2. We found that the sensitivity of the younger age group is higher than that for the older age group by 0.3 log units on average. The cut-off frequency of the contrast sensitivity functions decrease with age for all colour directions and the rate of this decline is dependent on the mean luminance level. We modelled these findings as

functions of age-related changes in optical properties of the human visual system. We found that the decline in yellow-violet contrast sensitivity is completely explained by the yellowing of the lens. In case of achromatic, and red-green contrast sensitivity functions, reduction in retinal illumination due to changes in both lens transmission, and pupil size explained the reduced contrast sensitivity.

Metacognition of emotional facial expression judgements

Aurelio Bruno[1], Daniel H. Baker[1,2]

1 Department of Psychology, University of York, Heslington, York, YO10 5DD, UK

2 York Biomedical Research Institute, University of York, Heslington, York YO10, 5DD, UK

The ability to perceive subtle changes in facial expressions is essential for social communication. The extent to which the accuracy of these judgments is accessible to introspection remains unclear. Here, we aimed to investigate how confidence judgments map onto performance for detecting and discriminating facial expressions. We sequentially presented two faces with the same identity, but with different morphed levels of intensity of the same emotional expression. One face carried a nominal 'pedestal' expression (0% or 75%), and the other carried one of 7 expression increments relative to the pedestal. We asked 98 participants to report which had the stronger expression intensity (performance measure) and also indicate confidence in their response (confidence measure). On average, performance thresholds for detection (0% pedestal) and discrimination (75% pedestal) did not differ, corresponding to about 18% intensity increment. However, the psychometric function was shallower for discrimination, meaning that participants could discriminate subtle expression differences better than they could detect them. Participants had surprisingly high confidence when performance was at chance, and this overconfidence was larger for expression discrimination than for detection. This could be because the pedestal reduces uncertainty about which expression is being presented on a given trial. Moreover, the difference between confidence and performance thresholds correlated negatively with performance thresholds, indicating that individuals with worse sensitivity were aware of their poor performance. These results are at odds with the 'Dunning-Kruger' effect and might reveal a more efficient cognitive strategy to interpret facial expressions under uncertainty.

Is it a bird? Is it a plane? Human recognition of biologically realistic flight

Lawson, R.[1], Gardiner, J. G. [1], & Parslew, B. [2]

1 University of Liverpool

2 University of Manchester

People can quickly and accurately recognise many complex, human-performed actions such as walking, dancing and smiling, even when shape cues are minimised, as in point-light-walker stimuli. We investigated whether our expertise at perceiving such biological motion extends to a different mode of locomotion used by non-human animals, namely birds flying. We predicted that, if participants were sensitive to the key factors determining flight, birds should be perceived as flying more naturally when the ratio of wing beat to flight speed maximised propulsive efficiency, with a

Strouhal number of around 0.2 (Nudds & Dyke, 2008 Evolution: International Journal of Organic Evolution 63 994-1002; Taylor et al, 2003 Nature 425 707-711). In three online studies participants rated the naturalness of a series of short animations of simulated bird flight. The flight kinematics of the baseline animation were based on experimental data collected from real bird flight. Wing beat frequency and flight speed were then manipulated systematically. We found no support for the hypothesis that naturalness ratings were predicted by the Strouhal number for the simulation or by the individual expertise of the participant. Nevertheless, ratings were sensitive to variation in both wing beat frequency and flight speed, and also by the size of the bird (manipulated by informing participants that it was a robin versus a goose). These results provide a better understanding of which parameters are important in determining the realism of bird flight. This could, in turn, improve the biologically plausibility of computer graphic animations and flapping, unmanned drones.

Posters

(in alphabetical order of 1st author)

Mapping stereopsis in the central visual field through use of eye-tracking virtual reality technologies

Alex S Baldwin, Tenia Wang, Robert F Hess

McGill Vision Research, Department of Ophthalmology & Visual Sciences, McGill University, Montreal, Quebec, Canada

Our visual system estimates distances to objects by extracting the disparity between the retinal images in the two eyes. In this study, we test our participants' ability to detect disparity in several locations around the central visual field. Previous studies (e.g. Richards & Regan, 1973, Investigative Ophthalmology 12, 904–909) found large "blind spots" when asking participants to detect disparity. Their stimulus was a vertical bar. It was presented on two monitors, combined optically to appear to oscillate in depth. In this study we set out to further investigate this question using a new method. We developed software to present stimuli in a head-mounted virtual-reality display. This device also has an eye-tracking function that allowed us to monitor fixation. The oscillating bar stimulus (4 deg high) was presented at eight locations around the fixation point (eccentricity 22 deg). On each trial the bar either oscillated back and forth in depth (600 arc sec disparity) or side-to-side. Participants ranked their confidence that they saw a bar oscillating in depth. They used a four-point scale, which allowed an ROC analysis to be performed. From this, we obtained the d' discriminability. Thirteen participants underwent five testing blocks. Each block consisted of 96 trials (half were target trials). The d' scores were converted to percent-correct to create maps for each participant. Only one of our thirteen participants showed a location-dependent deficiency in the task. We discuss differences between our task and the previous study that may explain why we did not replicate their results.

Evidence for the intrinsically nonlinear nature of receptive fields in vision

Marcelo Bertalmío[1], Alex Gomez-Villa[1], Adrián Martín[1], Javier Vazquez-Corral[1], David Kane[1] & Jesús Malo[2]

1 Universitat Pompeu Fabra, Barcelona, Catalonia, Spain

2 Universitat de València, València, Spain

The responses of visual neurons, as well as visual perception phenomena in general, are highly nonlinear functions of the visual input, while most vision models are grounded on the notion of a linear receptive field (RF). The linear RF has a number of inherent problems: it changes with the input, it presupposes a set of basis functions for the visual system, and it conflicts with recent studies on dendritic computations. Here we propose to model the RF in a nonlinear manner, introducing the intrinsically nonlinear receptive field (INRF). Apart from being more physiologically plausible and embodying the efficient representation principle, the INRF has a key property of wide-ranging implications: for several vision science phenomena where a linear RF must vary with the input in order to predict responses, the INRF can remain constant under different stimuli. We also prove that Artificial Neural Networks with INRF modules instead of linear filters have a remarkably improved performance and better emulate basic human perception. Our results suggest a change of paradigm for vision science as well as for artificial intelligence.

Does self-movement information influence contrast detection?

Martin Bossard[1], Emily M. Crowe[2], Eli Brenner[2], & Simon K. Rushton[1]

1. School of Psychology, Tower Building, Park Place, Cardiff University, CF10 3AT, Cardiff, United Kingdom.

2. Department of Human Movement Sciences, Institute of Brain and Behaviour Amsterdam, Amsterdam Movement Sciences, Vrije Universiteit Amsterdam, 1081 BT Amsterdam, The Netherlands.

It has been reported that abutting visual motion can change the detectability of a faint stimulus, and it has been suggested that this is evidence for a process that predicts how an image is evolving over time (Roach et al., 2011 Current Biology, 21 740-745). We built on this prior work and investigated, using radial optic flow, whether any predictive process is global in nature. Participants viewed a jittering cloud of dots, with four apertures arranged around fixation. Each trial included two 100ms time intervals. Participants had to judge in which interval a small probe appeared in one of the apertures. During the intervals the cloud of dots (i) continued to jitter, or moved coherently in an (ii) expanding or (iii) contracting radial pattern. Three interleaved staircases controlled the probe contrast level in each condition. The question was whether the presence of coherent global motion would change the contrast detection thresholds for the probe. Our preliminary data suggests it does not. To test the robustness of these findings we are currently exploring the effect of various spatio-temporal parameters such as interval duration and probe dot velocity.

Visual mechanisms that code inter-interactant distance exhibit psychophysical adaptation

Carl Bunce[1], Katie L H Gray[2], Richard Cook[1]

1 Department of Psychological Sciences, Birkbeck, University of London, London, U.K.

2 School of Psychology and Clinical Language Sciences, University of Reading, Reading, U.K.

The physical distance between interacting individuals ("inter-interactant distance") is an important cue when interpreting social interactions viewed from third-person perspectives. Smaller distances often suggest intimate interactions between people who know each other well, while larger distances may suggest professional interactions between people who are less familiar (Hall, 1963 Am. Anthropol. 65 1003–1026). In the present study we sought to determine whether the visual mechanisms that encode this attribute exhibit psychophysical adaptation, whereby prolonged exposure to a particular visual input biases the perception of subsequently viewed stimuli (Webster, 2015 Annu. Rev. Vis. Sci. 1 547–567). Participants were required to judge whether two actors were standing more or less than 1 metre apart, under three conditions: having adapted to a small inter-interactant distance, having adapted to a large inter-interactant distance, and in the absence of any adaptation. Participants' judgements were used to construct psychometric functions. Consistent with previously reported adaptation effects, we find that adapting to large distances makes subsequently viewed dyads appear closer together, while adapting to smaller distances makes subsequently viewed dyads appear further apart. These findings suggest that the mechanisms we use to represent the distance between people exhibit adaptation. Adaptation is thought to reflect the ongoing calibration of the visual system to the ambient environment. One possibility is that inter-interactant distance is represented via opponent-coding whereby distinct neural populations are tuned to small and large distances. Adaptation may modulate the relative excitability of these populations in order to optimise the representation of the interactions around us.

Can background motion nudge people to social distance?

Emily M. Crowe, Jeroen B. J. Smeets, & Eli Brenner

Department of Human Movement Sciences, Vrije Universiteit Amsterdam

'Nudging' is the process of modifying the environment to alter people's behaviour in a predictable manner. An advantage of this technique is that it leads to implicit behaviour change such that people follow the 'nudge' without realising it. The global Covid-19 pandemic calls for novel methods to increase compliance with social distancing. Since nudging overcomes the requirement of pulbic compliance, we will investigate the possibilities of using visual stimuli to nudge people towards social distancing. The manual following response describes the fast response of the hand in the direction of background motion and suggests that background motion is a good candidate to use as a 'nudge'. To identify the parameters of background motion that gave rise to the largest manual following response, we asked participants to hit a static horizontal bar when a second moving horizontal bar was aligned with it. At fixed times during participants' interceptive action, background motion was applied. Participants displayed the largest manual following response when background motion occurred later in the interceptive action and when this motion was abrupt rather than

continuous. Having identified the optimal 'nudge' for the hand, we will now investigate whether background motion can also be used to modify walking trajectories and nudge people to socially distance.

Visual foraging: feature versus conjunction targets and effects of display segmentation

Peter J Goodwin, Filipe Cristino, Duncan Guest, Christina J Howard

Department of Psychology, Nottingham Trent University

Visual foraging is the task of searching for multiple instances of targets within the same display. For example, humans might forage for the silver coins in a pile of spare change. Foraging targets can be defined by one feature (e.g. targets are silver coins) or a conjunction of multiple features (e.g. targets are heptagonal silver coins). At times there may be multiple target types (e.g. targets are bronze round coins and silver heptagonal coins). Participants might sequentially forage for instances of one target type before switching to search the other or they may forage for both types simultaneously. Individuals tend to adopt sequential foraging strategy to a greater extent for conjunction targets than for feature targets (e.g. Kristjánsson et al., 2014, PloS One, 9, 1-9). Segmenting the visual display has been shown to affect performance in classic visual search (Nakashima & Yokosawa, 2013, AP&P, 75, 299-307). However, it is unknown how display segmentation affects visual foraging. We asked participants to search for either forty targets defined by one feature (colour) or forty targets defined by a conjunction of features (colour and shape). Each display contained two target types (e.g. twenty red and twenty green) and participants clicked on targets to remove them from the display. On some trials, displays were segmented into quadrants bound by dividing lines and this segmentation affected participants' foraging strategies. Conjunction targets were associated with longer foraging times and fewer switches between target types compared to feature targets. Cognitive mechanisms for the effects are discussed.

Distractor suppression is a general mechanism that depends on the presence of multiple feature dimensions

Amanda Hardman[1], Thomas Töllner[2], Jasna Martinovic[1,3]

1 School of Psychology, University of Aberdeen

2 Department of Psychology, Ludwig Maximillian University

3 Department of Psychology, School of Philosophy, Psychology and Language Sciences, University of Edinburgh

Attention involves both target selection – directing processing resources towards the target – and distractor suppression – taking processing resources away from the distractor(s). Previous research (Hickey, Di Lollo and McDonald, 2009 J Cogn Neurosci 21:4 760-775) shows that the posterior contralateral negativity difference wave – a neural correlate of attentional selection derived from electrophysiological measurements – is formed through combining negative deflections associated

with target selection and positive deflections reflecting distractor suppression. However, it is still not fully understood how these two subprocesses might operate when targets and distractors are defined along multiple feature dimensions. Somewhat counterintuitively, the dimension weighing model of attentional selection would predict that all neuronal activity associated with the irrelevant feature dimension should be suppressed, even including target features. To evaluate this prediction, we analysed difference wave components related to target selection and distractor suppression when target and distractor were defined along single or multiple dimensions: hue or luminance polarity, with stimuli equated in terms of colour and luminance contrast. All targets and distractors elicited a negative deflection, probably reflecting a general mechanism associated with the initial orientation of attention. Following this, a positive deflection appeared only when multiple dimensions were present within the stimulus, most likely as a product of a suppressive mechanism. We conclude that the distractor suppression mechanisms occur after target enhancement and somewhat counterintuitively (but in line with dimension weighting account) may end up suppressing target features as well as distractor features when these features are irrelevant for selection.

Neural responses to symmetry for surfaces defined by binocular disparity

Karakashevska Elena, Marco Bertamini, Alexis D.J. Makin, John Tyson-Carr and Giulia Rampone.

Department of psychology, University of Liverpool

Visual symmetry generates an ERP component called Sustained Posterior Negativity (SPN). The SPN is generated in the extrastriate visual cortex, and its amplitude correlates with the salience of different symmetries. EEG studies have shown that the brain response to visual symmetry is automatic, and not altered by the participants' task. So far, the SPN has been tested with luminance-defined stimuli. We used shapes defined within random dot stereograms (RDS). In Experiment 1, we compared the SPN signal for contours specified solely by binocular disparity and contours containing contrast differences. We found that the SPN is equivalent for disparity and contrast-defined contours. Therefore, at suprathreshold level, the contour specification does not alter the SPN signal once the shape is visible. In Experiment 2 we used RDS to provide unambiguous figure-ground arrangements. Psychophysical work has shown that symmetry is more easily discriminated when it is a property of a single object (i.e. within a figure), compared to a property of a gap between objects (i.e. in the ground). Therefore, the symmetrical region could either be in the foreground or in the background. Our findings show no figure-ground modulation of SPN amplitude. However, there was a clear delay in SPN onset when the symmetry was in the ground, possibly because object formation interferes with the processing of shape information. In summary, we have confirmed for the first time a robust response to symmetry for disparity-defined contours, and started the study of the contributions of different factors to symmetry perception.

Are we practicing cumulative science? An exhaustive analysis of 6674 brain responses from 2215 participants in 40 projects.

Alexis D.J. Makin, John Tyson-Carr, Giulia Rampone, Yiovanna Derpsch and Marco Bertamini.

Department of psychology, University of Liverpool

For the last decade, we have been investigating the brain response to visual symmetry using an Event Related Potential (ERP) called the Sustained Posterior Negativity (SPN). The last decade has also seen growing anxiety about the trustworthiness of published science. For example, Bishop (2019) claims that many researchers work in ways almost guaranteed not to deliver meaningful results. Do these broad critiques apply to our SPN work? To investigate, we reanalyzed and catalogued all 249 grand-average SPNs ever recorded in Liverpool (6674 individual ERPs from 2215 participants). We then applied Bishop's four horsemen framework to evaluate our own practice. Based on quantitative analysis of effect size, reanalysis of EEG data using alternative pipelines, and some necessary qualitative consideration, we award ourselves a grade of A- for publication bias (Horse 1), C+ for statistical power (Horse 2), B+ for P-hacking (Horse 3) and B for HARKing (Hypothesizing After Results Known, Horse 4). The grades serve as meta-scientific discussion points - they are not completely objective or bias-free. Indeed, they only become interesting when questioned: Are they are good approximation? Are other labs better or worse? Compilation of the complete SPN catalogue also had conventional scientific value. It was possible to analyze the whole data set and glean new insights into symmetry perception that cannot be obtained from a single experiment. Furthermore, we have made the complete SPN catalogue public so others can conduct their own reanalysis. This is one obvious way science can become more transparent and trustworthy in future.

Bishop, D. (2019). Rein in the four horsemen of irreproducibility. Nature. Nature Research. https://doi.org/10.1038/d41586-019-01307-2

A novel 'chirp' stimulus protocol for assessing photoreceptor function across wavelength, time and contrast

Dr Joel Martin, Institute of Biomedical Engineering, University of Oxford

Dr Daniel Bulte, Institute of Biomedical Engineering, University of Oxford

Dr Manuel Spitschan, Department of Experimental Psychology, University of Oxford

The pupillary light reflex (PLR) is a widely used non-invasive tool to assess photoreceptor function. The most commonly used stimulus in clinical practice is a flash of white light, which activates all photoreceptors in the retina — rods, cones, and the intrinsically photosensitive retinal ganglion cells (ipRGCs) expressing the photopigment melanopsin) — non-selectively. The post-illumination pupil response (PIPR) method improves on this, describing the sustained constriction of the pupil following exposure to short-wavelength light relative to long-wavelength light. Here, we develop a novel 'chirp' stimulus comprising frequency and amplitude modulations designed to efficiently examine the frequency and contrast response characteristics of the ipRGCs and other retinal photoreceptors. Pilot data (n=2) were collected with a novel custom-built ganzfeld stimulation and measurement system using radiance-matched 53-second 'chirp' stimuli at different wavelengths (445, 475, 525, 660 nm), frequencies (0.01–0.5 Hz) and intensities under homogeneous peripheral stimulation. In addition to the conventional PIPR metrics, the resulting response waveforms revealed wavelength-specific features in the pupil response. This novel stimulus protocol may offer a more

fine-grained representation of the photoreceptor function while avoiding the technical complexities of more advanced, photoreceptor-selective stimulation protocols such as the method of silent substitution. Future work will focus on optimising the stimulus profile and developing analysis techniques.

Age related differences in perceived saturation as a function of stimulus size: a comparison of appearance and thresholds

Ana Rozman[1], Jasna Martinovic[1,2]

1 School of Psychology, University of Aberdeen

2 Department of Psychology, School of Philosophy, Psychology and Language Sciences, University of Edinburgh

Saturation of stimuli presented in the parafovea depends on stimulus size with smaller stimuli appearing desaturated. This desaturation is more pronounced in older compared to younger observers (Knau and Werner, 2002 JOSA A 19 208-2014). We assessed the dependency of saturation on stimulus size for colours that isolated the two cone-opponent mechanisms (L-M, S-(L+M)). While the previous study relied on Maxwellian viewing of pure wavelength stimuli, we presented our stimuli on a CRT device. Younger (aged 22-39 years) and older (60-82 years) observers matched perceived contrast of a reference 2˚ circular colour patch by adjusting contrast for patches of varying sizes (2˚, 1˚, 0.5˚, 0.33˚, 0.20˚, 0.15˚), presented at either 4˚ or 5˚ eccentricity from fixation. Colours were defined along cardinal directions of cone opponent colour space (reddish, greenish, blueish, yellowish). Data showed a decrease in saturation for stimuli sizes below 0.33° for younger and 0.5° for older observers. The effect was present for all colours and was strongest for bluish stimuli. Desaturation was more pronounced for older observers overall. Our findings are in line with predictions based on both optical and neural factors. We additionally measured contrast detection thresholds for a group of younger observers (22-34 years) on a subset of matching stimuli. Detection thresholds increased with a decrease in stimulus size but this effect was even across all colours. As thresholds follow a different pattern to perceived contrast, they are not able to fully explain the observed desaturation.

Age-related changes in low and mid-level vision: assessing the information degradation and neural inhibition accounts

Josephine Reuther[1], Ramakrishna Chakravarthi[1] and Jasna Martinovic[1,2]

1 School of Psychology, University of Aberdeen,

2 Department of Psychology, School of Philosophy, Psychology and Language Sciences, University of Edinburgh

Advancing age is accompanied by several changes to the visual system. In addition to physical/optical changes to the lenses' flexibility and opacity, healthy aging also coincides with

neuronal changes. Two prominent models attribute the latter either to a reduction in neural inhibition or to an increase in neural noise. In a sample of forty normal sighted participants (aged 42.6 ± 14.3 years), we assessed visual acuity (VA), contrast sensitivity, masking, crowding and grouping. While losses in acuity and contrast sensitivity would lead to subsequent reduction in overall processing efficiency, as predicted by the information degradation hypothesis; masking, crowding and grouping involve processing of multiple features and could be more subject to changes in neural inhibition (Monge & Madden, 2016 NeuroBioRev 69 166-173). All measures of spatial resolution (near & far VA, and peak & cut-off spatial frequency) were found to be reduced with age. These spatial measures of information degradation, as well as advancing age also translated to increased baseline contrast thresholds for target detection, orientation discrimination and feature integration in the masking, crowding and grouping tasks. Similarly, they coincide with an increase in the distance over which flankers interfered with target detection and discrimination. Hence, we found that ageing leads to a degradation of the visual information in the form of reduced spatial resolution and efficiency of contrast processing, which coincides with an increase in the distance over which flankers interfere with target detection and discrimination. This is largely in line with the predictions from the information degradation hypothesis.

Impact of verbal instructions and object rotation on the perception a shape

Līga Zariņa, Jurģis Šķilters, Diāna Ritere

Laboratory for Perceptual and Cognitive Systems, Faculty of Computing, University of Latvia

Research evidence (as summarized by Lupyan et al., 2020, Trends Cogn Sci, 24(11), 930–944) shows that language impacts perception. In two sets of experiments we tested the impacts of (a) verbal instructions and (b) degree of object rotation on the shape perception. The stimuli in our experiments were (1) upright square / tilted diamond, or (2) rhombus / upright diamond (tilted square) (Palmer, 1985, Acta Psychol, 59(1), 67-90), and (3) shapes representing gradual rotation (15 in each step) starting from stimulus position (1) to (2). First, an eye-tracking experiment (stimuli (1), (2)) indicates that instructions induce a focused distribution of fixations. Fixation durations are longer on the horizontal axis when observing without and on the vertical axis when observing with instructions. Second, a forced-choice task on the perception of a rotated square (stimuli (3)) shows that instructions impact whether an object is perceived as a rhombus or a square. Instructions induces larger corresponding categories of rotated shapes. The most balanced gradual transformation from square to rhombus occur in the control group without prior instruction. Our study indicates that (a) instructions impact shape perception both in eye movements and meaning assignment of gradually rotated shape but the impacts are subtler than previously assumed, (b) linguistic impacts support a more categorical perception.