Farran Briggs
Ernest J. Del Monte Institute for Neuroscience, Department of Neuroscience, University of Rochester

Title: Network mechanisms of visual attention

Abstract:
Visual attention enhances the signal to noise ratio of neuronal responses in the visual cortex, however the mechanisms by which these attentional modulations occur are not known. We are currently harnessing the power of local field potentials (LFPs), which are thought to represent activity in local networks of neurons, to better understand the neuron- and circuit-specific underpinnings of attentional modulation. We recently discovered that phase shifts in high-beta to low-gamma LFPs can serve as robust and consistent proxies for attention in the early visual pathways. We also observed consistent dynamics in the communication of attention signals between the visual thalamus and primary visual cortex during the course of the attention task. Our next goal is to examine specific relationships between neuronal spikes and LFPs recorded on the same electrodes to better understand changes in local network activity that lead to attentional modulation of neuronal spiking rate and signal-to-noise.

Our approach is to recorded LFPs simultaneously in multiple early visual structures of alert and behaving macaque monkeys performing attention-demanding detection or discrimination tasks. We measure changes in LFP amplitude and phase across attention conditions, coherence and Granger Causal interactions between visual structures including the visual thalamus and the layers in primary visual cortex, and reverse correlation and spike-triggered analyses of LFPs. In addition to identifying robust and consistent proxy signals for attention (e.g. LFP phase shifts) and dynamics in communication of attention signals across structures, we are focused on identifying LFP-based predictors of attentional modulation of neuronal spiking activity with millisecond resolution.

Preliminary data suggest that temporal dynamics in LFPs are behaviorally relevant and enable attention to prioritize the communication of relevant visual stimulus information. Spike-LFP analyses reveal structure in LFP wavelets that is predictive of attentional modulation of neuronal spiking rate. Together, our results suggest that the LFP is an information-rich neuronal signal that can provide important insight into the neuronal and circuit-level mechanisms of visual attention.

A Comparison of Three Cognitive Tasks and Five Analytical Methods in Identifying Infectious Diseases from ERP Measures

Bruce Brown, Logan Kowallis, Lance Erickson, Shawn Gale, and Dawson Hedges
Brigham Young University
Forty-Third Annual Interdisciplinary Conference
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Jackson Hole, Wyoming

Abstract

A number of studies have established a connection between infectious disease and psychometrically-measured cognitive function in adults (see Gale, et al, 2016 for a review), and there have been recent EEG demonstrations (Gajewski, et al, 2016) of diminished P300 for older subjects who have latent toxoplasmosis. Methods of ERP analysis differ in their relative power in identifying the effects of infections, as do the tasks employed in measuring working memory. In this study, five types of ERP analysis (standard ERP components such as P300, wavelets, Dien's ERP PCA Toolkit, cognitive spectral bands analysis, and linear models R2 decomposition) are tested in combination with three cognitive tasks (the n-back task, Sternberg memory-search paradigm, and a visual oddball task), in their relative power to identify each of four infectious diseases in older adults (toxoplasmosis, helicobacter pylori, HSV-1, and hepatitis C). Comparisons of the various combinations of ERP analysis methods, cognitive tasks, and type of infection are made using ROC curve signal detection analysis, cluster separation methods, lens model analysis, and training & test detection methods.

The Ocular Dominance Architecture: A Functional Theory

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No theory has emerged for cortical columns that satisfactorily accounts for the bewildering array of data in different sensory systems and species (Horton & Adams, 2005). A particularly vexing case involves ocular dominance columns, which are found in a variety of frontal-eyed animals including carnivora and primates, but not all primates. Yet primates without ocular dominance columns appear to have normal stereopsis. As pointed out by Horton and Adams, this seems distinctly problematic for the view that ocular dominance columns have a special functional role. Here I shall develop the proposal that ocular dominance columns do endow their possessors with special capabilities. In particular, ocular dominance columns provide the substrate for two functionally distinct classes of binocular neurons: correlation cells and anti-correlation cells. Correlation cells produce nonlinear binocular facilitation that depends on precise phase/position differences in the two eyes. In contrast, anti-correlation cells receive excitation through one eye and disparity-dependent inhibition through the other eye. Therefore, anti-correlation cells conserve eye-of-origin information and provide a substrate for representing the monocular image zones upon which da Vinci stereopsis is based. Just as significantly, anti-correlation cells provide a graded binocular inhibition that generates the Near/Far error signals for vergence eye movements. Predictions arising from this, and connections to eye movement data shall be discussed in some detail. We argue that these ocularly asymmetric, anti-correlation cells are the primary purpose of the ocular dominance architecture, underlying the operation of a primitive binocular system that permits fine ocular alignment and hence the experience-dependent bootstrapping of the fine correlation-based system. A prediction of this theory is that primates that don't have ocular dominance columns lack a complement of anti-correlation neurons and hence depend on other behaviors/cues to develop their correlation-based stereo system. Consistent with this idea is the observation that juvenile monkeys of species without ocular dominance columns are known to frequently make a variety of head movements, apparently employing motion parallax in the absence of the primitive binocular segmentation system.

Perceptual learning in n-alternative forced choice with response and accuracy feedback, and a reweighting model.

Barbara Dosher

Visual perceptual learning has, with few exceptions, been investigated in the context of two-alternative forced (2AFC) choice tasks. Here we examined the phenomena of perceptual learning in nAFC (here 8AFC) perceptual tasks, which is formally related to learning in absolute identification. We elaborated and extended the Integrated Reweighting Theory (Dosher et al., 2013) to n alternative identification by using multiple decision units and a max rule to model these data. Our studies examined learning in 8AFC tasks in the context of orientation identification or spatial frequency identification, in some cases contrasting response feedback and accuracy feedback. The nAFC model extension provides a good account of learning, when it occurs, percent correct, weighted κ, and confusion matrices.

Collaborators: Jiajuan Liu & Zhong-Lin Lu

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Scaling of Shape Perception

James Elder

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A considerable portion of primate visual cortex is involved in the coding of object shape. While objects in our visual world are generally 3D, the boundary of a 3D object projects to the retina as a closed 2D contour, and the shape of this contour provides important information about object shape and identity.

2D shape information ranges over many spatial scales. In this talk I report results from two empirical studies that examine the scale-tuning of human perceptual shape mechanisms. Results of the first study demonstrate that human judgements of local curvature are scale invariant. Results of the second study show that the linear component of shape discrimination is low-pass, biased to coarse-scale features. Together these results provide useful constraints on plausible models for neural shape coding mechanisms.

Decision-Variable Correlation

Wilson S. Geisler & Stephen Sebastian

University of Texas at Austin

A straightforward extension of the signal detection theory (SDT) framework is described and demonstrated for the two-alternative identification task. The extended framework assumes that the subject and an arbitrary model (or two subjects, or the same subject on two occasions) are performing the same task with the same stimuli, and that on each trial they both compute (in effect) values of a decision variable. Thus, their joint performance is described by six fundamental quantities: two levels of intrinsic discriminability ("d-prime"), two values of decision criterion, and two decision-variable correlations, one for each of the two categories of stimuli. We demonstrate the framework for the well-known task of detecting a Gaussian target in white noise. We find that (1) subjects' DVCs are approximately equal to the square root of their efficiency relative to ideal (in agreement with the prediction of a popular class of models), (2) between-subject and within-subject (double-pass) DVCs increase with target contrast and are greater for target-present than target-absent trials (rejecting many models), (3) model parameters can be estimated by maximizing DVCs between the model and subject, (4) a model with a center-surround template and a specific (modest) level of position uncertainty predicts the trial-by-trial performance of subjects as well (or better) than presenting the same stimulus again to the subjects (i.e., the double-pass DVCs), and (5) models of trial-by-trial performance should not include a representation of internal noise. The extended SDT framework should be widely applicable in behavioral and neurophysiological studies of perception and cognition.

Title: Attention model of binocular rivalry

David Heeger
Julius Silver Professor of Psychology and Neural Science
New York University

Abstract: When the corresponding retinal locations in the two eyes are presented with incompatible images, a stable percept gives way to perceptual alternations in which the two images compete for perceptual dominance. As perceptual experience evolves dynamically under constant external inputs, binocular rivalry has been used for studying intrinsic cortical computations, and for understanding how the brain regulates competing inputs. Converging behavioral and EEG results have shown that binocular rivalry and attention are intertwined: Binocular rivalry ceases when attention is diverted away from the rivalry stimuli. In addition, the competing image in one eye suppresses the target in the other eye through a pattern of gain changes similar to those induced by attention. These results require a revision of the current computational theories of binocular rivalry, in which the role of attention is ignored. Here, we provide a novel computational model of binocular rivalry. In the model, competition between two images in rivalry is driven by both attentional modulation and mutual inhibition, which have distinct selectivity (feature vs. eye-of-origin) and dynamics (relatively-slow vs. relatively-fast). The proposed model is the first to explain a wide range of phenomena reported in rivalry, including the three hallmarks: (I) Binocular rivalry requires attention; (II) Various perceptual states emerge when the two images are swapped between the eyes multiple times per second; (III) The dominance duration as a function of input strength follows Levelt's propositions. With a bifurcation analysis, we identified the parameter space in which the model's behavior was consistent with experimental results.

Individual Identification Using Functional Brain Fingerprint Detected by Recurrent Neural Network

Xiaoping Hu

Department of Bioengineering, UC Riverside, California, CA

Investigating individual differences in brain connectivity and using individual identification as a method to understand brain mechanism has gained a lot of attention recently. In this work, we introduce a recurrent neural network based model that can identify individuals with only a short segment (70 s) of resting state fMRI data. In addition, we demonstrate how global signal and different atlases affected the individual discriminating power and which neuronal features are important in terms of the uniqueness of each individual. Our results also indicate that features important for individual identification provide additional insights regarding the brain dynamics.

Examining the invariance of word processing: Do manipulations of size affect size judgments?

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Numerous studies have shown that the processing of linguistic stimuli is respectively facilitated or hindered by perceptually or motorically consistent vs. inconsistent contexts. These findings have been used as evidence that our semantic representations are embodied or grounded in sensorimotor experiences. At last year's mini AIC meeting, I presented studies failing to show that manipulations of perceptual information (i.e., text size manipulated to be congruent or incongruent with an object's actual size) had effects on the memory, property judgments, lexical or semantic decisions about words. The current research continued this work by presenting participants with the same stimulus items and asking them to make explicit judgments regarding 1) the word's appearance according to text size, 2) the size of the item the word represents, or 3) whether the item is something than can be grasped and held in one's hand. Like our previous findings, the size manipulations generally failed to result in significant effects, even though participants had to explicitly process and make decisions about size. These results suggest that word processing is indeed invariant of perceptual appearance and potentially challenge the embodiment of semantics, although some issues and potential explanations will be discussed. We have recently started similar studies with manipulations of color. Depending on the status of this work and if time permits, I may also present our initial findings involving color.

Estimation of gloss and shape from vision and touch

Michael S. Landy, Gizem Küçükoğlu & Wendy J. Adams

The image of an object depends on many factors: the object's shape, surface material and the light field. Thus, it would be sensible for the visual system to jointly estimate all three, leading to the hypothesis that varying cues to shape should impact perceived gloss and vice versa. We present several sets of experiments in which participants judged gloss and/or shape. In one experiment, objects were rendered in one light field (taken from the Southampton-York Natural Scenes dataset of high dynamic range, natural light fields), and sometimes placed with a background from a different or altered light field. We found modest but systematic effects of the incongruent light field suggesting that observers are sensitive to the context in which objects are presented when making judgments of surface gloss. When participants rated gloss and shape against physical scales (real objects varying in gloss or bumpiness), perceived gloss increased with rendered gloss and bumpiness. Although perceived bumpiness was largely independent of physical gloss, bumpiness was increasingly underestimated as depth increased. This supports the hypothesis that shape and gloss are jointly estimated: underestimation of shape is coupled with overestimation of gloss, consistent with the effects of these two variables on images of physical objects. Finally, we modified perceived shape by allowing participants to touch an object (with a haptic force-feedback device). Stretching the object along the line of sight did not affect perceived gloss, but changing the qualitative shape of a bi-stable stimulus had substantial effects: matte objects became glossy or vice versa.

Efficient Assessment of the Time Course of Perceptual Sensitivity Change

Zhong-Lin Lu, Yukai Zhao, Luis Lesmes

Perceptual sensitivity is usually estimated over trials and time intervals, which results in imprecise and biased estimates when it changes rapidly over time. We develop a novel procedure, the quick change detection (quick CD) method, to accurately, precisely, and efficiently assess the time course of perceptual sensitivity change. Based on Bayesian adaptive testing, quick CD selects the optimal stimulus, and updates, trial by trial, a joint probability distribution of the parameters that quantify perceptual sensitivity change over time. We demonstrate the utility of this measure using a dark adaptation experiment, in which the time course of visual sensitivity change was measured with quick CD and quick Forced-Choice (quick FC, Lesmes et al., 2015) methods in separate sessions. Simulations showed that the accuracy and precision of the estimated dark adaptation curve after one quick CD run (average absolute bias (AAB) = 0.002; the half width of the 68.2% credible interval (68.2% HWCI) = 0.017; standard deviation (SD) = 0.020; all in log10 unit) was higher than those obtained by 10 runs of quick FC (AAB = 0.015; 68.2% HWCI = 0.032; SD = 0.031) and a staircase procedure (Kaernbach, 1991) (AAB = 0.019; SD = 0.031). Further, the dark adaptation curve obtained from one quick CD run in a psychophysics experiment was highly consistent with the average of four quick FC runs (RMSE = 0.088 log10 unit). Overall, quick CD can characterize the time course of perceptual sensitivity changes in both basic research and disease progression and treatment.

Spatial Reference Systems in Spatial Updating

Timothy McNamara

Humans and other animals must update the spatial relations between their bodies and elements of the surrounding environment to stay oriented as they navigate. Spatial updating that relies solely on cues that are not themselves informative about position (e.g., vestibular & proprioceptive information; optic flow) is called path integration. We investigated the relative importance of egocentric and allocentric reference systems in spatial updating and path integration in experiments that manipulated the availability of body-based cues to self-motion, environmental geometry and features, familiarity of the environment, and cognitive strategies. Our results indicated that only two variables affected the spatial reference systems used in spatial updating and path integration: The availability of body-based cues to self-motion and spatial updating strategy. Environmental geometry and features had no influence on the selection of spatial reference systems, in contrast to their powerful effects on spatial memory.

Discovery of activities via statistical clustering of fixation patterns

Jeffrey Mulligan

Human behavior often consists of a series of distinct activities, each characterized by a unique pattern of interaction with the visual environment. This is true even in a restricted domain, such as a piloting an aircraft, where activities with distinct visual signatures might be things like communicating, navigating, and monitoring. We propose a novel analysis method for gaze-tracking data, to perform blind discovery of these hypothetical activities. The method is in some respects similar to recurrence analysis, but here we compare not individual fixations, but groups of fixations aggregated over a fixed time interval. The duration of this interval is a parameter that we will refer to as delta. We assume that the environment has been divided into a set of N different areas-of-interest (AOIs). For a given interval of time of duration delta, we compute the proportion of time spent fixating each AOI, resulting in an N-dimensional vector. These proportions can be converted to integer counts by multiplying by delta divided by the average fixation duration (another parameter that we fix at 280 milliseconds). We compare different intervals by computing the chi-square statistic. The p-value associated with the statistic is the likelihood of observing the data under the hypothesis that the data in the two intervals were generated by a single process with a single set of probabilities governing the fixation of each AOI. The method has been applied to approximately 100 hours of eye movement data collected from pilots in a high-fidelity B747 flight simulator, and the results have been compared to synthetic data in which the each activity is represented as first-order Markov process with random probabilities assigned to the AOIs. Randomly-generated synthetic activities can require thousands of fixations to be discriminated with statistical significance, while the human data can be clustered using averaging windows of some 10's of seconds, suggesting that the actual activities are much more narrowly focused than random Markov models.

Title: Computational model based approaches to monitoring affective states and their dynamics

Misha Pavel and Holly Jimison

Affective state is considered an increasingly important determinant of human performance and health, as well as a significant factor in the assessment of cognitive of function. The ability to understand, interpret and predict behaviors in real time, therefore, depends on our ability to monitor continuously individuals' affective states and their dynamics. The assessment of affective states, or even their rigorous definition is still challenging our capabilities and methodology. Recent advances in wearable devices are bringing us closer to the goal of continuous assessment, but these methods are still plagued with a variety of uncertainties, data anomalies and distortions. In this presentation, I will describe model-based approaches to a variety of continuous physiological measurements that inform us of affective states and their dynamics using heart rate variability, electrodermal activity and accelerometry from wrist-worn devices. The underlying models borrow from stochastic signal analysis, nonlinear systems analysis and physiological modeling. The data processing techniques deployed in our analyses include singular spectrum analysis and non-negative signal deconvolution. We will describe how these approaches can be used to develop insights into the affective states dynamics.

Multidimensional encoding of brain connectomes: building biological networks with preserved edge properties to study the visual white matter

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The ability to map brain networks in living individuals is fundamental in efforts to chart the relation between brain and behavior in health and disease. We present a framework to encode brain connectomes and diffusion-weighted magnetic resonance data into multidimensional arrays. The framework goes beyond current methods by integrating the relation between connectome nodes, edges, white matter fascicles and diffusion data. We demonstrate the utility of the framework for in vivo white matter mapping and anatomical computing by evaluating more than 1,400 connectomes across thirteen tractography methods and four data sets in normal and clinical populations.

We show that this framework allows mapping connectivity matrices, edge anatomy, and microstructural properties of the white matter tissue in each connectome edge. The framework is based on statistical evaluation principles introduced with the Linear Fascicle Evaluation and virtual lesions methods (LiFE; Pestilli et al., 2014). In short, instead of building networks by relying uniquely on the terminations of fascicles into the cortex, we exploit the full measured signal available for each connectome edge by extracting a forward-prediction of the biological tissue properties of the edge. We validated the framework by comparing results with standard connectome measures (fiber count and density). To do so, we generated ten repeated-measures connectomes in each individual brain in various datasets, using different tracking methods. For each connectome estimated in an individual, we computed the mean network clustering coefficient across repeated measures. We demonstrate high reliability of the clustering coefficients. We also demonstrate profound differences in connectomes across brains, beyond what can be captured using standard measures (fiber density). We also show that the proposed method is highly sensitive to differences between individuals by improving subject classification into various diagnostic groups. Finally, we show that the framework is useful in clarifying fundamental properties of the human visual white matter as well as identifying useful network science biomarkers for predicting degenerative changes in the Alzheimer's brain.

We publish the method with software compatible with data from the Human Connectome Project, the Alzheimer Disease Neuroimaging Initiative, and Indiana Alzheimer Disease Center Data. The software integrates the Brain Connectivity Toolbox and is available open source www.github.com/brain-life and stand-alone at hub.docker.com/u/brainlife and as open service at www.brainlife.io

Modeling Numeracy Decisions on a Continuous Scale

Roger Ratcliff

The Ohio State University

I present a model for decision making for stimuli and responses in continuous space. The model is applied to three numeracy tasks: in one, a two-digit number is presented and the participant has to move their finger to a matching location on a number line, in the second, an array of dots is presented and the participant is to move their finger to a matching location on an arc, and in the third, an array of dots is presented and the participant has to speak the number. The model is composed of diffusion processes on lines and planes in which evidence from a stimulus (distributed across space) drives the noisy decision process which accumulates evidence over time to a criterion at which point a response is initiated. Noise is represented as a continuous Gaussian process. The model produces fits for the full distributions of response times and choice probabilities across the stimulus space and provides distributed stimulus acuity measures.

The encoding of binocular disparity in primary visual cortex

Jenny Read (presenting), Sid Henriksen, Dan Butts, Bruce Cumming

Primate stereopsis is remarkably precise and can break camouflage, revealing structures that are monocularly invisible. This ability depends on matching up the two eyes' images, a process which begins with disparity-sensitive neurons in primary visual cortex, V1. The currently accepted model of these neurons is a 3-layer linear/nonlinear neural network. The weights from the input layer to the hidden layer represent binocular simple-cell receptive fields. These simple cells then converge onto a single V1 complex cell.

With the right parameters, this model can reproduce many general properties of V1 neurons, notably their attenuated responses to anticorrelated images. Here, contrast is inverted in one eye, meaning there are many false local matches but no global depth. However, attempts to fit these models to V1 neurons using spike-triggered covariance have not shown this attenuation. Thus it is unclear whether this model really describes how V1 works.

We have used a new machine learning approach to train models on correlated, uncorrelated and anti-correlated random-line patterns with a range of disparities. Despite being given only raw images – not disparity or correlation – as input, the model predicts disparity tuning curves well for all three correlations. This shows for the first time that these models can describe individual V1 neurons. However, many neurons show very high activity for one preferred disparity, which the models cannot capture. This suggests that the real puzzle of V1 neurons may not be how they attenuate their response to false matches, but how they boost their signal for one preferred disparity.

Exploring Structural Mechanisms of Synapse Connectivity

Susanne Ressl

Proper brain function is based on neuronal networks, which are based on synapses, the fundamental unit of neuronal communication. Synaptic adhesion proteins bind across the synaptic cleft to form complexes tethered to both pre- and post-synaptic membranes. Dysfunction of synaptic adhesion proteins cause brain disorders, 'synaptopathies'. Members of the family of complement component 1, q subcomponent-like proteins (C1QL1-4) promote synapse organization (*1*, *2*). The underlying mechanism is unknown. Genetic analysis on *C1ql3* revealed its expression in the limbic system with phenotypes of hyperactivity, sleeping disturbances, and a deficit in forming emotional memories (*3*)(*4*). C1QLs are secreted into the synaptic cleft and bind to a post-synaptically localized G protein-coupled receptor (GPCR) called adhesion GPCR B3 (ADGRB3) (*1*, *2*). This raises the question whether C1QL has potential to bi-directionally coordinate a trans-synaptic complex to mediate a ternary complex that influences synapse homeostasis. Moreover, C1QLs' electrostatic surface is distinct from each other and they can form higher oligomer species (*5*), which together with calcium specificity dictate the nature of binding and stoichiometry, resulting in a novel mechanism of how trans-synaptic adhesion is achieved.

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2. W. Kakegawa *et al.*: *Neuron*. **85**, (2015).
3. D. C. Martinelli *et al.*: *Neuron*. **91**, (2016).
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Assessing Consciousness in the Vegetative State: A proposal

Adina L. Roskies

In this talk I suggest how to significantly improve experimental paradigms to communicate with brain damaged patients who lack behavioral means to indicate their thoughts. I will explain the current state of neuroimaging experiments that enable researchers to assess levels of consciousness in unresponsive, brain-damaged patients diagnosed to be in a Persistent Vegetative State (PVS). These have shown that a significant proportion of clinically diagnosed patients are misdiagnosed, because even though they lack behavioral abilities, they retain consciousness and higher cognitive capacities. Using this technology, we now have the possibility of engaging in two-way communication with these patients. However, there are significant limitations associated with these communicative technologies, and these complicate dealing with the moral issues surrounding the care of these patients. I suggest a potential way to augment current experiments, one that will provide more purchase on assessing levels of consciousness and on cognitive competence.

Segmenting the human LGN using a temporal response model

Keith Schneider

The thalamus is an important subcortical structure that regulates the flow of information throughout the brain. Most of the interesting perceptual processes operate at time scales one or two orders of magnitude faster than the temporal resolution of fMRI. However, it is still possible to study temporal processing in deep structures in the human brain through analysis of aggregate and modeled population responses. I will present the results of some of our recent work investigating the temporal frequency responses and transient/sustained channels in the human lateral geniculate nucleus (LGN) and thalamic reticular nucleus. We are able to segment the magno- and parvocellular sections of the LGN based on temporal response properties. These results will help us to understand the dynamics and fundamental mechanisms of perception.

A brief review, with demos, of the evidence that there are three independent systems that compute a perceived direction of motion from visual inputs.

Sperling, G., Lu, Z-L, Chubb, C., and Sun, P.

This review is concerned with the basic algorithms the visual system uses to extract motion direction from a sequence of pixel images. Visual systems from drosophila to humans seem to have three classes of motion extracting mechanisms (1st, 2nd, and 3rd order) that are distinguished by the preprocessing of the input prior to the motion extraction algorithm. The motion extraction algorithm itself seems to be similar in all classes but with different parameters. The input to first order motion is primarily the normalized input stimulus filtered into oriented spatial frequency bands, modeled by yoked V1 simple cells in which one member of the pair represents positive contrasts and the other negative contrasts. The input to 2nd-order motion is local contrast energy, essentially the local variance (absolute value) of the input to 1st order. The input to 3rd-order motion is a figure-ground map or, more accurately, a salience map. Under normal circumstances, the three systems combine their outputs. The three systems can be distinguished by selective adaptation, by oppositely directed afterimages at the same retinal location, and by phase dependence. That is, for two weak sinewave stimuli of the same spatial and temporal frequency, same orientation, and same motion direction, there is phase independence when they are delivered to different systems, and strong phase dependence (motion cancellation or enhancement) within the same system. For ambiguous stimuli containing oppositely directed motion, the higher-order motion direction tends to be perceived in the fovea, the lower-order in the periphery. New barber-pole illusions and plaid motion stimuli that move in opposite directions depending only on the temporal frequency or on central versus peripheral viewing were predicted by and are explained by the relative contributions of the different systems.

Binocular vision requirements for aircrew

Laurie M. Wilcox, Centre for Vision Research, Department of Psychology, York University
Co-author Brittney Hartle

Title: Mechanisms of Action's Effect on Spatial Perception Illuminated by Individual Differences

Jessica Witt

Abstract: A person's ability to act can influence spatial perception of the target objects. For example, objects that are harder to block appear faster. How does action exert its influence on perception? To answer this question, we used an individual differences approach. We compared magnitude of action's effect on perception with the magnitude of other perceptual phenomenon including context effects, affordance perception, multimodal perception, and sensitivity to biological motion.
Bayesian analyses revealed strong evidence that there were no relationships among these factors, suggesting that action's effect on perception does not engage the same processes as those underlying these other illusions. The data are consistent with the possibility of a novel mechanism for which a person's potential for action impacts spatial perception.

When Color and Shading Flow Together

Steven W. Zucker

Visual cortex is organized around orientation, which is well studied for luminance and contrast, and from which many aspects of perceptual organization (including shape-from-shading) emerge. Color, unlike contrast, is not well studied in the orientation domain. Rather, spatio-spectral information is normally summarized with differences of isotropic averages (over wavelength and position).
Such opponency is natural for coding efficency but problematic for inferring appearance.
We here combine an orientation-based approach for intensity with one for color, and
ask: what organizational properties emerge from the interaction between orientation information in the intensity domain with those in the color domain. A variety of lighting, texture, and material effects are revealed.
(Joint research with Emma Alexander (Harvard), Daniel Holtmann-Rice (Google), Benjamin Kunsberg (Brown), and Roland Fleming (Giessen).)