

Monday

◆ **A model of perceived bar rotation, the Venetian-blind effect, in square-wave gratings as a function of contrast disparity**

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When a square-wave grating with either luminance or contrast disparity is viewed, one often perceives a rotation of the individual bars (the Venetian-blind effect: Cibis and Haber, 1951 *Journal of the Optical Society of America* **41** 676–683; Filley and Stine, 1998 *Perception* **27** Supplement, 99). Stine et al (2004 *Perception* **33** Supplement, 39) developed a description of the effect where the p th root of a difference of p th powers of the luminance or contrast in the image in each eye predicts the degree of perceived rotation. We now offer a theoretically substantive and simple model of the Venetian-blind effect. Using Naka–Rushton equations that describe the response of V1 cells in *Macaca* cortex (Sclar et al, 1990 *Vision Research* **30** 1–10) and descriptions of perceived slant as a function of horizontal size ratio (Backus et al, 1999 *Vision Research* **39** 1143–1170), we present a model where the perceived horizontal size ratio is a linear function of the difference in response of cortical cells to the contrast of the image in each eye. The perceived horizontal size ratio, with perceived values for other relevant variables (eg vertical size ratio), then determines perceived rotation.

◆ **Bilateral symmetry in binocular vision**

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Human vision is highly sensitive to bilateral symmetry in 2-D images. It is not clear yet whether our visual sensitivity relates to image symmetry itself or that image symmetry is regarded as a special case of object symmetry. 2-D images are not appropriate stimuli to address this question. We used a bisection task during the viewing of stereograms to study bilateral symmetry in 3-D stimuli. Beneficial properties of using bisection are that human subjects can do it with great accuracy and that image and object symmetry make different predictions. The bisection stimulus consisted of three parallel lines of which two lines were located in one depth plane and the third one in another. Bisection judgments of horizontal lines showed that bisection was related to image symmetry independently of object symmetry. Bisection of vertical lines showed that bisection was related to image symmetry in either the left or the right eye. Which eye's image was symmetric appeared to be given by the orientation of the plane of symmetry of the bisection stimulus relative to the subject's head. The image was symmetric in the eye that was closest to the plane of stimulus symmetry.

◆ **The perceived depth of a dot cloud is the centroid of the disparity distribution**

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Spatial position and texture orientation appear to be encoded as the centroid (ie mean) of the distribution of the relevant variable. Although the perception of stereoscopic depth has been extensively investigated, little is known about how separate estimates of disparity are combined to produce overall perceived depth. We employed base-in prisms mounted on a trial frame and half-images presented on a computer screen, to produce stereoscopic images of dot clouds with skewed (ie asymmetrical) distributions of disparity. Three subjects judged in a 2AFC task whether the dot cloud was in front of or behind an adjacent flat plane of dots. Psychometric functions were generated and the point of subjective equality was calculated. For dot clouds of thickness up to about 6 min of arc disparity, the perceived depth was close to the centroid for all three subjects, regardless of skew. For thicker clouds (we tested thicknesses up to 25 min of arc), the perceived depth was slightly closer to the subject than the centroid, regardless of skew. The human visual system therefore integrates depth information veridically for thin surfaces. For thick surfaces, the dots closest to the observer have a higher weighting, possibly owing to their greater salience.

THE REPRESENTATION OF SPACE AND DYNAMIC UPDATE DURING EYE MOVEMENTS

◆ **A corollary discharge for perceptual stability**

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Helmholtz argued that our percept of visual stability in spite of saccadic eye movements results from an input to visual processing by an 'effort of will'. This input, known as efference copy or corollary discharge, provides information about the impending eye movement and permits

compensation for the visual effect of the movement. We have recently identified a pathway in the monkey brain that could convey such a corollary discharge signal from the superior colliculus in the brain stem through the medial dorsal nucleus of the thalamus (MD) to the frontal eye fields of the cerebral cortex. We have now investigated whether this pathway might contribute to the perception of a stable visual world. We tested whether a possible mechanism of this stability—the shifting receptive fields in anticipation of an impending saccade discovered by Duhamel, Colby, and Goldberg—might be dependent upon the identified corollary discharge pathway. We found that inactivation of MD did alter this shift indicating that the shift does indeed depend upon the corollary discharge. The combined findings of the shifting receptive fields and their dependence on an identified corollary discharge give insight at a neuronal level of the brain mechanisms underlying the stability of visual perception.

◆ **Active vision and corollary discharge: When the brain is split, is space still unified?**

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How does the brain keep track of visual stimuli when the eyes move? In parietal, frontal, and extrastriate cortex, and in the superior colliculus, neurons remap stimulus representations in conjunction with eye movements. The circuitry that produces remapping in two split-brain monkeys was investigated. The hypothesis was that the forebrain commissures provide the primary route for remapping memory traces of salient stimuli across visual hemifields. A striking initial impairment was observed in the monkeys' ability to remap stimuli across hemifields in the double-step task. Surprisingly, however, the animals were ultimately capable to perform these sequences accurately. In subsequent physiological experiments, neurons in lateral intraparietal cortex (LIP) were found to be still activated by remapped visual signals, even when those signals originated in the opposite hemisphere. These behavioural and neurophysiological findings indicate that the transfer of visual information is not abolished by transection of the forebrain commissures. It is concluded that a unified and stable representation of visual space is produced by circuitry with a remarkable capacity for reorganisation.
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◆ **Neural basis of spatial encoding during eye movements**

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Eye movements challenge the brain. While the image of external objects moves across the retina, we perceive the outer world as being stable. Yet, this perceptual stability is not complete. Numerous studies have recently shown that spatial perception is modulated during smooth tracking and during saccadic eye movements. The location of visual stimuli briefly flashed during smooth-pursuit eye movements is shifted in the direction of the pursuit. Mislocalisation during saccades depends on the exact experimental conditions. If saccades are performed in total darkness, all perceived locations are shifted in the direction of the saccade (shift). In ambient light conditions, all perceived locations are shifted towards the endpoint of the saccade (compression). In a recent psychophysical study we could show that spatial mislocalisations are observed also during reflexive optokinetic eye movements. Perceived locations are shifted in the direction of the slow eye movements. Yet, this shift is modulated during the saccade-like resetting phases. I briefly review the findings of our psychophysical study on reflexive eye movements in humans. Then I present neurophysiological data from recordings in posterior parietal cortex of monkeys that relate to the above-described psychophysical findings.

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◆ **Spatiotemporal changes in receptive fields around the time of saccades: Evidence from motion integration and form aftereffects**

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Visual perception does not begin afresh with each new fixation. Instead, what is perceived can be influenced by useful and predictive information from the previous fixation. Motion and form information is integrated across saccades, but the nature of this integration in space and time depends on whether the stimuli are spatiotopically or retinotopically matched. The properties of visual integration suggest a progressive transformation from retinotopic to eye-independent fields along the visual processing pathway, mediated by the updating of spatial maps in parietal cortex.