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Cyclopean riches: Cooperativity, neurontropy, hysteresis, attention, hyperglobality and hypercyclopean processes in random-dot stereopsis

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Although the concept of cyclopean combination of the monocular images dates back over a century, it was the development of the random-dot stereogram by Julesz that revealed the richness of the cyclopean process. The complex cyclopean phenomena include cooperativity between different regions of the stereo image; catabolic hysteresis for interocular correlation processing (neurontropy); attentional seeding of the perception of ambiguous stereoplanes; and hyperglobality in the ability to perceive more than one plane simultaneously. Beyond this is hypercyclopean processing of the form elements of the cyclopean depth image. These and other phenomena may be viewed in the context of a five-stage model of stereopsis as a serial-parallel heterarchy for combining information from the two eyes. The first stage is the optical transform generating the disparity field, followed by a sequence of specialized parallel processing mechanisms. The next stage represents the binocular receptive field properties structure, followed by cooperative interactions resulting in a 'cleaned' cyclopean depth image. The fourth stage represents the receptive field of hypercyclopean mechanisms viewing the cyclopean stereoimage. The final stage combines this sensory mapping with information from other sources and from memory to assign distance information. This model can accommodate all known stereoscopic phenomena in a unified heterarchical scheme.

Psychoanatomical strategies for studying human visual perception

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Efforts to link visual psychophysics/perception with neurophysiology inevitably involve questions about the neural locus of events critical for the engagement of perceptual processes. When attempting to answer locus questions using perceptual data, we usually must be satisfied with answers framed in relative terms. Thus, conclusions about neural 'locus' typically take the form of 'X occurs before Y' or 'X occurs after Y', where X is the process of interest and Y refers to some other perceptual process. For example, an afterimage can be induced in a pressure-blinded eye, indicating that the neural signals responsible for generation of the afterimage arise within the retina, before the ganglion cell level. In contrast, the neural events underlying visual aftereffects of adaptation that evidence interocular transfer (as most, in fact, do) are said to arise after the point of binocular combination. The general strategy of localizing sites of visual information processing based on perceptual data has been termed psychoanatomy by Julesz, who has given wonderful examples of psychoanatomical conclusions based on observations using random-dot stereograms. This presentation summarizes several fruitful psychoanatomical strategies, with particular emphasis on binocular rivalry as a neural 'reference' for localizing other sites of action.