Neural systems for processing depth information: convergence vs. combination

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Estimating the depth structure of the environment is a principal function of the visual system, enabling many key computations, such as segmentation, object recognition, material perception and the guidance of movements. The brain exploits a range of depth cues to estimate depth, combining information from shading and shadows to linear perspective, motion and binocular disparity. This process is broadly conceived in modular terms, with the independent processing of individual cues followed by a combination stage in which the influence of each cue reflects the reliability with which it is encoded. In this chapter I will review the application of this computational model of cue combination to neural processing, and describe experiments that combine human psychophysics and fMRI to address the neural basis of depth perception. I will argue that the use of multiple depth cues can be conceived in terms of two different processing operations - one that generates invariant neural representations that have high uncertainty and one that results in highly-specific representations that have low variance. I will suggest that this provides a computationally useful distinction with which to conceive dorsal vs. ventral visual processing.