Development of global form and motion perception in monkeys studied with fMRI.

Perceptual integration is critical for perception and interpretation of the visual world. Psychophysical studies suggest that these integrative processes for global form and motion develop slowly; when spatial resolution and motion sensitivity approach adult levels (12 months in monkeys), global form and motion perception are still immature. The goal of this study was to investigate the neural development of perceptual integration by using fMRI in anesthetized macaques at different developmental stages.

We examined the functional development of higher extrastriate visual areas whose delayed development might be responsible for the last maturation of coherent form and motion perception. We used Glass patterns, that is, random dot patterns in which global structure is defined by the spatial and spatiotemporal orientation of correlated dot pairs to form contour and motion stimuli with identical local statistics but different global forms (e.g. radial, concentric). To compare form and motion processing directly, we used static and dynamic patterns with both spatial and temporal offset between dots. Glass patterns to activate the ventral and dorsal pathways, respectively. We compared fMRI responses for static and dynamic Glass patterns to those for static and dynamic random noise patterns. Longitudinal study of two infant monkeys from the age of 6 months showed different activation dynamics for dynamic than random patterns but not for static Glass patterns. These results are consistent with previous evidence that the dorsal extrastriate pathway may develop more quickly than the ventral pathway.

Stabilization in the scanner

A longitudinal fMRI study was successfully performed on two monkeys showing fMRI activation across visual areas from the age of 3 months. fMRI responses in area MT were stronger for random than coherent dynamic Glass patterns up to 8 months of age, while the opposite pattern was observed at later ages; that is, stronger fMRI responses were observed for coherent than random patterns. However, in area V4 some small differences in the fMRI responses for coherent vs. random Glass patterns appeared only within 12–15 months of age, consistent with the proposed delayed maturation of ventral compared to dorsal areas.

The lack of increasing activations across age for a full field rotating checkerboard stimulus suggests that the observed changes in fMRI activations for Glass patterns are most likely related to neural development.