The Limits of Shape Recognition following Late Emergence from Blindness.

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Abstract:

Visual object recognition develops during the first years of life [1]. But what if one is deprived of vision during early post-natal development? Shape information is extracted using both low-level cues (e.g., intensity- or color-based contours) and more complex algorithms that are largely based on inference assumptions (e.g., illumination is from above, objects are often partially occluded) [2]. Previous studies, testing visual acuity using a 2D shape-identification task (Lea symbols), indicate that contour-based shape recognition can improve with visual experience, even after years of visual deprivation from birth [3]. We hypothesized that this may generalize to other low-level cues (shape, size, and color), but not to mid-level functions (e.g., 3D shape from shading) that might require prior visual knowledge. To that end, we studied a unique group of subjects in Ethiopia that suffered from an early manifestation of dense bilateral cataracts and were surgically treated only years later. Our results suggest that the newly sighted rapidly acquire the ability to recognize an odd element within an array, on the basis of color, size, or shape differences. However, they are generally unable to find the odd shape on the basis of illusory contours, shading, or occlusion relationships. Little recovery of these mid-level functions is seen within 1 year post-operation. We find that visual performance using low-level cues is relatively robust to prolonged deprivation from birth. However, the use of pictorial depth cues to infer 3D structure from the 2D retinal image is highly susceptible to early and prolonged visual deprivation.

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