Impact of magnification on depth perception and visually-guided reaching

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Previous experiments and computational analysis have shown that optical magnification not only changes the content of visual cues like texture gradient and binocular disparity cues (Purdy, 1960; Lumsden 1980), but also affects the availability of some cues (Du et. al. 2001). Then how are these cues combined and how is their relative effectiveness changed by magnification? Most previous research examined the perception of depth in action space and focused mainly on pictorial cues. The current study investigates the effects of magnification on spatial perception and guided action within arm's reach under microscope. In two experiments, magnification was optically created using a low-power stereoscopic microscope. The subjects looked through the microscope (magnification power of 1.05x, 3.5x, and 5.0x, or naked eyes) with one or two eyes (monocular vs. binocular), and then compared the relative depth between two targets (Experiment 1) or directed a stylus from a starting point to a target (Experiment 2). In Experiment 1, the consequences of magnification for the accuracy of relative depth judgments were assessed using a matching task. Under binocular viewing, matching error was found to increase with magnification and to be lowest with the naked eye. In contrast, performance improved with magnification under monocular viewing. In Experiment 2, where performance in a reaching task was tracked and analyzed, similar patterns were observed for action responses. The results suggest that changes in depth cues induced by magnification, particularly decreased effective range of distance and increased demands on accommodation, result in differential utilization of accommodation and binocular cues.

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