The role of monocular occlusions in the construction of three-dimensional surfaces

Inna Tsirlin, Laurie M. Wilcox, Robert S. Allison

Center for Vision Research, York University

Background

Recent experiments have established that monocular regions arising from occlusion of one object by another contribute to stereoscopic depth perception.

The pioneering investigators of monocular occlusions have suggested that their primary role is to define depth discontinuities and object boundaries in depth (Anderson, 1994, Gillam & Borsting, 1988, Nakayama & Shimojo, 1990).

To date, this hypothesis has not been evaluated directly. We demonstrate empirically that monocular occlusions determine the location of depth edges and define object shape.

Experiment 1

Objective: Determine whether occlusion information can affect perceived shape of an occluding surface.

Stimuli: Random-dot stereograms consisting of three parts – a random dot surround at zero disparity, a central random dot square with crossed disparity (d) and an abutting blank area

Conditions: (A) (Figure 2-A) no monocular information is present, (B) a monocular dot region was added along the right border of the blank area in the right image (Figure 2-B), (D) the monocular region was added in the left image (Figure 2-D), (E) a binocular strip was added instead of the monocular region on along the right border of the blank area in the right image (Figure 2-E)

Task: Observers were asked to report the shape of the foreground (square or rectangle).

Results: As shown in Figure 2-F, the presence of a monocular region at the right border of the blank area dramatically changed the perceived shape of the foreground (the occluder).

Experiment 2

Objective: The minimum possible depth of the occluded region consistent with the occluder is determined by the width of the monocular region (see Figure 1-B). The visual system could use this relationship to provide a quantitative estimate of the relative depth of the monocular region. In Experiment 2, we tested whether monocular occlusions could give rise to quantitative depth percepts in our stimuli.

Stimuli and task: We manipulated the size of the occluded regions in our stimuli (see Figure 2-B and C) and asked the observers to match a disparity probe to the depth of the blank region.

Results: Depth estimates (Figure 2-G) were linearly correlated with the width of the monocular regions.

Experiments 3 & 4

Objective: Quantitative depth in our stimuli could be perceived due to matching of the texture-defined edges. The disparity between these edges would be equal to the width of the monocular region. To test this we removed the right portion of the random-dot surround from our stimuli (see Figure 3) and repeated Experiments 1 and 2.

Results: The results of Experiment 3 (Figure 3-F) were consistent with Experiment 1 (Figure 2-F). The results of Experiment 4 (Figure 3-G) were markedly different from those of Experiment 2 (Figure 2-G). Regardless of their width, monocular occlusions yielded a percept of the blank region at the same depth as the random-dot rectangle.

Conclusions

- Monocular occlusions can drastically affect the perceived shape and depth of the occluder.
- In our stimuli, this phenomenon is qualitative but not quantitative in nature.
- Our results provide definitive evidence that monocular occlusions play an important role in defining object boundaries in depth.

Bibliography


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