Exploring here, seeing where? Visualization with *in-situ* vs. *ex-situ* viewing

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Previous studies of aperture viewing showed that a figure moving behind a narrow slit can be perceived as integrated, even though only a small part of it is visible at any time. Here we allow subjects to explore a hidden virtual target by moving an imaging probe over it, exposing a series of cross-sectional slices. These were displayed either *in-situ*, at the location of the target, using an augmented-reality display, or *ex-situ*, at a LCD display displaced approximately 1 m from the target. Experiment 1 examined subjects' ability to identify letters and digits through such exploration. In-situ viewing led to faster identification; however, both devices produced errors indicative of local feature processing, such as mirror-image reversals (e.g., the misidentification of S as 3). To preclude this strategy, Experiment 2 required subjects to identify whether a rotated letter was normal or mirror-imaged. In-situ viewing produced the classic function associated with the cognitive process of mental rotation, such that the response time increased linearly with the departure of the tested letter from the normal upright. In contrast, ex-situ viewing yielded much longer response time for letters oriented along obliques, consistent with feature-based strategies (Jolicoeur, 1990). Experiment 3 used unfamiliar shapes to test effects of memory load and spatiotemporal complexity. The results indicate that effective integration of whole objects from spatiotemporally distributed components demands not only displaying object segments revealed by exploration, but also co-locating the hidden object and the process of exploration in a common reference frame.

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