

# Efficacy of Image-Guided Action is Controlled by Perception

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Researchers on human perception have devised a number of methods for measuring perceived location and using it to assess perceptually guided action. Such work has primarily been performed in space accessible by reaching and walking. Here we use the same approach to assess perceptually guided action in very near space, specifically, in the applied context of ultrasound-guided surgical manipulation. Our approach measured the ultrasound user's perception of the location of a target independently from assessing the action employed to reach it. Experiments were conducted with the Sonic Flashlight (SF), a visualization device that creates a virtual in situ image, and conventional ultrasound (CUS), which displays the image on a screen displaced from the target. Two studies determined subjects' perception of target location with a triangulation-by-pointing task. Depth perception with the SF was comparable to direct vision, while the CUS caused considerable underestimation of target depth. Binocular depth information in the SF was shown to significantly contribute to its superiority. A third experiment tested subjects in an ultrasound-guided needle insertion task. With direct visualization of the target, subjects performed insertions faster and more accurately by using the SF rather than CUS. Furthermore, the trajectory analysis showed that insertions with the SF generally went directly to the target along the desired path, while the CUS led to an arc-shaped deviation from the ideal path, as predicted by the previously measured underestimation of target depth. Ongoing research is further examining the time-course of learning with the two devices, measuring precise trajectories for needle insertion. This work extends the demonstration of the perception/action linkage to near space and provides a very practical application for such research. In particular, different image methods, which lead to different percepts, will lead to actions with differential efficacy.