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Brief article

People cannot locate the projection of an object on the surface of a mirror

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ABSTRACT

People cannot veridically perceive reflections of objects as projections on the surface of mirrors. People tried to locate an object's projection on a flat mirror. The observer stood at the opposite end of a long mirror to the experimenter. They were told to remember the location of the projection of the experimenter's face. The experimenter then moved and the observer stuck a card onto the mirror at this remembered location. The actual location was midway along the mirror between the experimenter and the observer. However, cards were placed much too close to the experimenter. Repeated testing with feedback reduced, but did not eliminate, errors. Our perception of mirrors is dominated by what appears to be visible *through* the mirror, not what is projected onto its surface. In contrast, if the experimenter stuck a card onto the mirror then removed it, observers remembered this physically-specified location accurately.

1. Introduction

Flat mirrors are commonplace in our everyday environment, but people make striking errors when asked about reflections projected onto their surface. For example, they overestimate the size of projections of objects. Most people believe that a mirror must be about face-sized to see all of their face reflected in it, when in fact it need only be half that size (Bertamini & Parks, 2005; Lawson & Bertamini, 2006). People also think that they can see more of themselves in a mirror as they move away from it, when actually the size of their projection remains the same (Lawson, Bertamini, & Liu, 2007). Many people believe that they will be able to see their face reflected in a mirror from a wide range of angles. However, you need to be directly in front of a mirror to see yourself. People also often incorrectly think that they will see their face reflected simultaneously in multiple mirrors which are mounted flat on the same wall (Lawson, 2009).

These examples of errors in understanding the optics of mirrors relate to the visibility and size of projections of objects. They led to a new prediction: if people only accurately perceive the virtual world through a mirror, not projections on the surface of a mirror, then people should be unable to locate *where* an object is projected on the mirror surface, see Fig. 1. Informal observation supports this hypothesis. It is surprisingly hard to point to the projection of an object when standing to the side of a mirror.

In two experiments, an observer and an experimenter stood at fixed, initial positions and the observer was told to remember the location of the projection of the experimenter's face on a mirror, see Fig. 2. The experimenter then moved away and the observer stuck a card onto the surface of the mirror at this remembered location. The experimenter then returned to their initial position to allow the observer to check the accuracy of their response. Children and adults readily understood this task but, nevertheless, made large, systematic errors. This is because there is a compelling perception that projections *on* a mirror are located *through* the mirror. This illusion resulted in observers placing their cards much too far away, close to the experimenter's end of the mirror.

Few people notice their misperception of projection locations. This is likely due to three factors. First, we often use mirrors to look at ourselves. Here, our reflection is projected directly in front of us. Second, as an object approaches a mirror, the location of that object, its projection

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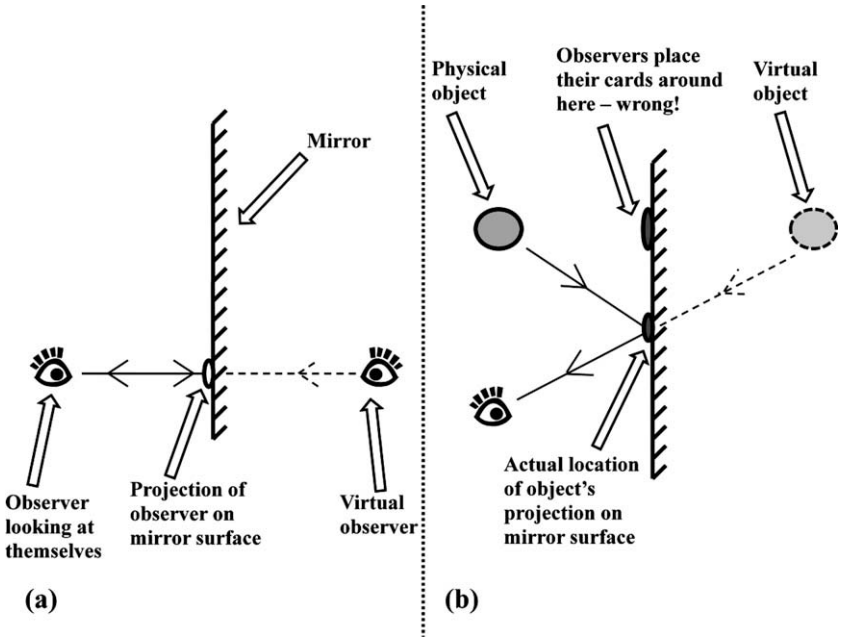

Fig. 1. Two bird's eye views of an observer looking at a mirror. (a) The observer looks at themselves. Here, the projection of the observer is directly inbetween the observer and the virtual observer. (b) The observer looks at another object which is as far away from the surface of the mirror as the observer. Here, the object is projected onto the mirror surface midway along it between the observer and the object. However, to the observer, the object's projection *appears* to be located *behind* the mirror surface. Therefore when asked to stick a card onto the mirror at the location of the projection of the object they put their card much too far away, approximately inbetween the physical object and the virtual object. In fact, relative to both the physical and virtual objects, projections are *always nearer* to the observer along the plane of the mirror surface unless, first, the virtual object is directly in front of the observer (as in (a) here) or unless, second, the physical object is placed right against the mirror.

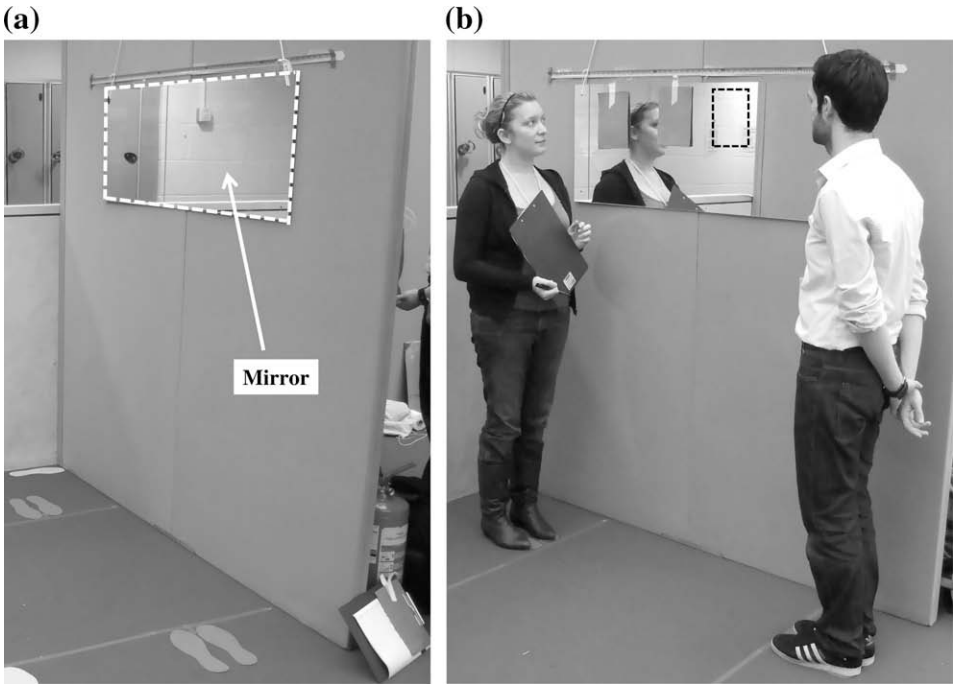

Fig. 2. The set-up for Experiment 1. The general set-up was identical for Experiment 2. (a) The mirror with the tape-measure above it and the two pairs of footsteps on the floor beneath. (b) An experimenter (on the left, with a clipboard) and an observer (on the right) standing on their respective footsteps. The left and right cards stuck on the mirror show typical responses on the first and second trials respectively for the projection location task. The dotted box shows the correct position of a card for it to cover up the observer's view of the projection of the experimenter's face on the surface of the mirror.