Spatial Ability in the Representation of Cross Sections

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This paper reports on three experiments that examined the contributions of spatial ability, spatial strategies, and external animations to performance in the mental representation of cross sections.

Method

In each experiment, participants were asked to mentally represent key spatial relationships in cross sections of an imaginary 3D object displayed on a computer monitor. In Experiment 1 participants were asked to match a cross-sectional image with an image of the 3D object indicating the location at which the object was sliced (see Figure 1). Experiments 2 and 3 used production (drawing) tasks to measure performance. Experiment 2 introduced interactive animations as external aids to spatial visualization and Experiment 3 compared the relative contributions of interactive and non-interactive animation. Participants in all experiments completed two tests of spatial ability (Guay 1976; Vandenberg & Kuse, 1979) and participants in the latter 2 experiments also responded to a spatial strategies questionnaire (Schultz, 1991) to indicate how they performed the cross section task.

Results and Discussion

Across the three experiments, spatial ability was significantly correlated with accuracy in interpreting and producing accurate representations of cross sections Participants reported the use of spatial strategies, particularly mental rotation, in performing the cross section task. In addition, some participants reported supplementing the use of spatial strategies with non-spatial processes, such as feature matching (e.g., noting and comparing the number of structures bisected when the object was sliced).

In Experiment 2, high spatial individuals used the interactive animation more than low-spatial individuals, and this might have partially accounted for their superior performance. In Experiment 3, an instructional animation intended to clarify the requirements of the drawing task preceded the drawing task. Under these conditions, high- and low-spatial individuals used the animation equally, and the differences in performance were reduced. These unexpected results in Experiment 3 suggest that it may be possible to implicitly train participants to use mental rotation and perspective taking by modeling these spatial strategies through animation. Experiment 3 also indicated that interactive animations are more effective than non-interactive animations, especially for low-spatial participants.

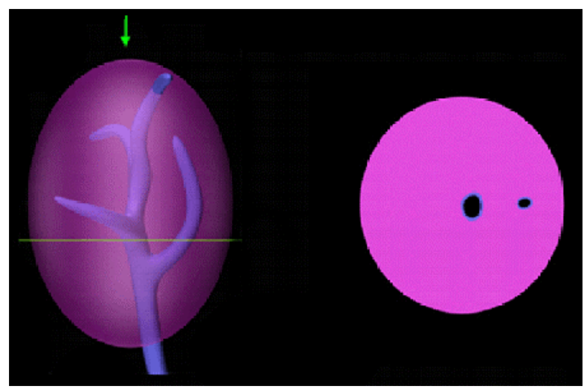

Figure 1. Experiment 1 stimulus trial. Participants indicated by a true or false response whether the cross section on the right would result from slicing the object on the left at the location indicated by the line.

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References

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