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Spatial Abilities and Learning Complex Scientific Topics

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Successful science learning is often thought to be contingent on the ability to mentally visualize or manipulate relevant spatial information, especially in physical science domains such as earth science, biology, and chemistry (Mathewson, 1999). While this may be the case, there has been little research connecting spatial abilities to learning outcomes. This study directly examined the influence of static (SSA) and dynamic spatial ability (DSA), in addition to working memory capacity (WMC), on the comprehension of a unit about a complex scientific topic. It is hypothesized that dynamic spatial ability (i.e., the ability to manipulate spatial information over time) is directly connected to how well participants can mentally animate (Hegarty & Sims, 1994), and should be most relevant in those situations that require learners to engage in this mental animation process.

Methods

$N = 196$ undergraduates from the University of Illinois at Chicago that were low in prior knowledge of the scientific topic participated in this experiment for course credit.

Participants read a text about ‘Volcanic Eruptions’, developed by Wiley (2001) that was either non-illustrated, illustrated with relevant static images, or illustrated with animated versions of the static images. After reading the text, participants were asked to write a causal essay about ‘What caused Mt. St. Helens’ to erupt?’, which was then evaluated for the presence of 13 a priori causal concepts.

All participants also completed measures of SSA (Paper Folding; French, Ekstrom & Price, 1963), DSA (Intercept task; adapted from Hunt, et al., 1988), and WMC (OSpan and RSpan; Conway, et al., 2005).

Results

Overall, animations produced significantly better learning than the static or non-illustrated conditions ($F(2, 193) = 4.37$, $MSe = .05$, $p < .01$). There was no difference between the non-illustrated and static conditions. Pairwise comparisons between illustration groups indicated that DSA only predicted learning in conditions that required mental animation (e.g., static- and non-illustrated conditions); ($R^2 = .09$, $F(4, 128) = 3.08$, $MSR = .05$, $p < .02$), see Fig. 1. SSA and WMC were not uniquely related to essay performance.

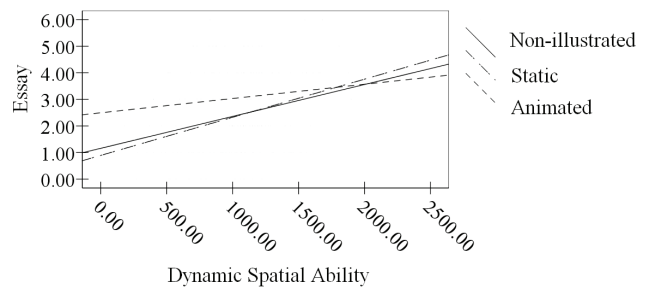


Figure 1: DSA across Illustration Condition

Conclusions

Results suggest that DSA is directly related to learning scientific topics, but only when participants are required to construct mental animations from non-illustrated text or texts with static illustrations. Animations also appear to improve learning, especially for low DSA learners. These results further highlight the need to consider the interaction of individual differences and learning materials when designing learning environments for science topics (Sanchez & Wiley, 2006).

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