Asymmetries in Analogical Mapping: A Test of a Process Model

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Introduction

Asymmetry in analogical reasoning has previously been thought to occur at the post-mapping inference stage, with the mappings themselves being inherently symmetric. However, unlike previous theoretical explanations and computational models, the LISA (Learning and Inference with Schemas and Analogies) model of analogical reasoning (Hummel & Holyoak, in press) makes the unique prediction of asymmetry at the mapping stage.

In LISA, analogical mapping is a directional, capacity-limited, and serial process. The directional aspect of mapping is a result of the model's distinction between *driver* and *recipient* analogs. The model determines the correspondences between two analogs through a process of guided pattern recognition, where one analog generates a pattern of activation which is then received by the other analog. The analog that generates the pattern of activation is the driver analog, and the analog that receives it is the recipient analog. Thus, mapping is an inherently asymmetrical process. This mapping process is also capacity-limited in keeping with the limited capacity of human working memory. If a driver analog contains more propositions than working memory can hold, the propositions must be fired in a serial manner in order to process the entire analog.

This serial firing order in the driver analog is crucial to LISA's mapping performance, because mapping is in part determined by the grouping of propositions. One variable presumed to affect this grouping is the degree of causal connectivity in the semantic content of the propositions. If the propositions in one analog are optimally grouped (because of causal semantic content) and the propositions in the other analog are non-optimally grouped (because of noncausal semantic content), different (i.e., asymmetrical) mappings can be made, depending on the direction of mapping. The LISA model makes the unique prediction that mapping performance with isomorphic analogies will be more accurate if the driver analog has causal semantic content and the recipient analog has noncausal semantic content than if the driver analog has noncausal semantic content and the recipient analog has causal semantic content. In addition, the model predicts that causal content in the recipient analog will only facilitate mapping if there is also causal content in the driver analog.

To test these predictions, we assessed the influence of varying levels of causal content and direction of mapping in both simulations with LISA and in experiments with human subjects. Both the simulated and human mapping tasks involved two isomorphic analogs with either causal or noncausal semantic content (a mapping task similar to that used by Keane, 1996). In the Causal-Causal (CC) condition, both the driver and recipient analogs had causal semantic content; in the Causal-Noncausal (CN) condition, the driver analog had causal content and the recipient analog had noncausal semantic content; in the Noncausal-Causal (NC) condition, the driver analog had noncausal semantic content and the recipient analog had causal semantic content; and in the Noncausal-Noncausal (NN) condition, both analogs had noncausal semantic content.

In both the simulations and the experiment, mapping accuracy in the CN condition was significantly higher than in the NC condition. This result shows that asymmetry can be obtained at the mapping stage. In addition, for both simulated and human mapping, mapping accuracy in the CC condition was significantly higher than in the CN condition, whereas the NC and NN conditions did not differ in accuracy. This finding supports the prediction that causal semantic content in the recipient analog only facilitates mapping when there is also causal semantic content in the driver analog.

The experimental results showed that human reasoners, like LISA, are subject to asymmetries in analogical mapping. These findings suggest that both from an empirical and a theoretical viewpoint, it is necessary to reconsider the assumption that asymmetry in analogical reasoning occurs only at the post-mapping inference stage.

References

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