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Consistent Argument-Predicate Binding Is Important for Predicate-Predicate Linking

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The fundamental process of connecting instances to each other is essential to many types of learning: from generalization over instances, to category learning, to learning from analogies. The present work seeks an understanding of these processes by studying how adults learn about relations. Learning about relations requires learning about two kinds of entities: arguments and predicates.

Gentner (2003) proposes that arguments, and particularly arguments that take the form of concrete objects, are psychologically prior to predicates. Further, she has shown that object-object similarities play a key role in the relational mappings that both children and adults make. This suggests that when learners are presented with a set of instances in the form of arguments and predicates, the similarity among arguments may be more important than among predicates in connecting learning instances to each other.

However both Gentner (2003) and Billman and Knutson (1996) have also suggested that systematicity of predicates is important. More specifically, Billman and Knutson propose that what is important when learning is how many cues are systematically predictive of the categories. All cues – arguments and predicates – can contribute to systematicity with the critical issue being the degree to which cues are mutually predictive. Thus, it may be the systematicity relations across a set of instances and not specifically argument and predicate similarity that guides learning.

The present experiment uses a learning task in which object categories are defined by the relational roles of the objects and not by their properties. These relational categories have high systematicity: knowing that object X is in relation P to object Y determines both what other relation X enters into and the relational roles of all other objects. In order to learn this, learners must link one relation to another. In these experiments, we manipulate argument similarity and the systematicity of argument-predicate links; keeping predicate systematicity high and constant.

Design

The experiment consisted of a training and test phase. On each trial there were three objects: two actors (A_1, A_2) and one receiver (R). The actors each performed two actions relative to the receiver (e.g. A_1 might "jump over" R and also circle R). On each trial the actions that define A_1 and A_2 did not change. Participants were assigned to one of three training conditions: (1) low argument similarity (different objects each trial), (2) high argument similarity (same objects each trial) and (3) high argument similarity but low argument-predicate systematicity (same objects but different roles on each trial).

In the test trials, new object triads were used that were not superficially similar to the training objects. On each trial the experimenter demonstrated one of the actions for A_1 or A_2. Since the predicates (actions) are systematically related, if the argument-predicate structure has been learned then participants should infer the correct object and predicate pairs from this single cue. In order to measure learning, participants were asked to perform the demonstration object's second action and the two actions of the other actor.

Results and Discussion

A test trial was scored as correct if the actions were paired correctly and the correct receiver was used for every action. Participants failed to learn the argument-predicate structure in the low argument similarity condition (Mean percent of trials correct=16%) and in the high argument similarity and low argument-predicate systematicity condition (M=22%), but they did learn the argument-predicate structure in the high argument similarity condition with high argument-predicate systematicity (M=65%). Our results indicate that systematicity matters in learning. However systematicity of predicates alone is insufficient because this was present in all conditions. The systematicity that was crucial for learning in this case was the systematicity between arguments and predicates. This type may be critical to the learning process because it facilitates the linking of distinct temporal events. The arguments may thus serve as the indexes in working memory that bind one instance to another and thus enable learning across them. The next question is whether objects or arguments in general are privileged in this role or whether any common index to all learning instances would do.

References

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