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Decoding Abstract Relations: Investigating the Neural Representation of Relational Categories in the Human Brain

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Abstract

Analogical reasoning requires representations of relations between concepts that generalize beyond their semantic meaning (e.g., “fruit:apple” and “car:sedan” both instantiate a “category:exemplar” relation). We asked whether abstract relations are encoded only during analogical reasoning or also arise implicitly during semantic processing. Across two tasks, we modeled abstract relations using representational similarity analysis. Relational categories were incidental to the first task (semantic relatedness judgments), allowing us to test for implicit activation, whereas the second required analogy judgments. RSA revealed regions that reflected relational categories across both tasks, with additional task-specific effects. To test whether representations supporting analogical reasoning generalize to those during semantic processing, we trained a classifier on data from analogy judgments to decode categories and tested it on data from semantic relatedness judgments, providing evidence for a shared format. These findings support a network that encodes abstract relations independent of analogical reasoning demands.