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Children's development of analogical reasoning: Insights from scene analogy problems

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Abstract

We explored how relational complexity and featural distraction, as varied in scene analogy problems, affect children's analogical reasoning performance. Results with 3- and 4-year-olds, 6- and 7-year-olds, 9- to 11-year-olds, and 13- and 14-year-olds indicate that when children can identify the critical structural relations in a scene analogy problem, development of their ability to reason analogically interacts with both relational complexity and featural distraction. Error patterns suggest that children are more likely to select a distracting object than to make a relational error for problems that present both possibilities. This tendency decreases with age, and older children make fewer errors overall. The results suggest that changes in analogical reasoning with age depend on the interplay among increases in relational knowledge, the capacity to integrate multiple relations, and inhibitory control over featural distraction.

Keywords: Analogy; Relational complexity; Similarity; Inhibitory control; Working memory

Introduction

Analogical reasoning is an important component of children's higher order cognitive development. Analogy is a conceptual strategy enabling children to make inferences about novel phenomena, to transfer learning across contexts, and to extract relevant information

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from everyday learning experiences on the basis of relational similarity (Chen, Sanchez, & Campbell, 1997; Gentner, 1977; Goswami, 2001; Halford, 1993; Holyoak, Junn, & Billman, 1984). It has been argued that this sophisticated conceptual process is central to children's everyday learning; however, the underlying mechanisms that support the development of analogical reasoning are not yet well understood.

Possible mechanisms of developmental change

Within the literature on cognitive development, three major hypotheses have been advanced to account for age-related differences in analogical reasoning: increased domain knowledge, a relational shift from object similarity to relational similarity, and increased working memory capacity for manipulating relations.

Increased domain knowledge

Goswami and colleagues have proposed a relational primacy hypothesis, arguing that analogical reasoning is fundamentally available as a capacity from early infancy but that children's analogical performance increases with age due to the accretion of knowledge about relevant relations (Goswami, 1992, 2001; Goswami & Brown, 1989). Goswami's proposal for knowledge acquisition as a mechanism for development emerged in reaction to Piagetian studies suggesting that children are unable to reason analogically prior to achieving formal operations at approximately 13 or 14 years of age (Piaget, Montangero, & Billeter, 1977). Piaget's tasks frequently involved uncommon relations, such as "steering mechanism," which would likely have been unfamiliar to younger children. In contrast, Goswami and Brown (1989) found that children as young as 3 years could be successful on analogical reasoning tasks when they demonstrated knowledge about the relevant relations.

In a series of studies, Goswami, Leevers, Pressley, and Wheelwright (1998) presented children with complex versions of analogy tasks in which two physical causal relations (e.g., cutting and wetting) were manipulated to change one object, "A," into another object, "B." Children were required to map the relation between A and B to a different object, "C," and its transformed version, "D." They were given a set of alternatives and asked to identify the D object. On a second task, the children were tested to assess their knowledge of the causal relations used in each problem. Goswami and colleagues found that children as young as 4 years were fairly competent on these problems with two relational changes when they showed knowledge of the relations on an additional task, although 3-year-olds did not perform as well. The authors interpreted these data as evidence that domain knowledge is the primary constraint on children's analogical reasoning. However, as Goswami and colleagues noted, the knowledge-based account cannot fully account for age-related effects in young children's performance on analogical reasoning tasks. In particular, these authors pointed out that children seem to fail on analogies in systematic ways even when the children possess relational knowledge relevant to the task.

Relational shift

In an alternative formulation of young children's observed age-related increase in analogical reasoning performance, Gentner and Rattermann (1991; see also Rattermann &