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Developmental changes in semantic knowledge organization

Layla Unger [a,*], Anna V. Fisher [a], Rebecca Nugent [b], Samuel L. Ventura [b], Christopher J. MacLellan [c]

[a] Department of Psychology, Carnegie Mellon University, Pittsburgh, PA 15213, USA
[b] Department of Statistics, Carnegie Mellon University, Pittsburgh, PA 15213, USA
[c] Human–Computer Interaction Institute, Carnegie Mellon University, Pittsburgh, PA 15213, USA

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ABSTRACT

Semantic knowledge is a crucial aspect of higher cognition. Theoretical accounts of semantic knowledge posit that relations between concepts provide organizational structure that converts information known about individual entities into an interconnected network in which concepts can be linked by many types of relations (e.g., taxonomic, thematic). The goal of the current research was to address several methodological shortcomings of prior studies on the development of semantic organization, by using a variant of the spatial arrangement method (SpAM) to collect graded judgments of relatedness for a set of entities that can be cross-classified into either taxonomic or thematic groups. In Experiment 1, we used the cross-classify SpAM (CC–SpAM) to obtain graded relatedness judgments and derive a representation of developmental changes in the organization of semantic knowledge. In Experiment 2, we validated the findings of Experiment 1 by using a more traditional pairwise similarity judgment paradigm. Across both experiments, we found that an early recognition of links between entities that are both taxonomically and thematically related preceded an increasing recognition of links based on a single type of relation. The utility of CC–SpAM for evaluating theoretical accounts of semantic development is discussed.

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* Corresponding author.
E-mail address: lunger@andrew.cmu.edu (L. Unger).

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Introduction

Semantic knowledge refers to information that is learned about entities (e.g., objects, animals, people) and relations between them. Many accounts of semantic knowledge posit that information known about individual entities is organized into an interconnected network according to relations between them (Bjorklund, 1987; Collins & Loftus, 1975; Cree & McRae, 2003; Crowe & Prescott, 2003; McClelland & Rogers, 2003) and that this organization plays a critical role in a wide array of cognitive tasks (Belke, Humphreys, Watson, Meyer, & Telling, 2008; Bjorklund & Jacobs, 1985; Fisher, Godwin, Matlen, & Unger, 2015b; Moores, Laiti, & Chelazzi, 2003; Roediger & McDermott, 1995). Therefore, understanding how the organizational structure of semantic knowledge is acquired and how it changes over the course of development and learning is a core aspect of understanding higher order cognition.

Research on semantic organization development has primarily focused on the influence of different types of relations on organizational structure. For instance, entities may be linked by *taxonomic* relations when they share features that indicate that they are of the same "kind" (e.g., both *chickens* and *eagles* have wings and beaks) or by primarily *thematic* relations when they are associated with the same environment (e.g., both *chickens* and *cows* can be found on a farm). The influence of these relations may change over the course of development. For instance, computational models of semantic development suggest that learning features that entities share increasingly organize knowledge according to taxonomic relations (Hills, Maouene, Maouene, Sheya, & Smith, 2009; Kemp & Tenenbaum, 2008; McClelland & Rogers, 2003). However, characteristics of paradigms used to study developmental changes in the influence of different relations on semantic organization may have limited the degree to which the data they yield can inform this question. Below, we first review prior research on semantic development and the paradigms they have used and then describe a novel paradigm designed to provide new insights into the development of semantic organization.

Insights into semantic development from match-to-sample tasks

Much of semantic development research has used *match-to-sample* tasks in which participants are asked to match a target item with one of at least two other items. Commonly, the items that participants can match to the target include a taxonomic match and a thematic match (e.g., Smiley & Brown, 1979; Walsh, Richardson, & Faulkner, 1993; Waxman & Namy, 1997). For instance, given a target *dog,* participants may be asked to choose between a thematic match (e.g., *bone*) and a taxonomic match (e.g., *cat*). Researchers can then assess children's preferences for matching on the basis of different types of relations. Early research using this paradigm indicated that children up to approximately 6 years of age prefer thematic matches, after which children increasingly prefer taxonomic matches (Smiley & Brown, 1979). Subsequent research suggested that children's responses can be influenced by multiple factors. For instance, Waxman and Namy (1997) found that instructions to "choose another one" yield a greater proportion of taxonomic choices, whereas instructions to "choose the one that goes best with [the target]" yield a greater proportion of thematic choices.

In an alternate version of this paradigm, the items that participants can match to the target include one item that is related to the target on some dimension and one or more unrelated items. This approach allows researchers to investigate whether children can differentiate between related and unrelated items rather than children's *preference* for one type of one relation over another. In one such study, items belonged exclusively to the domain of foods, such that taxonomically related items were foods of the same kind (e.g., meats, dairy) and thematically related items were foods associated with the same meal (e.g., breakfast, lunch) (Nguyen & Murphy, 2003). In a related study, items belonged to multiple domains (Nguyen, 2007). Across both studies, children selected both taxonomically and thematically related items more frequently than unrelated items from an early age (2 years in Nguyen, 2007; 4 years in Nguyen & Murphy, 2003).

Despite yielding insights into developmental changes in children's recognition of and preference for different types of relations, the degree to which findings from studies using the match-to-sample paradigm can shed light on the developmental trajectory of *semantic organization* may be

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