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Integrating across episodes: Investigating the long-term accessibility of self-derived knowledge in 4-year-old children

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ABSTRACT

Semantic memory, defined as our store of knowledge about the world, provides representational support for all of our higher order cognitive functions. As such, it is crucial that the contents of semantic memory remain accessible over time. Although memory for knowledge learned through direct observation has been investigated previously, we know very little about the retention of knowledge derived through integration of information acquired across separate learning episodes. The current research investigated cross-episode integration in 4-year-old children. Participants were presented with novel facts via distinct story episodes and tested for knowledge extension through cross-episode integration as well as for retention of the information over a 1-week delay. In Experiment 1, children retained the self-derived knowledge over the delay, although performance was primarily evidenced in a forced-choice format. In Experiment 2, we sought to facilitate the accessibility and robustness of self-derived knowledge by providing a verbal reminder after the delay. The accessibility of self-derived knowledge increased irrespective of whether participants successfully demonstrated knowledge of the integration facts during the first visit. The results suggest that knowledge extended through integration remains accessible after delays even in a population where this learning process is less robust. The findings also demonstrate the facilitative effect of reminders on the accessibility and further extension of knowledge over extended time periods.

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Introduction

To build a knowledge base, it is necessary to integrate information learned across separate episodes of experience. We regularly integrate information learned at different times, in different contexts, and through different media. For instance, in an early episode, an individual may learn that George Washington was the first president. In a later episode, perhaps in the context of a history class, the individual may then learn that George Washington led the Continental Army during the American Revolution. Integration of the two distinct traces may support self-generation of new knowledge that the leader of the American Revolution was also the first president, an understanding not directly specified. As this example demonstrates, knowledge extension through memory integration is pervasive, allowing for the combination of newly and previously learned information. Without this capacity, knowledge development would be significantly hindered if not impossible. Yet the apparent ease with which we link related information in memory to form new knowledge (as many of us have seamlessly done with respect to George Washington) often leads us to take this ability for granted. In fact, systematic investigations of cross-episode integration have only recently appeared in the literature (e.g., Bauer & San Souci, 2010). As a consequence, although we know a great deal about the long-term retention of information learned through a single direct experience (e.g., Bauer, Stewart, White, & Larkina, in press; Ornstein et al., 1998), we know very little about the later accessibility of knowledge derived through cross-episode integration. To address this issue, in the current research we examined whether knowledge extended through integration is retained in preschool-age children (Experiment 1). Because this is a population in which knowledge extension through integration is less robust (e.g., Bauer & San Souci, 2010; Bauer, Varga, King, Nolen, & White, 2015), we also examined whether cues aimed to reinstate prior learning episodes would facilitate the later accessibility of self-derived knowledge (Experiment 2).

The question of how knowledge emerges from experience has been disputed for decades (e.g., Karmiloff-Smith, 1986; Karmiloff-Smith, 1990; Mandler, 1988; Mandler, 1992; Nelson, 1974; Piaget, 1972). For example, proponents of the core knowledge perspective argue that infants are born with a set of innate concepts and that this foundational knowledge provides the essential elements for learning and reasoning about one's experiences (e.g., Spelke, 2004; Spelke & Kinzler, 2007). On the other end of the spectrum, proponents of constructivist perspectives (e.g., Piaget, 1972) argue that all knowledge is actively constructed through one's direct experience in the world (for reviews, see Greeno, Collins, & Resnick, 1996, and Packer, 1985). In spite of this range of perspectives regarding the role of experience, until recently the empirical study of general knowledge acquisition (i.e., semantic memory) and of memory for previous experiences (i.e., episodic memory) has been largely separate (Tulving, 1972). Nonetheless, prior research makes clear that as knowledge becomes increasingly integrated in memory, the capacity for flexible knowledge extension is more readily observed (Chi, Hutchinson, & Robin, 1989; Chi & Koeske, 1983). For example, child expertise in the domain of dinosaurs is marked by extensive integration of shared properties (e.g., habitat, defense mechanisms) that results in hierarchically organized knowledge structures (i.e., into families such as tyrannosaur and stegosaur). Although the episodes in which children initially integrated this information were not examined, the benefits of knowledge integration are readily apparent. Specifically, when children were asked to extend their knowledge in order to make inferences about dinosaurs they had never seen before, child experts were able to use their integrated knowledge to generate sophisticated conclusions based on non-observed properties (e.g., this dinosaur must have a plant-based diet). In contrast, novices ascertained only surface-level observable properties (e.g., this dinosaur can fly) and generated significantly fewer accurate conclusions (Chi et al., 1989).

Given the importance of developing an integrated knowledge base, a growing body of literature has begun to examine the ability to integrate information acquired across separate episodes of experience (Bauer et al., 2015; Bauer, King, Larkina, Varga, & White, 2012; Bauer & San Souci, 2010; Varga & Bauer, 2013). In this line of work, children are taught novel facts (i.e., stem facts) that can be combined to generate new knowledge. For instance, two facts about dolphins (e.g., Dolphins talk by clicking and squeaking; Dolphins travel in groups called pods), can be integrated to produce new knowledge that