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An associative-activation theory of children's and adults' memory illusions

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ABSTRACT

The effects of associative strength and gist relations on rates of children's and adults' true and false memories were examined in three experiments. Children aged 5–11 and university-aged adults participated in a standard Deese/Roediger–McDermott false memory task using DRM and category lists in two experiments and in the third, children memorized lists that differed in associative strength and semantic cohesion. In the first two experiments, half of the participants were primed before list presentation with gist-relevant cues and the results showed that: (1) both true and false memories increased with age, (2) true recall was higher than false recall for all ages, (3) at all ages, false memory rates were determined by backward associative strength, and (4) false memories varied predictably with changes in associative strength but were unaffected by gist manipulations (category structure or gist priming). In the third experiment, both gist and associative strength were varied orthogonally and the results showed that regardless of age, children's (5) true recall was affected by gist manipulations (semantic cohesion) and (6) false recall was affected by backward associative strength. These findings are discussed in the context of models of false memory illusions and continuities in memory development more generally.

Introduction

Recent research has shown that children are less susceptible to false memories than adults especially when those false memories are generated spontaneously as in the Deese/Roediger–McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm (Brainerd, Reyna, & Forrest, 2002; Howe, 2005, 2006, 2008a; Howe, Cichetti, Toth, & Cerrito, 2004; Howe, Gagnon, & Thouas, 2008). Briefly, the DRM task consists of presenting lists of words that are related to an unpresented concept (e.g., *hot*, *snow*, *warm*, *winter*, *ice*, *wet*, *frigid*, *chilly*, *heat*, *weather*, *freeze*, and *air* are related to the unpresented item COLD). The unpresented item, also termed the critical lure, is often reported along with presented list items during subsequent recall or recognition tasks.

Although the false-memory illusion arising from the DRM paradigm is a robust phenomenon, it is not clear what mechanisms underlie children's false memories and why false memories increase across childhood. From the adult literature it is generally suggested that the items on the DRM list directly activate related but unpresented concepts during study and this happens automatically outside of conscious awareness. When it is time to recall or recognize the list items, the unpresented but activated concept is also falsely output because participants cannot discriminate them from the original list members.

Theoretical explanations of this effect, such as fuzzy-trace theory (FTT), have attempted to account for these findings by suggesting that there are two memory traces encoded during list presentation—verbatim and gist (Brainerd & Reyna, 2005). These traces are qualitatively different from each other: verbatim traces are concerned with item-specific surface information (e.g., the number of phonemes in a word) and gist traces with meaning-based information (i.e., the theme of a word list). It is this gist

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trace that is thought to be responsible for false recall in the DRM paradigm particularly when verbatim traces (which fade more rapidly) are not available. Gist traces are particularly relevant in recall rather than recognition because the physical presence of the item in the recognition test is more likely to activate its verbatim trace. Although gist is not clearly defined in FTT (e.g., Howe, 2008b), in general it concerns the abstraction of a common "theme" contained within the presented material (e.g., see Brainerd, Reyna, & Ceci, 2008). Thus, for example, in the DRM paradigm, the gist is the theme of the list. When categorized or taxonomic items are used, the category itself serves as the gist. Not only do word lists contain gist, but so too do single words—that is, individual words can have their own unique meaning or local gist that can cause false memories (e.g., Reyna & Lloyd, 1997). It is the extraction of this gist that underlies false memory production, particularly when verbatim traces have faded. Developmentally, although young children are capable of extracting the gist, the ability to do so improves with age, especially their ability to extract thematic meaning across list items (Brainerd & Reyna, 2005). As this ability increases with age, so does the child's susceptibility to the DRM illusion.

An alternative explanation, associative-activation theory (AAT), states that children's false memories are a product of associative-activation processes (Howe, 2005, 2006, 2008b). Associative relations between list items and the critical lure are important contributors to the false memory illusion (Deese, 1959; McEvoy, Nelson, & Komatsu, 1999; Roediger, Watson, McDermott, & Gallo, 2001b; Underwood, 1965). This theory (as well as activation-monitoring theory, AMT, Roediger, Balota, & Watson, 2001a) derives from spreading activation models that suggest that the processing of one word activates a corresponding node (i.e., concept) in our mental lexicon (or more generally, our knowledge base) and this activation spreads to surrounding concept nodes (Collins & Loftus, 1975; Landauer & Dumais, 1997). In particular, one word (or concept) activates another and some of these activated concepts are items that have not been presented but have been "incorrectly" activated due to their connection with presented items in the knowledge base. Howe (2005, 2006, 2008b; Howe et al., 2008) suggests that increases in children's false memory with age may be due to changes in children's knowledge base (e.g., accretion of associations, reorganization of knowledge). This, combined with additional experience and practice utilizing concepts results in increases in the automaticity with which children access or activate associations in their knowledge base, including associations that mediate false remembering.

According to the AAT (Howe, 2005, 2006, 2008b; Howe et al., 2008), children's false memories, like those of adults, should increase as a function of increasing associative strength between list items and the critical lure. However, it is unlikely that young children's rates of false memories will be similar to those of older children and adults because concepts and the associative relations among them are not activated as automatically as they are for adults. As demonstrated by studies of memory organization, the quantity and quality of associative relations between old and newly acquired concepts continue to undergo significant changes with development (Bjorklund, 1987, 2004). As children gain knowledge and experience through exposure and development, their conceptual representations and the associative links among related concepts become better integrated in memory (Bjorklund,1987, 2004; Howe, 2000). Although these changes in the organization of conceptual representations strengthen the links between related concepts, children's ability to automatically process these relations and activate related concepts will depend on their developing cognitive abilities.

The production of false memories in the DRM paradigm is relatively automatic for adults, for whom associated but unpresented items, such as the critical lure, are primed through their associative links with the presented list items. Children's ability to process and activate these items through their associative links with list items is not as automatic (for a review, see Howe, 2000). The activation of these associative links is effortful for young children, but as children get older, less cognitive effort is required to process and activate associative links between related concepts, which in turn increases their susceptibility to the DRM false memory illusion (Howe, 2005; Metzger et al., 2008). For example, Howe (2005) found that young children are able to inhibit false memories suggesting that they are less automatic *per se*. In this study children were presented with two DRM lists. After the first list had been presented children either received remember instructions ("keep remembering the words on this list") or forget instructions ("this was just a practice list, you can forget it") and then told to remember the second list. A third control group received no instructions and served as a baseline for true and false memory rates. The results showed that children in the forgetting condition had significantly fewer false memories than children in the control condition whereas children in the remember condition had significantly more false memories than children in the control condition. If false memories occurred automatically at the time of encoding or retrieval, as they do in adults (see Kimball & Bjork, 2002), inhibition would have been extremely difficult. The fact that children were able to inhibit false memories suggests that they are less automatic than for adults. Therefore, consistent with the predictions of AAT, it is likely that as the automaticity of associative-activation increases with age so too does children's susceptibility to false memory illusions.

FTT contains no assumptions about the role of consciousness and automaticity in the development of the false memory illusion (Brainerd, Forrest, Karibian, & Reyna, 2006; Brainerd & Reyna, 2005). However, FTT differs from AAT on other important dimensions, ones in which distinct predictions can be derived and tested. One critical difference between AAT and FTT is that according to AAT, activation spreads from one word or concept representation to another whereas according to FTT it spreads from a word or list of words to an extracted gist (e.g., thematic representation) to additional representations consistent with the extracted gist. In other words, in AAT concepts directly activate each other in the knowledge base whereas in FTT there is an additional, mediated step involving a separate thematic representation that must be extracted prior to the activation of additional, nonpresented words or con-