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Phonological false memories in children and adults: Evidence for a developmental reversal

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ABSTRACT

False memories created by the Deese/Roediger–McDermott (DRM) procedure typically show a developmental reversal whereby levels of false recall increase with age. In contrast, false memories produced by phonological lists have been shown to decrease as age increases. In the current study we show that phonological false memories, like semantic false memories produced by the DRM procedure, show a developmental reversal when list items converge on a single critical lure. In addition, effects of list length were observed in adults and older children but not in the younger children, again mirroring effects previously observed in semantic false memories. These findings suggest that differences in list structure underlie the divergent developmental trajectories previously reported in semantic and phonological false memories. The findings are discussed in relation to theories of false memory and theories of spoken word recognition.

Introduction

Roediger and McDermott (1995) demonstrated a powerful and robust false memory illusion that does not depend on providing participants with suggestive materials at study or leading questions at test. Based on a procedure originally developed by Deese (1959), participants are presented with lists of semantic associates of a nonpresented *critical lure* (e.g., participants are presented with *thread*, *pin*, *sewing*, *sharp*, etc., which are associates of the critical lure *needle*). Deese found that the probability of extra-list intrusions at recall was proportional to the probability of the critical lure being generated as an associate in response to the list items; i.e., backward associative strength (BAS). Roediger and McDermott revived and extended what is now referred to as the Deese/Roediger–McDermott (DRM) paradigm and found robust false memory effects in tests of both recall and recognition, with levels of false memory matching or even exceeding levels of veridical memory.

Two theoretical accounts of the DRM illusion have been proposed. According to activation-monitoring theory (Roediger, Watson, McDermott, & Gallo, 2001), critical lures are activated at encoding in response to the study lists. They are then subject to errors of source monitoring at test (see Johnson, Hashtroudi, & Lindsay, 1993) and falsely endorsed as having been studied. According to fuzzy trace theory (Reyna & Brainerd, 1998), participants encode two traces of study items; a verbatim trace that encodes specific details of an item and its encoding context, and a gist trace that preserves relational information about the meaning of an item or list of items. False memories occur when critical lures presented at test match the gist traces formed at study, but this effect can be suppressed via a process of recollection rejection whereby lures are rejected on the grounds that they do not contain the expected verbatim information.

False memories have also been investigated using lists of words that are associated phonologically rather than semantically. For example, Sommers and Lewis (1999) presented participants with lists of the most confusable phonological neighbours of a single critical lure. They found high levels

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of false recall, with no difference between the mean probability of recalling the critical lure and that of recalling studied items (.54 and .58 respectively). These results parallel those found by Roediger and McDermott (1995) in semantic false memory. In recognition tests, participants responded *old* to critical lures 64% of the time, a rate similar to that at which participants falsely recognised semantic critical lures in Roediger and McDermott's study. High levels of false memories produced by phonological lists have been reported in a number of subsequent studies (e.g., Ballardini, Yamashita, & Wallace, 2008; Budson, Sullivan, Daffner, & Schacter, 2003; McDermott & Watson, 2001; Sommers & Huff, 2003; Watson, Balota, & Roediger, 2003; Westbury, Buchanan, & Brown, 2002).

Sommers and Lewis (Experiment 3) found that the magnitude of the false memory effect was related to the confusability between critical lures and phonological neighbours. They used the Frequency Weighted Neighbourhood Probability (FWNP) calculation developed by Luce and Pisoni (1998) to calculate the confusability between a critical lure (e.g. *hit*) and one of its phonological neighbours (e.g. *heat*) whilst also controlling for word frequency. Significantly more critical lures were recalled in lists comprising most confusable neighbours and, at recognition more false alarms were made to critical lures of lists with most confusable neighbours. As discussed by Sommers and Lewis, these findings are consistent with the Neighbourhood Activation Model (NAM) of word recognition (Luce & Pisoni), in which words are organised into neighbourhoods based on phonological similarity. According to the NAM, words are similar to a stimulus word if they can be created by adding, subtracting or deleting a single phoneme. For example *sadder* (addition), *add* (deletion) and *mad* (substitution) all belong (amongst others) to the similarity neighbourhood of *sad*. Moreover, graded activation of phonemes occurs such that items that are more similar to stimulus input will receive greater activation than those that are less similar. This feature of the NAM can be compared with activation models of semantic false memories, in which levels of false memory are determined by the strength of association between studied items and critical lures (see Roediger et al., 2001).

Despite the similarity between the phonological false memories reported by Sommers and Lewis (1999) and the semantic false memories produced by DRM lists, findings from subsequent studies suggest that they are supported by different underlying processes. Watson et al. (2003) found that hybrid lists (containing both semantic and phonological associates of the critical lure) produced levels of false recall and recognition that were greater than what would be expected from lists comprising only one type of associate. They suggested that this over-additive pattern was due to differences between the activation processes for the two list types (conceptually-based processes in semantic lists versus perceptually-based processes in phonological lists). In support of this, Ballardini et al. (2008) found that phonological false recall peaked after short (20 ms) presentation durations, whereas semantic false recall peaked after longer (250 ms) presentation durations. Ballardini et al. suggested that the 20 ms window was sufficient to activate the perceptual associations that give rise to phonological false memories, but not the conceptual associations that give rise to semantic false memories. Evidence for the independence of semantic and phonological false memories was also provided by Ballou and Sommers (2008). Using an individual differences approach, they found significant correlations between semantic and phonological lists for veridical memories but not for false memories.

A further difference between semantic and phonological false memories, and the focus of the current study, is their developmental trajectory. A counterintuitive finding from the DRM literature is a developmental reversal, whereby young children produce lower levels of false memory than older children, adolescents, and young adults (for examples see Anastasi & Rhodes, 2008; Brainerd, Reyna, & Forrest, 2002; Howe, 2005, 2006; Sugrue & Hayne, 2006; for reviews see Brainerd, Reyna, & Ceci, 2008; Holliday, Brainerd, & Reyna, 2011). A similar pattern has been observed in studies using lists of category exemplars (Brainerd & Reyna, 2007). Developmental reversals in false memory have been interpreted in terms of activation models and fuzzy-trace theory. According to the associative activation theory proposed by Howe (2005, 2006; Howe, Wimmer, Gagnon, & Plumpton, 2009), developmental reversals reflect the increasing automaticity with which associates are activated at study. According to fuzzy-trace theory, developmental reversals reflect a trade-off between gist-extraction and the use of verbatim traces to reject critical lures. A key component of FTT is that developmental reversals are driven entirely by improvements in gist connection, rather than changes in the familiarity of the individual items (Brainerd et al., 2008).

As discussed above, developmental reversals have been observed with lists of semantic associates (either associatively or categorically related). A similar reversal has also been reported in studies of memory suggestion (e.g., Pezdek & Roe, 1995, 1997; Ross et al., 2006; see Brainerd et al., 2008). Developmental reversals thus appear to be common feature across a number of false memory paradigms. However, phonological false memories are an exception to this pattern as they have been shown to decrease as age increases. For example, Dewhurst and Robinson (2004) presented children aged 5, 8, and 11 years with shortened DRM lists in which each item had at least one possible rhyming word (although the studied words did not rhyme with each other). They observed a developmental shift from phonological to semantic false memories, whereby 5-year-olds falsely recalled more phonological associates of studied items, but fewer semantic associates of studied items, relative to 11-year-olds. This pattern suggests that young children make associations based primarily on phonological features of studied items, whereas older children (and adults) make associations based primarily on semantic features.

Divergent developmental trajectories for semantic and phonological false memories were also observed by Holliday and Weekes in false recognition. Specifically, they found that false recognition of critical lures from semantically related lists increased with age, whereas false recognition of critical lures from phonological lists decreased with age (see Brainerd & Reyna, 2007, for a similar age-related decline in phonological false recognition). Holliday and Weekes (2006) discussed their findings in terms of the Cohort Model of word recognition (Marslen-Wilson & Tyler, 1980). Due to the fact that the initial phoneme of a word is necessarily perceived first during spoken word recognition,