RUNNING HEAD: Investigating children's false memories

What factors underlie children's susceptibility to semantic and phonological false memories? Investigating the roles of language skills and auditory short-term memory

Sarah P. McGeown[1], Eleanor A. Gray[2], Jamey L. Robinson[2], and Stephen A. Dewhurst[2]

[1]School of Education, University of Edinburgh, UK

[2]Department of Psychology, University of Hull, UK

Word count: 5210

Address for correspondence:

Stephen A. Dewhurst

Department of Psychology

University of Hull

Hull HU6 7RX

England

Phone +44 1482 465931

Fax +44 1482 465599

Email s.dewhurst@hull.ac.uk

Highlights

Performance on verbal similarities test is positively associated with semantic false recall.

Performance on phoneme awareness test is negatively associated with phonological false recall.

Auditory short-term memory is negatively associated with semantic but not phonological false recall.

Findings identify some of the cognitive processes that underlie developmental reversals in susceptibility to false memories.

Abstract

Two experiments investigated the cognitive skills that underlie children's susceptibility to semantic and phonological false memories in the Deese/Roediger-McDermott procedure (Deese, 1959; Roediger & McDermott, 1995). In Experiment 1, performance on the Verbal Similarities subtest of the British Ability Scales (BAS) II (Elliott, Smith & McCulloch, 1997) predicted correct and false recall of semantic lures. In Experiment 2, performance on the Yopp-Singer Test of Phonemic Segmentation (Yopp, 1988) did not predict correct recall, but inversely predicted the false recall of phonological lures. Auditory short-term memory was a negative predictor of false recall in Experiment 1, but not in Experiment 2. The findings are discussed in terms of the formation of gist and verbatim traces as proposed by fuzzy trace theory (Reyna & Brainerd, 1998) and the increasing automaticity of associations as proposed by associative activation theory (Howe, Wimmer, Gagnon, & Plumpton, 2009).

Keywords: False memory development; semantic DRM; phonological DRM; fuzzy trace theory; associative activation theory.

What factors underlie children's susceptibility to semantic and phonological false memories? Investigating the roles of language skills and auditory short-term memory

1. Introduction

False memories in children and adults have been widely investigated using lists of words that converge on a common theme. For example, in the Deese/Roediger-McDermott (DRM) procedure, named after studies by Deese (1959) and Roediger and McDermott (1995), participants study lists of words that are semantic associates of a nonstudied critical lure (e.g., participants study words such as *bed*, *dream*, *awake*, and *tired*, which are associates of the critical lure *sleep*). When memory for the lists is tested, participants typically show high levels of false recall and false recognition of the critical lures (for a review see Gallo, 2006). Similar phenomena have been observed 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 critical lure (e.g., participants studied words such as *fat*, *cab*, *cot*, and *kit*, which differ by one phoneme from the critical lure *cat*). Sommers and Lewis also found high levels of false recall, paralleling the results reported by Roediger and McDermott using semantic lists.

Although these methods reliably produce high levels of false recall and recognition in adult participants, they are less effective when it comes to eliciting false memories in children. Many studies have reported a *developmental reversal*, whereby levels of false memory are lower in young children than in older children and adults. For example, using the semantic DRM procedure, Brainerd, Reyna, and Forrest (2002) found near-floor levels of false recall in five- and seven-year-olds, and lower levels of false recognition in five-year-olds relative to eleven-year-olds and young adults. This pattern has been replicated in many subsequent studies (e.g., Howe, 2006; Howe, Wimmer, Gagnon, & Plumpton, 2009; Metzger, Warren, Shelton, Price, Reed, & Williams, 2008; Odegard, Holliday, Brainerd, & Reyna, 2008, see Brainerd, Reyna, & Ceci, 2008, for a review). Investigations of the developmental trajectory of phonological false memories have produced less consistent results. Holliday and Weekes (2006) 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). In contrast, a recent study by Swannell and Dewhurst (2012) found a developmental reversal in phonological false recall when study lists converged on a single critical lure. However, Swannell and Dewhurst did not measure false recognition so their findings cannot be compared directly with those of Holliday and Weekes.

The two dominant accounts of children's false memory are fuzzy trace theory (Reyna & Brainerd, 1998) and associative activation theory (Howe, Wimmer, Gagnon, & Plumpton, 2009). According to fuzzy trace theory, participants encode two traces of study items; verbatim traces that include specific details of each item and its encoding context, and gist traces that reflect the underlying theme of a set of items. Gist traces are assumed to be responsible for false memories, and susceptibility to false memories is attributed to the ability to extract the gist of DRM lists (see Brainerd et al., 2008, for a review). Gist extraction improves with age, leading to the aforementioned developmental reversal. According to associative activation theory, susceptibility to false memories is determined by the automaticity with which associates are activated in response to study items. Adults are more susceptible than children to the DRM illusion because the automaticity of associations increases with age (see also Wimmer & Howe, 2009, 2010).

The aim of the current study was to investigate the cognitive processes that give rise to false memories in children. As discussed above, previous developmental studies have typically measured age-related changes in levels of false memory and interpreted their trajectory in terms of cognitive development. In the current study, we took a different approach by investigating whether susceptibility to false memories among children within the same age range was predicted by individual differences in their language skills. Experiment 1 investigated whether susceptibility to semantic false memories was related to performance on the Verbal Similarities subtest of the British Ability Scales (BAS) II (Elliott, Smith & McCulloch, 1997), which measures awareness of semantic associations between words. Experiment 2 investigated whether susceptibility to phonological false memories was related to performance on the Yopp-Singer Test of Phonemic Segmentation (Yopp, 1988) which measures phonemic awareness. In both experiments, our prediction was that test scores would be positively associated with susceptibility to false memories, such that children who achieved the higher scores on the tests would show higher levels of false recall.

Two previous studies have taken a similar individual differences approach to the investigation of children's false memories. In a study looking at the role of learning ability, Brainerd, Forrest, Karibian, and Reyna (2006: Experiment 2) found that levels of correct and false recall were lower in learning-disabled children relative to nondisabled children. Comparison of 7- and 11-year-olds also showed that the learning disabled children did not show the developmental reversal observed in nondisabled children. These findings are consistent with those of studies showing that the ability to connect meaning across words within other types of list (e.g., lists of category associates) is reduced in learning-disabled children (Swanson, 1991).

More recently, Weekes, Hamilton, Oakhill, and Holliday (2008) investigated semantic and phonological false memories in 9- and 11-year-olds who were either normal readers or poor comprehenders (defined as having impaired reading comprehension but intact word recognition and phonological decoding skills). Relative to normal readers, poor comprehenders showed lower levels of false recall and recognition after studying semantic lists but not after studying phonological lists. Weekes et al. interpreted this pattern of findings in terms of the claims by Nation and colleagues (Nation & Snowling, 1999; Nation, Adams, Bowyer-Crane, & Snowling, 1999) that poor comprehenders have weak semantic skills. In Experiment 1 of the current study, we tested this view directly by investigating whether susceptibility to semantic false memories is predicted by a test that measures the understanding of high level semantic knowledge. As noted above, Weekes et al. found that poor comprehenders did not show reduced levels of phonological false memories. In Experiment 2 of the current study we investigated whether susceptibility to phonological false memories can be predicted by performance on a test of phonological rather than semantic knowledge.

To summarise, the two experiments reported below investigated false memories in children using lists of words that were associated semantically (Experiment 1) or phonologically (Experiment 2). In each experiment, we investigated whether susceptibility to false memories was positively associated with performance on a relevant test of language ability. Our sample consisted of children within the age range of 8 to 11 years, as previous research has shown that children within this age range are susceptible to both semantic and phonological false memories (e.g., Dewhurst & Robinson, 2004; Holliday & Weekes, 2006). It is also similar to the age range tested by Weekes et al. (2008). We also investigated the influence of auditory short-term memory using the BAS II Recall of Digits Forward subtest (Elliott et al., 1997). Research with adults has shown that high working memory capacity is negatively related to levels of false memory (Watson, Bunting, Poole, & Conway, 2005). Based on this finding, our prediction was that children with high short-term memory capacity would show reduced susceptibility to false memories.

2. Experiment 1

2.1. Method

2.1.1. Participants

Seventy children from three local primary schools took part in Experiment 1. The children (35 male, 35 female) were aged between 8 and 11 years (*M*=10.22, *SD*=1.03). All spoke English as their first language. Ethical approval was sought and granted from the local University Ethics Committee prior to contacting the schools.

2.1.2. Materials

Semantic DRM lists. Ten child-normed lists, with nine items per list, were selected from Anastasi and Rhodes (2008). The lists were based on the following critical lures: *window, river, car, sleep, rubber, lion, city, fruit, music* and *king*, with the first nine common associates on each list presented at study (see Appendix 1). Raw scores were used in the analysis (number of correct and falsely recalled items across all 10 lists).

British Ability Scales (BAS) II Verbal Similarities subtest (Elliott, Smith & McCulloch, 1997). The verbal similarities subtest involves inductive reasoning with verbal concepts and is typically used as a measure of verbal IQ. To complete this assessment, children are required to state how three things are similar (e.g., peas, cabbages, and carrots). This test was administered and marked in accordance with manual guidelines with a maximum score of 37. As raw scores were used in the DRM task, raw scores for this assessment were also used in the analyses.

BAS II Recall of Digits Forward subtest (Elliott et al., 1997). The recall of digits forward subtest measures short term auditory memory, using oral recall of sequences of numbers. Children are required to repeat a series of digits of increasing length. This test was administered and marked in accordance with manual guidelines and has a maximum possible score of 36. As with the other tests, children's raw scores were used in the analyses.

2.1.3. Procedure

The DRM task was completed first, followed by the verbal similarities subtest and finally the auditory short term memory subtest. For the DRM task, children were instructed to pay attention to each of the list items which were read out at a rate of one per second. Children were told that they would be asked to recall the items from this list, but that they could recall them back in any order. After reading each list, the examiner counted backwards from five before the child recalled as many items from the list as they could remember. The study items named by the child were ticked off on a pre-prepared sheet and any additional items said by the child were written down by the examiner. After children indicated that they could not recall any more items, the examiner proceeded with the next list. All assessments were administered individually and took approximately 30 minutes per child. After participating, children were thanked for their time.

2.2. Results and discussion

Table 1 illustrates the mean levels of correct and false recall on the semantic DRM lists[1] and mean scores on the BAS II Verbal Similarities Test and BAS II Recall of Digits Forward Test. Regression analyses were conducted to investigate whether chronological age, performance on the verbal similarities and digit recall tests predicted correct and false recall of the DRM lists. The results of the regression analyses are shown in Tables 2 and 3.

Chronological age did not predict significant variance in correct or false recall of the semantics lists (though as can be seen from Table 2, chronological age was a significant predictor of correct recall with a one-tailed hypothesis). Correct recall was, however, significantly predicted by children's semantic knowledge as measured by Verbal Similarities Test; the higher their score, the more items they recalled. Children's semantic knowledge also significantly predicted the false recall of critical lures; the higher their score on the Verbal Similarities Test, the more critical lures they falsely recalled, which was consistent with predictions. Short-term auditory memory, as measured using the BAS II recall of digits

[1] In response to a reviewer's suggestion, we analysed correct and false recall for each individual list used in Experiments 1 and 2. There was no evidence of systematic changes in performance or proactive interference across successive lists.

forward, did not predict correct recall but inversely predicted false recall; children with better short-term auditory memory recalled fewer critical lures, again consistent with predictions.

The findings of Experiment 1 indicate that children's semantic knowledge predicts their susceptibility to false memories in the DRM paradigm and is a stronger predictor than chronological age. The Verbal Similarities Test measures children's ability to find higher order associations within a set of words. The finding that the test predicts susceptibility to the DRM illusion is consistent with the view that the illusion is driven by the identification of the theme or gist of a DRM list. At the same time, auditory memory protected against the recall of critical lures; those children with better auditory memory recalled fewer critical lures. It is possible that children with better auditory memory were more adept at using a recollection rejection strategy whereby they avoided endorsing critical lures by correctly recalling the studied items (Brainerd, Reyna, Wright, & Mojardin, 2003).

3. Experiment 2

Experiment 1 showed that children's susceptibility to semantic false memories is predicted by their ability to identify higher order semantic associations. This is consistent with the findings of Weekes et al. (2008) that the false recall of semantic lures is positively associated with comprehension skills. The effects observed by Weekes et al. were, however, confined to semantic DRM lists. Comprehension skills were not reliably associated with the false recall of phonological lures. In Experiment 2 we investigated whether phonological false memories can be predicted by individual differences in a test of phoneme awareness. Based on the findings of Experiment 1, it was predicted that children with better language skills (in this case, phoneme awareness) would be more prone to the false recall of phonological lures.

3.1. Method

3.1.1. Participants

Seventy-one children took part in Experiment 2. Children were selected from the same schools as Experiment 1 but had not previously taken part in Experiment 1. The children (36 male, 35 female) were aged between 8 and 11 years (*M*=10.31, *SD*=1.08). All spoke English as their first language.

3.1.2. Materials

Phonological DRM lists. Ten lists with nine 3-phoneme items per list were created for this study using the following critical lures: *cat, bill, beat, hit, pot, lad, right, rain, ride,* and *set*. Using the ESRC Children's Printed Word Database (Lovejoy, Masterson, Stuart & Dixon, 2003), the ten critical lures for the phonological DRM lists were matched for frequency per million with the semantic DRM critical lures, to ensure that any differences in recalling a critical lure between these tasks could not be attributed to word frequency. Average frequency per million for the semantic DRM lists was 389.00 (241.59 SD) and for the phonological DRM lists was 349.00 (379.57 SD); these did not differ significantly; p = .81. List items for the phonological DRM test were further constrained by the fact that three items had to be derived from changes to the initial phoneme (e.g., cat – fat), three from changes the middle phoneme (e.g., cat – cot) and three from changes to the final phoneme (e.g., cat – cab) (see Appendix 2).

Yopp-Singer Test of Phonemic Segmentation (Yopp, 1988). To complete this assessment, children are required to segment fourteen spoken words into individual phonemes. Children received one mark for each phoneme correctly identified, giving a raw score out of 56. Children practiced this with three words prior to beginning the assessment.

BAS II Recall of Digits Forward subtest (Elliott et al., 1997). As described in the Method section of Experiment 1.

3.1.3. Procedure.

The phonological DRM test was completed first, followed by the phonemic segmentation test, and finally the short-term auditory memory subtest. In all other respects, the procedure followed that of Experiment 1.

3.2. Results and discussion

Mean levels of correct and false recall and mean scores on the Yopp Singer Phoneme Awareness and BAS II Recall of Digits Forward tests are shown in Table 4. Regression analyses investigated whether chronological age and performance on the phoneme awareness (measured by Yopp-Singer test of Phoneme Segmentation) and digit recall tests predicted correct and false recall of phonological DRM lists. The results of the regression analyses are displayed in Table 5 and 6.

Chronological age predicted correct recall, but not false recall, of the phonological lists. Furthermore, correct recall of phonological DRM lists was not significantly related to children's phoneme awareness. In contrast, phoneme awareness inversely predicted children's false recall of critical lures; the better children's phoneme awareness, the lower their levels of false recall. This is counter to our prediction, based on the findings of Experiment 1, that test scores would positively predict levels of false recall. A further contrast to the finding of Experiment 1 is that auditory memory was positively associated with levels of correct recall but was not significantly related to levels of false recall. These findings are considered in more detail in the next section.

4. General discussion

The present study examined whether language abilities (specifically, the awareness of semantic associations and phonemic awareness) and auditory short-term memory predicted children's correct and false recall using semantic and phonological DRM lists. In Experiment 1, performance on the Verbal Similarities Test (Elliott et al., 1997) significantly predicted correct recall of semantic DRM lists, suggesting that children with better understanding of semantic associations are more proficient at utilising these associations to recall studied items. However, this advantage came at a cost, as semantic knowledge also predicted false recall; children who achieved higher scores on the Verbal Similarities Test were more likely to falsely recall the critical lures. In Experiment 2, performance on the Phonemic Segmentation Test (Yopp, 1988) did not significantly predict correct recall of phonological DRM lists. However, phoneme awareness significantly predicted false recall of phonological critical lures; the better the children's phoneme awareness, the less likely they were to falsely recall the critical lures.

In line with our predictions, Experiment 1 showed that susceptibility to semantic false memories was positively predicted by knowledge of semantic associations. This finding is consistent with the assumption of fuzzy trace theory that susceptibility to the DRM illusion depends on the ability to extract the semantic gist of the study lists (see Brainerd et al., 2008). Gist extraction is likely to rely on the same knowledge of semantic associations that is measured by the Verbal Similarities Test. Hence, higher scores on the Verbal Similarities Test were associated with higher levels of false recall. The results of Experiment 1 are also consistent with the findings of Weekes et al. (2008) that poor comprehenders showed reduced susceptibility to false recall and recognition with semantic lists but not with phonological lists, which they also interpreted as an impairment in the ability to form a gist representation.

In contrast, the findings from Experiment 2 ran counter to our predictions. We hypothesized that children with better phoneme awareness would be more likely to recognise the phonological similarities among the items within the list, thereby increasing the likelihood of generating the critical lure. Unexpectedly, however, the phoneme awareness skills assessed in Experiment 2 *inversely* predicted susceptibility to phonological false memories, though it is notable that the effect is much weaker in magnitude than the effect of semantic knowledge observed in Experiment 1. One possible explanation for the inverse effect may lie in the participants' encoding strategies. It is likely that, when listening to lists of phonologically similar words, the children were more concerned with discriminating between items, leading to a focus on differences rather than similarities between list members. Such a strategy is likely to facilitate the formation of verbatim rather than gist traces (see Brainerd et al., 2008). This is supported by research with adults showing that encoding activities that engage item-specific processing rather than relational processing (see Einstein & Hunt, 1981) reduce levels of false recall (e.g., McCabe, Presmanes, Robertson, & Smith, 2004). As the Phonemic Segmentation Test measures the ability to separate adjacent phonemes, it is likely to reflect the ability to form verbatim traces of phonologically similar items. If so, it is unsurprising that test scores were inversely related to levels of phonological false recall.

The current findings can also be interpreted in terms of associative activation theory (Howe et al., 2009). According to this account, children's susceptibility to false memories increases with the automaticity of semantic associations. Performance on the Verbal Similarities Test is also likely to improve as the retrieval of semantic knowledge becomes increasingly automatic, hence the parallel increases in false recall and task performance. In terms of the reversed effect of phonological similarity observed in Experiment 2 (in which phonological false recall was inversely related to phoneme awareness), we have suggested that improvements in phoneme awareness lead children to focus on differences between words rather than similarities. Automatic activation theory would predict that the ability to identify such differences becomes increasingly automatic with age. Our findings do not, therefore, arbitrate between fuzzy trace theory and automatic activation theory. Investigation of the encoding strategies used by children when studying semantic and phonological DRM lists is likely to inform this debate.

The findings of Experiments 1 and 2 also differed with regard to the effects of auditory short-term memory. In Experiment 1, children with higher scores on the digit recall task were less susceptible to false recall. This pattern suggests that auditory short-term memory acts as a monitoring mechanism, possibly via a process of recollection rejection (see Brainerd et al., 2003). Thus, whilst language skills appear to facilitate recall of the critical lure in semantic DRM lists, leading to more false memories, their effect is moderated by short-term memory processes. In contrast, performance on the digit recall task did not predict the false recall of phonological critical lures in Experiment 2. This is surprising as it would be expected that short-term memory would act as a monitoring mechanism regardless of the nature of the study lists. However, as the auditory memory task used in the present study involved recalling lists of digits, which were easily distinguished from one another, it is possible that this assessment was not sensitive enough to capture the level of auditory memory needed to recall lists of phonologically similar items.

One potential criticism of the current study is that we did not use the same measures of language skills across the two experiments. For this initial investigation, we restricted our analyses to tests that we judged most likely to tap into the cognitive processes underlying semantic and phonological false memories. It is entirely feasible that susceptibility to semantic false memories will be influenced by phoneme awareness and susceptibility to phonological false memories by semantic knowledge, though we are aware of no a priori reasons why this should be the case. Nevertheless, a useful direction for future research might be to compare semantic and phonological false memories using a larger battery of language tests. It would also be informative to compare children's encoding strategies when presented with semantic and phonological lists. In the meantime, our findings provide novel insights into the cognitive processes that may underlie the developmental reversal in susceptibility to false memories observed in previous research. Our findings also add to the growing body of evidence that semantic and phonological false memories are supported by different underlying processes.

Authors' note

Sarah P. McGeown, School of Education, University of Edinburgh, Edinburgh EH8 8AQ, UK. Eleanor A. Gray, Jamey L. Robinson, and Stephen A. Dewhurst, Department of Psychology, University of Hull, Hull, HU6 7RX, UK. We wish to thank the staff and students from all schools for their participation in this research.

This manuscript is jointly first authored by Sarah P. McGeown and Stephen A. Dewhurst. Correspondence concerning this article should be addressed to Sarah P. McGeown, School of Education, University of Edinburgh, Edinburgh EH8 8AQ, UK, email S.McGeown@ed.ac.uk, or to Stephen A. Dewhurst, Department of Psychology, University of Hull, Hull, HU6 7RX, UK, email s.dewhurst@hull.ac.uk.

Appendix 1. Semantic lists used in Experiment 1 (selected from Anastasi & Rhodes, 2008).

List 1: dance, sing, loud, sound, drum, guitar, nice, play, instrument (CL = music)

List 2: crown, queen, castle, royal, boss, princess, ruler, throne, prince (CL = king)

List 3: glass, see, house, open, blinds, outside, tree, doors, metal (CL = window)

List 4: water, fish, swim, stream, lake, ocean, flow, frog, beach (CL = river)

List 5: wheel, drive, seat, fast, steering, engine, gas, school, doors (CL = car)

List 6: bed, pillow, blanket, tired, dream, snore, nap, rest, awake (CL = sleep)

List 7: roar, fur, teeth, meat, eat, scary, tail, zoo, hair (CL = lion)

List 8: buildings, people, houses, skyscrapers, town, state, work, hotels, store (CL = city)

List 9: apple, eat, banana, healthy, orange, grape, sweet, watermelon, seeds (CL = fruit)

List 10: stretchy, band, bounce, plastic, squishy, toys, duck, goo, hard (CL = rubber)

Appendix 2. Phonological lists used in Experiment 2.

List 1: fat, cot, cab, sat, kit, cad, mat, cut, cap (CL = cat)

List 2: hill, bowl, bid, fill, ball, bit, will, bell, big (CL = bill)

List 3: heat, bet, beak, seat, bat, beef, cheat, bit, bead (CL = beat)

List 4: fit, heat, his, sit, hot, him, lit, hat, hill (CL = hit)

List 5: got, pit, pod, rot, pat, pop, hot, put, posh (CL = pot)

List 6: had, lid, lap, pad, loud, lag, bad, lead, lack (CL = lad)

List 7: night, root, rice, tight, rot, rhyme, fight, rat, ripe (CL = right)

List 8: gain, ran, raid, pain, run, race, cane, roan, rail (CL = rain)

List 9: wide, raid, ripe, bide, red, rice, side, rude, rise (CL = ride)

List 10: let, sat, said, net, sit, cell, wet, seat, sent (CL = set)

References

Anastasi, J. S., & Rhodes, M. G. (2008). Examining differences in the levels of false memories in children and adults using child-normed lists. *Developmental Psychology, 44*, 889-894.

Brainerd, C. J., Forrest, T. J., Karibian, D., & Reyna, V. F. (2006). Development of the false-memory illusion. *Developmental Psychology, 42*, 962-979.

Brainerd, C. J., & Reyna, V. F. (2007). Explaining developmental reversals in false memory. *Psychological Science, 18*, 442-448.

Brainerd, C. J., Reyna, V. F., & Ceci, S. J. (2008). Developmental Reversals in False Memory: A Review of Data and Theory. *Psychological Bulletin, 134*, 343-382.

Brainerd, C. J., Reyna, V. F., & Forrest, T. J. (2002). Are young children susceptible to the false-memory illusion? *Child Development, 73*, 1363-1377.

Brainerd, C. J., Reyna, V. F., Wright, R., & Mojardin, A. H. (2003). Recollection rejection: False-memory editing in children and adults. *Psychological Review, 110*, 762-784.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58*, 17-22.

Dewhurst, S.A., & Robinson, C.A. (2004). False memories in children: Evidence for a shift from phonological to semantic associations. *Psychological Science*, *15*, 782-786.

Elliott, C.D., Smith, P., & McCulloch, K. (1997). *The British Ability Scales II*. Windsor: NFER-Nelson.

Gallo, D.A. (2006). *Associative illusions of memory*. New York: Psychology Press.

Holliday, R. E., & Weekes, B. S. (2006). Dissociated developmental trajectories for semantic and phonological false memories. *Memory, 14*, 624–636.

Howe, M. L. (2006). Developmentally invariant dissociations in children's true and false memories: Not all relatedness is created equal. *Child Development*, *77*, 1112.

Howe, M. L., Wimmer, M. C., Gagnon, N., & Plumpton, S. (2009). An associative-activation theory of children's and adults' memory illusions. *Journal of Memory and Language*, *60*, 229-251.

Hunt, R. R., & Einstein, G. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning & Verbal Behavior*, *20*, 497–514.

Lovejoy, S., Masterson, J., Stuart, M., & Dixon, M. (2003). Children's Printed Word Database website. Link for details: http://www.esrc.ac.uk/my-esrc/grants/R000223406/outputs/read/46085a42-9814-44b6-b02f-04ac7dd545d2

McCabe, D.P., Presmanes, A.G., Robertson, C.L., & Smith, A.D. (2004). Item-specific processing reduces false memories. *Psychonomic Bulletin & Review*, *11*, 1074-1079.

Metzger, R. L., Warren, A. R., Shelton, J. T., Price, J., Reed, A. W., & Williams, D. (2008). Do children 'DRM' like adults? False memory production in children. *Developmental Psychology*, *44*, 169-181.

Nation, K., & Snowling, M. (1999). Developmental differences in sensitivity to semantic relations among good and poor comprehenders: evidence from semantic priming. *Cognition*, *19*, B1–B13.

Nation, K., Adams, J. W., Bowyer-Crane, C. A., & Snowling, M. J. (1999). Working memory deficits in poor comprehenders reflect underlying language impairments. *Journal of Experimental Child Psychology*, *73*, 139–158.

Odegard, T. N., Holliday, R. E., Brainerd, C. J., & Reyna, V. F. (2008). Attention to global gist processing eliminates age effects in false memories. *Journal of Experimental Child Psychology*, *99*, 96–113.

Reyna, V. F., & Brainerd, C. J. (1998). Fuzzy-trace theory and false memory: new frontiers. *Journal of Experimental Child Psychology, 71*, 194–209.

Roediger, H. L., III, & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803-814.

Roediger, H. L., III, Watson, J. M., McDermott, K. B., & Gallo, D. A. (2001). Factors that determine false recall: A multiple regression analysis. *Psychonomic Bulletin & Review*, *8*, 385-407.

Sommers, M. S., & Lewis, B. P. (1999). Who really lives next door: Creating false memories with phonological neighbors. *Journal of Memory and Language, 40*, 83-108.

Swannell, E.R., & Dewhurst, S.A. (2012). Phonological false memories in children and adults: Evidence for a developmental reversal. *Journal of Memory & Language, 66*, 376-383.

Swanson, H. L. (1991). Learning disabilities, distinctive encoding, and hemispheric resources: An information-processing perspective. In J. E. Obrzut & G. W. Hynd (Eds.), *Neuropsychological foundations of learning disabilities* (pp. 241–280). San Diego, CA: Academic Press.

Weekes, B.S., Hamilton, S., Oakhill, J.V., & Holliday, R.E. (2008). False recollection in children with reading comprehension difficulties. *Cognition, 106*, 222-233.

Wimmer, M. C., & Howe, M. L. (2009). The development of automatic associative processes and children's false memories. *Journal of Experimental Child Psychology*, *104*, 447-465.

Wimmer, M. C., & Howe, M. L. (2010). Are children's memory illusions created differently than adults'? Evidence from levels-of-processing and divided attention paradigms. *Journal of Experiment Child Psychology, 107,* 31-49.

Yopp, H.K. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly, 23*, 159–177.

Table 1. Descriptive statistics for Experiment 1.

Assessment	Mean	Standard deviation	Skewness	Kurtosis
Semantic DRM list correct recall	43.51	7.63	.009	-.007
Semantic DRM list false recall	2.00	1.44	.594	-.260
BAS II Verbal Similarities	13.46	4.98	.415	-.421
BAS II Recall of Digits Forward	21.54	3.71	.875	.566

Table 2. Predicting correct recall of semantic DRM lists with age, BAS II verbal similarities and BAS II recall of digits forward as predictors.

					Confidence Interval	
DRM Correct recall	R^2	*B*	*p*	*Final β*	Lower	Upper
Chronological age		1.435	.078	.195	-.17	3.04
BAS II Verbal Similarities		.714	.000	.467	.37	1.06
BAS II Recall of Digits Forward	.364	.145	.500	.071	-.28	.57

Table 3. Predicting false recall of semantic DRM lists with age, BAS II verbal similarities and BAS II recall of digits forward as predictors.

					Confidence Interval	
DRM False recall	R^2	*B*	*p*	*Final β*	Lower	Upper
Chronological age		-.055	.755	-.039	-.40	.30
BAS II Verbal Similarities		.119	.003	.409	.04	.20
BAS II Recall of Digits Forward	.155	-.101	.034	-.260	-.19	-.01

Table 4. Experiment 2 Descriptive statistics.

Assessment	Mean	Standard deviation	Skewness	Kurtosis
Phonological DRM list correct recall	26.96	5.99	.509	.332
Phonological DRM list false recall	3.79	1.81	.458	.199
Yopp Singer Phoneme Awareness	43.38	8.49	-.729	.226
BAS II Recall of Digits Forward	23.44	3.96	-.147	.120

Table 5. Predicting correct recall of phonological DRM lists with age, Yopp-Singer test of phonemic awareness and BAS II recall of digits forward as predictors.

					Confidence Interval	
DRM Correct recall	R^2	*B*	*p*	*Final β*	Lower	Upper
Chronological age		1.258	.033	.226	.10	2.42
Y-S Phoneme Awareness		.086	.495	.070	-.17	.34
BAS II Recall of Digits Forward	.352	.694	.000	.458	.37	1.01

Table 6. Predicting false recall of phonological DRM lists with age, Yopp-Singer test of phonemic awareness and BAS II recall of digits forward as predictors.

					Confidence Interval	
DRM False recall	R^2	*B*	*p*	*Final β*	Lower	Upper
Chronological age		-.297	.153	-.176	-.71	.11
Y-S Phoneme Awareness		-.052	.045	-.243	-.10	-.00
BAS II Recall of Digits Forward	.103	-.014	.807	-.031	-.13	.10