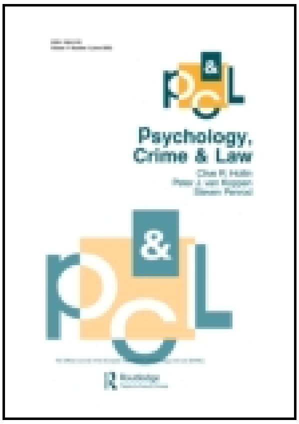

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Children's false memories: different false memory paradigms reveal different results

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Children's false memories: different false memory paradigms reveal different results

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The aim of the present study was to examine whether two different false memory paradigms (DRM vs suggestion) produce similar results. In Experiment 1, 100 children from four age groups (5/6-year-olds, 7/8-year-olds, 9/10-year-olds, and 11/12-year-olds) were instructed to remember lists of semantically related words (DRM paradigm) and to complete a children's suggestibility measure (i.e. BTSS-NL). Results showed that children's false memories for non-presented words increased with age while accepting suggestive information decreased with age. Moreover, no significant relation was found between children's susceptibility to the DRM illusion and concurring to suggestive information. In Experiment 2, DRM false recall and recognition was compared between children with ($n = 20$) and without ($n = 20$) false memories for entire events. Children with implanted false memories did not falsely recall and recognize more critical lures than children without implanted false memories. This study shows that children's DRM intrusions are not related to their acceptance of suggestive information.

Keywords: children; false memories; DRM; suggestibility

Introduction

Examining under what conditions human memory can be inaccurate has sparked researchers' interest for several decades (see for an overview Loftus, 2004).

Moreover, this interest has boosted tremendous public attention since it led to new insights valuable for the legal domain, such as new findings concerning the authenticity of memories of childhood sexual abuse (Ceci & Bruck, 1993; Loftus, 1997). Researchers have used different paradigms to study erroneous memories, also labelled false memories. The aim of this study was to examine whether two different false memory paradigms produce similar results.

A well-known and often used false memory paradigm is the Deese–Roediger–McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm in which participants have to study lists of words, like *wet*, *tears*, *laugh*, and *sorrow* which are semantically related to a non-presented critical lure *cry*. A robust finding is that participants tend to falsely recall and recognize the critical lures with rates not reliably different from the recall and recognition of presented words (Roediger & McDermott, 1995; Roediger & Gallo, 2005). While the development of false memories using DRM word lists is rather *spontaneously* (see Brainerd, Reyna, & Ceci, 2008), other paradigms focus on the development of false memories by

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providing participants with suggestive information. In some studies, the suggestive information is presented in the form of false narratives or doctored photographs suggesting that participants took part in a fictitious event (Loftus & Pickrell, 1995; Otgaar, Candel, & Merckelbach, 2008; Otgaar, Candel, Merckelbach, & Wade, 2009; Pezdek, Finger & Hodge, 1997; Pezdek & Hodge, 1999; Strange, Sutherland, & Garry, 2006; Wade, Garry, Read, & Lindsay, 2002). Overall, these studies have shown that a wide range of events can be implanted. So, these studies showed that people can develop false memories of a great variety of events (e.g. being abducted by a UFO, being lost in a shopping mall). In other studies, suggestive information is presented in the form of misleading questions (e.g. Candel, Merckelbach, Jelicic, Limpens, & Widdershoven, 2004; Garven, Wood, Malpass, & Shaw, 1998). These studies show that participants have the tendency to yield to suggestive information.

Theoretical accounts for false memories are provided by the Fuzzy-Trace Theory (FTT; Brainerd & Reyna, 2005) and by the source-monitoring framework (Johnson, Hashtroudi, & Lindsay, 1993). From a fuzzy-trace perspective, memories are stored along parallel, dissociated traces called verbatim and gist traces (Brainerd & Reyna, 2002; for an overview see Brainerd et al., 2008). Verbatim traces are involved in storing details and surface components of memory and fade quite fast; gist traces store meaning and persist much longer in memory. According to the FTT, false memories are mainly supported by gist memories. Therefore, false memories arise because a series of words or events repeatedly activate their underlying general meaning and when people are asked to report what they saw or heard, they recall gist-related information that may include incorrect information (e.g. critical lure).

Source monitoring, however, capitalizes on people's ability to correctly ascribe the sources of their memories (Johnson et al., 1993). Specifically, this framework posits that people can use different source monitoring strategies to make attributions about the origins of their memories. According to this framework, a false memory occurs, when people wrongfully attribute internally generated information (e.g. critical lure) to an external source (e.g. a presented word).

A critically important, yet unresolved theoretical issue is whether the false memories produced by different paradigms (i.e. DRM, paradigms using suggestion) are akin or unrelated to each other. Recently, it has been questioned whether these false memory paradigms generate the same type of memory illusion (see Pezdek & Lam, 2007; Pezdek, 2007; Wade et al., 2007). Specifically, Pezdek and Lam (2007) argued that there are constraints on generalizing findings from false memory research directly to real world settings since it could well be the case that the processes that are involved in producing false memories differ among the paradigms. Thus, Pezdek and Lam (p. 9), stated that 'it has not been demonstrated that the mechanisms that operate to explain the DRM findings apply as well to memory for planting entirely new events in memory, specifically memory for child sexual abuse.'

The question that rises here is whether results of studies using different false memory paradigms are interchangeable and therefore equally appropriate as a base for conclusions about, for example, the accuracy of children's claims about sexual abuse. According to Wade and colleagues (2007), a bulk of evidence shows that false memory studies has improved our knowledge about false memory in real world settings since 'some memory illusions can occur across different stimuli and different subject groups' (p. 26). So, these authors argue that false memory studies that have employed simple stimuli (such as words) can serve as a starting point for more complex, ecological valid stimuli (such as autobiographical memories). However, does the finding that for example children (e.g. Brainerd, Reyna, & Forrest, 2002) and women falsely reporting childhood sexual abuse (Geraerts et al., 2006) have the tendency to falsely recall critical lures after studying DRM word lists mean that they are also more at risk for suggestive interview techniques?

The point here is that semantic networks rather than the acceptance of suggestive information accounts for the development of false memories in a DRM paradigm (Brainerd et al., 2008; for an overview see Gallo, 2006). Between studies comparison has shown that suggestive interview techniques, at least in children, reveal different results as compared to DRM lists. Specifically, studies using different false memory paradigms have revealed different developmental trends. Studies using DRM lists have shown that the susceptibility to the DRM illusion increases with age. Children have less extensive semantic networks than adults and as a result critical lures are less likely to become activated (Brainerd & Reyna, 2002; Sugrue & Hayne, 2006; but see Ghetti, Qin, & Goodman, 2002). This finding suits well with predictions of the FTT which hold that young children are less able to rely on gist memories than older children and adults. Therefore, young children are less likely to fall prey to the DRM illusion than older children and adults (Anastasi & Rhodes, 2008; Metzger et al., 2008).

In contrast, studies using suggestion have found that false memories decrease with age with children concurring more to suggestion than adolescents and adults (Ceci, Ross, & Toglia, 1987; Sutherland & Hayne, 2001; for reviews, see Bruck & Ceci, 1999). This can be explained because children's memory and source-monitoring functioning are not as optimal as adults' (Lindsay, Johnson, & Kwon, 1991; for an overview see Roberts & Blades, 2000). Surprisingly, no attempt has ever been made to employ both paradigms (DRM and suggestion) in one single study. In this article, we present two experiments that took up this challenge and sought to examine whether children's false memories elicited by the DRM paradigm are related to false memories produced by suggestion. Experiment 1 examined the relationship between children's susceptibility to the DRM illusion and their acquiescence of suggestive questions by using a children's suggestibility measure (Bonn Test of Statement Suggestibility; BTSS-NL; Candel, Merckelbach, & Muris, 2000; Endres, 1997). Experiment 2 focused on the relation between children's DRM illusion and their implanted false memories.

Concerning the relationship between children's false memories produced by both paradigms, we hypothesized that no relation exists between these false memories since the DRM paradigm triggers spontaneous semantic-related false memories whereas the other false memories are based on suggestion. Thus, our prediction was that different false memory paradigms reveal contrasting results. Furthermore, this hypothesis is supported by different developmental trends for DRM- and suggestion-based false memories. That is, FTT predicts that the DRM memory illusion increases with age (Brainerd & Reyna, 2002; Sugrue & Hayne, 2006; but see Ghetti et al., 2002) whereas the source monitoring framework postulates that false memories induced by suggestion decreases with age (Ceci et al., 1987; Johnson et al., 1993; Sutherland & Hayne, 2001; for reviews, see Bruck & Ceci, 1999; Ceci & Bruck, 1993). Also, Wilkinson and Hyman (1998) argued that memory errors based on suggestion may reflect different underlying processes than DRM-like intrusions, since the first is more based on schemas whereas the latter concentrates on semantic activation of related concepts.

Experiment 1

The goal of Experiment 1 was to examine whether children's susceptibility to suggestive information was related to children's false recall and recognition in the DRM paradigm. Furthermore, different age groups (5/6-year-olds, 7/8-year-olds, 9/10-year-olds, and 11/12-year-olds) were used to investigate a developmental trend in children's false memory development. To this end, 100 children were presented with DRM lists and a suggestibility measure.

Method

Participants

One hundred children from four age groups ($n=23$, 5/6-year-olds, $M=5.70$, $\text{SD}=0.47$; $n=26$, 7/8-year-olds, $M=7.62$, $\text{SD}=0.57$; $n=26$, 9/10-year-olds, $M=9.69$, $\text{SD}=0.47$; $n=25$, 11/12-year-olds, $M=11.24$, $\text{SD}=0.52$) were recruited from different elementary schools in the Netherlands. All children had parental consent. Children received a small present for their participation.

Materials

DRM lists. Children were presented with 10 10-words lists (e.g. *baker*, *butter*, *filling*, *brown*, *dough*, *corn*, *flour*, *knife*, *wheat*, *old*). The words on the lists were all semantically related to a non-presented word (i.e. critical lure, e.g. *bread*). Lists were recorded on a CD and all words were read aloud via a digital voice CD recorder. The interval between word presentations was 2 s. After each list presentation, participants were instructed to verbally recall all the words they remembered. A non-verbal filler task was employed between free recall and the presentation of the next list. List items were selected from the Dutch word association norms (Van Loon-Vervoorn & Van Bekkum, 1991) and from the Dutch version of the DRM paradigm (Peters, Jelicic, & Merckelbach, 2008). Using the Celex lexical database (Centre for Lexical Information, 1995), critical lures were matched on mean word frequency ($t(8)=0.22$, NS). Dutch word association norms showed that mean associative strength between the list words and their critical lures did not differ ($t(8)=1.69$, NS).

DRM recognition task. The 78-word recognition test consisted of 40 studied words (i.e. four items from each list); the 10 critical lures; 10 semantically-related distractors (i.e. the unpresented 11th or 12th word from each list), 18 unrelated distractors. Two parallel versions of the recognition test were created differing in the four studied items and the 18 unrelated distractors.

Bonn Test of Statement Suggestibility-NL (BTSS-NL). The BTSS-NL is a sufficiently reliable and valid tool to measure children's level of suggestibility (Candel, Merckelbach, & Muris, 2000). Like other suggestibility measures (Video Suggestibility Scale for Children; VSSC; Scullin & Ceci, 2001; Gudjonsson Suggestibility Scale; GSS; Gudjonsson, 1984), the test consists of stimulus material and questions. Specifically, the BTSS-NL includes a short story, four coloured pictures, and 27 questions. Children listen to the story and look at the pictures illustrating the story. The story is about a boy who is roller-skating with his friend and bumps into another boy who is doing some shopping for his grandmother. Following this, children are asked what they remember about the event with the pictures still in front of them.

After a 10-min interval in which children have to do a non-verbal task (i.e. make a drawing), 27 questions are asked. These questions can be subdivided into three categories: (1) memory questions (i.e. Memory scale) that intend to mask the real purpose of the test (e.g. 'Did the mother of Sven forbid to roller-skate on the sidewalk?'); (2) suggestive questions (i.e. Yield scale) that either describe an incorrect statement in such a way that it results in a confirmative answer or that has two equal, but incorrect answers (e.g. 'Was there a car or was there a bus on that picture depicting the accident?'; (3) repeated questions (i.e. Shift scale) that are immediate repetitions of the suggestive questions irrespective of which answer was given (e.g. 'Think again. Was there a car or was there a bus on that picture depicting the accident?').

Design and procedure

Children were tested individually in a separate room at their elementary school. To prevent BTSS-DRM carry over effects, a within subjects design was used in which all children first listened to the 10 DRM-lists (i.e. to assure that details of the BTSS were not reported during the DRM free recall test, children were first presented with the DRM lists). After the recall of each list, a non-verbal filler task was used (i.e. make a drawing). Following the recall of the last list, a recognition test was presented to the children. They were instructed to say 'yes' if they recognized the word as presented before and 'no' if they experienced the word as new. Subsequently, the BTSS-NL-story was read out and the pictures were displayed. Then, the children had to recall the story. During a 10-min interval, children had to make a drawing. Finally, the 27 questions were asked. At the end, they were debriefed.

Scoring

DRM lists. Free recall was scored in terms of number of correctly recalled words (i.e. true recall) and number of reported critical lures (i.e. false recall). Recognition was scored in terms of number of correctly recognized words (i.e. true recognition) and number of false alarms for critical lures (i.e. false recognition). Recall and recognition scores were expressed in proportions.

BTSS-NL. Each correct answer to a memory question was assigned 1 point. The Memory scale was calculated by summing all correct answers (min. = 0, max. = 8). Suggestive and repeated questions were scored as follows. One point was assigned when a child yielded to the suggestion (min. = 0, max. = 12) and when a child changed its answer in relation to the previously given answer (min. = 0, max. = 7). The Yield and Shift scale, then, were computed by summing all points of each scale. The sum score of the Yield and Shift scale reflects the Total suggestibility scale (min. = 0, max. = 19). Memory, Yield, Shift and Total suggestibility scores were expressed in proportions.

Results

DRM

Free recall. Mean proportions of true and false recall for each age group are shown in Table 1. To examine the effect of age on true and false recall, a one-way analysis of variance (ANOVA) was computed using proportions of hits and critical lures as dependent variable and age (5/6-year-olds, 7/8-year-olds, 9/10-year-olds, and 11/12-year-olds) as independent variable. For true recall, we found a significant effect of age ($F(3,96) = 39.52$, $p < 0.001$, $\eta^2 = 0.55$). *Post hoc* analyses using Bonferroni correction showed that true recall improved significantly across all age comparisons, with the exception of 9/10-year-olds vs 11/12-year-olds (5/6-year-olds, $M = 0.27$; 7/8-year-olds, $M = 0.38$; 9/10-year-olds, $M = 0.51$, all *p*s < 0.01).

For false recall of the critical lures, there was a significant effect of age ($F(3,96) = 8.39$, $p < 0.001$, $\eta^2 = 0.21$) where *post hoc* analyses using Bonferroni correction showed that four age comparisons were significant (5/6-year-olds vs 9/10-year-olds; 5/6-year-olds vs 11/12-year-olds; 7/8-year-olds vs 9/10-year-olds; 7/8-year-olds vs 11/12-year-olds, all *p*s < 0.05).

Recognition. Mean proportions of true and false recognition for each age group are shown in Table 1. A one-way ANOVA was performed to examine the effect of age on true and false recognition. Regarding true recognition, results revealed a significant effect of age ($F(3,95) = 10.42$, $p < 0.001$, $\eta^2 = 0.25$). *Post hoc* analyses using Bonferroni correction showed that four age comparisons were significant (5/6-year-olds, $M = 0.61$ vs 9/10-year-olds, $M = 0.76$; 5/6-year-olds, $M = 0.60$ vs 11/12-year-olds, $M = 0.78$; 7/8-year-olds, $M = 0.63$ vs 9/10-year-olds, $M = 0.76$; 7/8-year-olds, $M = 0.63$ vs 11/12-year-olds, $M = 0.78$, all *p*s < 0.01) indicating that children displayed an age-related increase in true recognition.

For false recognition of the critical lures, we also found a significant effect of age ($F(3,95) = 9.41$, $p < 0.001$, $\eta^2 = 0.23$). Similarly, *post hoc* analyses using Bonferroni correction showed that four age comparisons were significant (5/6-year-olds, $M = 0.41$ vs 9/10-year-olds, $M = 0.61$; 5/6-year-olds, $M = 0.41$ vs 11/12-year-olds, $M = 0.65$; 7/8-year-olds, $M = 0.44$ vs 9/10-year-olds, $M = 0.61$; 7/8-year-olds, $M = 0.44$ vs 11/12-year-olds, $M = 0.65$, all *p*s < 0.05) indicating that false recall of critical lures increases significantly with age.

Since it is known that there are age differences in 'yea-saying' or in response bias, recognition data were transformed into A', a non-parametric counterpart of the signal detection statistic *d* (e.g. Brainerd et al., 2002; Howe, Cicchetti, Toth, & Cerrito, 2004; Howe, 2007; Snodgrass & Corwin, 1988) [1]. An $A \cdot$ value of 0.5 refers to an absence of true recognition (low accuracy: acceptance not higher for hits than for unrelated distractors) or false recognition (low false memory levels: acceptance not higher for critical lures than for related distractors) whereas an A' value close to 1 indicates perfect true recognition (high accuracy) or false recognition (higher acceptance for critical lures than related distractors). Using A', we found reasonably

Table 1. Mean proportion true recall, false recall, true recognition (A' value), and false recognition (A' value; standard deviations in parentheses).

Age (years): Sample size (*n*):	5–6 23	7–8 26	9–10 26	11–12 25
True recall	0.27 (0.09)	0.37 (0.09)	0.51 (0.11)	0.58 (0.13)
False recall	0.13 (0.10)	0.14 (0.15)	0.25 (0.15)	0.30 (0.16)
True recognition	0.87 (0.04)	0.87 (0.07)	0.91 (0.06)	0.92 (0.04)
False recognition	0.79 (0.10)	0.81 (0.08)	0.85 (0.07)	0.89 (0.05)

similar patterns of results for true and false recognition as revealed with untransformed data. Specifically, results indicated a significant effect of age for true recognition ($F(3,94) = 5.17$, $p < 0.01$, $\eta^2 = 0.14$). *Post hoc* Bonferroni analyses showed that the 5/6-year-olds and the 7/8-year-olds truly recognized fewer words than the 11/12-year-olds (all ps > 0.05; see Table 1). With respect to false recognition, there was a significant effect of age ($F(3,94) = 8.74$, $p < 0.001$, $\eta^2 = 0.22$) where *post hoc* analyses using Bonferroni correction showed that 5/6-year-olds were less likely to falsely recognize the critical lure than 9/10-year-olds and 11/12-year-olds (all ps < 0.05). Also, 7/8-year-olds significantly falsely recognized fewer critical lures than 11/12-year-olds ($p < 0.001$).

BTSS-NL

Mean proportions of the Memory, Yield, Shift, and Total suggestibility scale are shown in Table 2. A one-way ANOVA was conducted with BTSS-scores (Memory, Yield, Shift, and Total suggestibility scale; one missing value) as dependent variable and age (5/6-year-olds, 7/8-year-olds, 9/10-year-olds, and 11/12-year-olds) as independent variable. For the Memory scale, a significant age effect ($F(3,93) = 10.90$, $p < 0.001$, $\eta^2 = 0.19$) was present with 5/6-year-olds answering less memory questions correctly than the 7/8-year-olds, 9/10-year-olds, and 11/12-year-olds (all ps < 0.05) and the 7/8-year-olds answering less memory questions correctly than the 11/12-year-olds ($p < 0.05$).

With regard to the Yield scale, a significant age effect ($F(3,93) = 7.53$, $p < 0.001$, $\eta^2 = 0.20$) was found with 5/6-year-olds concurring more to the yield questions than the 7/8-year-olds, 9/10-year-olds, and 11/12-year-olds, all ps < 0.05). For the Shift scale, there was also a significant main effect of age ($F(3,93) = 5.25$, $p < 0.01$, $\eta^2 = 0.15$) with only the 5/6-year-olds, shifting significantly more than the 11/12-year-olds ($p < 0.01$). Furthermore, we found a trend with 5/6-year-olds having higher shift ratings than the 9/10-year-olds ($p = 0.05$).

Concerning the Total suggestibility score, results revealed a significant age effect ($F(3,93) = 9.70$, $p < 0.001$, $\eta^2 = 0.24$) with 5/6-year-olds being more suggestible than the 7/8-year-olds, 9/10-year-olds (all ps < 0.05), and 11/12-year-olds.

Relation between DRM and BTSS-NL

For each age group[2], Pearson's correlations were computed between false recall and recognition on the one hand, and Yield, Shift, and Total suggestibility scale on the

Table 2. Mean proportion scores and standard deviations (in parentheses) on the Memory, Yield, Shift, and Total suggestibility scale of the BTSS-NL.

Age (years): Sample size (n):	5–6 22	7–8 26	9–10 26	11–12 25
Memory	0.64 (0.16)	0.74 (0.16)	0.84 (0.14)	0.85 (0.12)
Yield	0.67 (0.22)	0.51 (0.22)	0.45 (0.19)	0.43 (0.15)
Shift	0.71 (0.24)	0.58 (0.27)	0.48 (0.36)	0.38 (0.29)
Total suggestibility	0.69 (0.18)	0.53 (0.19)	0.46 (0.21)	0.41 (0.16)

other hand. We did not find significant correlations (all *p*s >0.1; strongest $r=0.34$, $p=0.10$ for relation between total suggestibility and false recognition for 9/10-year-olds) indicating that falsely remembering critical lures is not related to accepting suggestive information.

Discussion

In Experiment 1, two key findings were observed. First, we showed that children's susceptibility for the DRM illusion significantly increased with age while the acquiescence of suggestive information significantly diminished over time. Second, we found that the DRM illusion and the vulnerability for suggestion were not associated with each other.

The finding that children show an age-related increase in the DRM illusion has consistently been documented (for an overview see Brainerd et al., 2008; Brainerd & Reyna, 2002; Sugrue & Hayne, 2006; but see Ghetti et al., 2002). Similarly, with respect to the acceptance of suggestive information, a standard result is that younger children are more likely to fall prey to suggestion than older children and adults (Ceci et al., 1987; Sutherland & Hayne, 2001; for reviews, see Bruck & Ceci, 1999). As pointed out in the introduction, FTT and the source monitoring framework account for these findings.

More interestingly, it seems that children are not equally prone for the DRM illusion as for the inclusion of suggestive information. Apparently, children's susceptibility for semantic-based and suggestion-based false memories is distinct from each other. A limitation of Experiment 1 might be that, by using the BTSS-NL, we focused on false memories for details of experienced events. This might be problematic as the starting point of this study was Pezdek and Lam's (2007) and Wade et al.'s (2007) debate on the relationship between false memories elicited by DRM-lists and false memories for entire events. So, the question remains whether the DRM illusion is related to suggestively-induced false memories for entire events.

Evidence for this relation comes from a study that showed that people who have false memories for entire events are more at risk for the DRM illusion than a control group without these false memories. Clancy, McNally, Schacter, Lenzenweger, and Pitnam (2002), for instance, showed that people who reported to have recovered memories of alien abduction had higher DRM false memory rates than people who did not have such memories. Their experimental group consisted of people who recovered their memories during hypnotic therapeutic sessions. Although this study compellingly demonstrates that false memories in the DRM paradigm are related to other types of false memories, these results have never been shown in children.

The aim of Experiment 2 was to examine whether children's DRM performance was related to children's false memories for entire events. Children who participated in previous false memory implantation studies (Otgaar et al., 2008, 2009; Otgaar, Candel, Scoboria, & Merckelbach, 2010) were asked to participate and complete the DRM task.

Experiment 2

The purpose of Experiment 2 was to compare DRM task performance of children who developed false memories for entire events and children who did not develop such memories. Based on Clancy and colleagues' (2002) findings, one might expect that children with false memories for entire events would have higher DRM false memory levels than children without false memories. However, based on the theories on false memory development as discussed in the introduction and on the results of Experiment 1, we hypothesized to find no differences in terms of DRM performance between children with and without false memories for entire events.

Method

Participants

Forty children ($M_{age} = 9.08$, SD = 1.40) participated with parental consent. All children were involved in previous false memory implantation studies (Otgaar et al., 2008, 2009, 2010). In these studies, children were led to falsely remember entire events (abducted by a UFO, almost choking on a candy, being accused of copying off his/her neighbour, moving to another classroom, receiving a rectal enema, being stuck with your finger in a mousetrap). Specifically, children were read true narratives about experienced events and one researcher-created false narrative. They were interviewed twice with a one-week interval in between about these events and encouraged to report everything they remembered about the events. Twenty children ($M_{age} = 9.00$, SD = 1.03) then developed a false memory for an entire event (FM^+ group) and 20 children ($M_{age} = 9.15$, SD = 1.73) did not have a false memory for an entire event (FM^- group).

Material

DRM lists and recognition task. Children were presented with the same DRM word lists and recognition task as in Experiment 1.

Design and procedure

All children had to complete a DRM task in a separate room at their home. Children were asked whether they remembered the previous studies in which they participated. The majority of the children ($n = 30$) correctly indicated the procedure of the previous study.

Scoring

True and false recall and true and false recognition were computed as in Experiment 1.

Results

Free recall

Mean proportions of true and false recall and true and false recognition for each false memory group are shown in Table 3. For recall, independent samples *t*-tests were carried out with proportions true and false recall as dependent variable and group (FM^+ vs FM^-) as independent variable. With regard to true recall, we found no significant differences between the two groups ($t(38) = 1.07$, $p = 0.29$, $d = 0.35$).

We also found that the FM$^+$ group did not falsely recall more critical lures than the FM$^-$ group ($t(38) = -0.88$, $p = 0.38$, $d = 0.29$).

Recognition

For recognition, independent samples *t*-tests were performed with proportions true and false recognition as dependent variable and group (FM$^+$ vs FM$^-$) as independent variable. For true recognition, no differences were detected between the FM$^+$ group ($M = 0.67$, SD $= 0.12$) and FM$^-$ group ($M = 0.69$, SD $= 0.14$, $t(36) = -0.54$, $p = 0.60$, $d = 0.17$, two missing values). Similar to false recall, the FM$^+$ group ($M = 0.59$, SD $= 0.21$) did not falsely recognize more critical lures than the FM$^-$ group ($M = 0.58$, SD $= 0.21$; $t(36) = -0.13$, $p = 0.90$, $d = 0.04$).

When we transformed our recognition data into A' (see Experiment 1), we found similar results. The FM$^+$ group did not correctly recognize more words than the FM$^-$ group ($t(36) = 0.93$, $p = 0.36$, $d = 0.31$). Moreover, the FM$^+$ group did not falsely recognize more critical lures than the FM$^-$ group ($t(36) = 0.59$, $p = 0.57$, $d = 0.19$).

Discussion

In Experiment 2, we examined whether children with false memories for entire events were more vulnerable for the DRM illusion than children without these memories. We found that children with false memories for entire events did not falsely recall and recognize more critical lures than a control group without false memories.

Our findings show that children who develop false memories triggered by suggestions are not more vulnerable to develop spontaneous false memories as elicited by DRM lists than children who are not susceptible to suggestion. Although Clancy et al.'s (2002) study has revealed contrasting results, this is the first study that shows that the findings reported in this study do not hold for children.

The finding that children with and without false memories are equally prone for the DRM illusion can be explained because semantic processing and concurring to suggestion have differential developmental trajectories. Whilst children are less able to extract the underlying gist of information than adults (Brainerd et al., 2008), they are more easily affected by suggestive information than adults (Ceci & Bruck, 1993). More specifically, it could well be that children's semantic networks are less well developed than adults', which decreases the chance that non-presented material (i.e. critical lure) will be activated (e.g. Roediger, Balota, & Watson, 2001). Also,

Table 3. Mean proportion true recall, false recall, true recognition (A' value), and false recognition (A' value) of the FM$^+$ and FM$^-$ groups (standard deviations in parentheses).

Group	FM$^+$	FM$^-$
True recall	0.45 (0.10)	0.42 (0.09)
False recall	0.22 (0.15)	0.18 (0.14)
True recognition	0.66 (0.09)	0.68 (0.08)
False recognition	0.62 (0.10)	0.64 (0.08)

because children lack efficient source monitoring abilities, they are more prone for suggestion than adults.

The results of Experiment 2 demonstrate that children's false memories elicited by the implantation paradigm are not related to children's DRM false memories. Obviously, these findings bear relevance to the debate between Pezdek and Lam (2007) and Wade and colleagues (2007) in that Experiment 2 indicates that no association between different types of children's false memories exist.

General discussion

The present study explored whether two different false memory paradigms (i.e. DRM and suggestion) produce similar results. The current study was inspired by the ongoing debate by Pezdek and Lam (2007) and Wade and colleagues (2007) about the relation between different types of false memories. Pezdek and Lam (2007) argued that researchers should not use the same term (i.e. false memories) for different kinds of memory distortions as this could imply that similar processes underlie these memory distortions (see also Pezdek, 2007). Therefore, generalizing false memory findings to false memories of child sexual abuse could be problematic. Wade and colleagues, however, noted that different types of false memories can improve our insight into false memories occurring in real world situations and that when studies have high internal validity, they can be valuable in real world settings.

In the present study, we found that reverse age effects were present with a developmental increase in DRM false memory rates and developmental decline in accepting suggestive information (Experiment 1). These effects are in agreement with on the one hand studies finding that the susceptibility for the DRM illusion is positively related with age (Anastasi & Rhodes, 2008; Brainerd & Reyna, 2002; Metzger et al., 2008; Sugrue & Hayne, 2006; but see Ghetti et al., 2002) and the other hand studies showing that assenting to suggestion decreases with age (Ceci et al., 1987; Sutherland & Hayne, 2001; for reviews, see Bruck & Ceci, 1999; Ceci & Bruck, 1993). From a FTT perspective, our reverse age effects can be explained since younger children are less able to extract gist information from word lists than older children. Since false memories arise chiefly out of gist memories, younger children will therefore less likely report the critical lure than older children (Brainerd & Reyna, 1998). Indeed, it could well be that the age-related changes in semantic density could account for the finding that younger children are less vulnerable for the DRM illusion than older children and adults (e.g. Roediger et al., 2001). Moreover, at a similar time, presenting suggestive information creates verbatim traces that conflict with original presented information (Brainerd & Reyna, 1998, 2002). Hence, since younger children retrieve more verbatim traces than older children, they will display an enhanced acceptance of suggested information (but see Brainerd et al., 2008).

In terms of the source monitoring framework, research has shown that younger children are less likely to correctly discriminate between sources of information than older children implying that false memories are more prevalent among younger than older children (Johnson et al., 1993). Indeed, our study shows that using the BTSS-NL, younger children concurred more to suggestion than older children. However, in the DRM task, younger children were less prone to falsely remember the critical lure than older children. A more recent extension of the source monitoring framework, the activation-monitoring theory (Roediger et al., 2001), could explain this finding. According to this theory, the inefficient use of source monitoring can not account alone for the developmental pattern of false memories. Specifically, age differences in false memories are also the result of age-related differences in the activation of semantic networks. Thus, younger children possess lower spreading activation levels than older children, leading to lower rates of the DRM illusion (see also Carneiro, Albuquerque, Fernandez, & Esteves, 2007).

Our result that children's DRM performance is not related to endorsing suggested information can be explained by the different procedures which evoke these false memories. While studying and recalling DRM word lists induces *spontaneous* false memories through the activation of semantic networks (Brainerd et al., 2008; Roediger et al., 2001), the BTSS-NL focuses on false memories generated by suggestion. Clearly, in children, these two false memories are not associated with each other. Indeed, Mazzoni (2002) also argued that false memory researchers should exert caution in drawing conclusions from one false memory paradigm to another. This author (p. 37), for example, stated that '[m]emory scholars have operated under the implicit assumption that what is true for the DRM paradigm must also be true for other memory distortions as well' and that 'that assumption is unwarranted.'

Relatedly, researchers have recently warned that generalizing DRM studies to other types of false memories and to real life settings is not always guaranteed (Foley, Hughes, Librot, & Paysnick, 2009; Plancher, Nicolas, & Piolino, 2008). Foley and colleagues, for instance, examined the effect of imagery on DRM false memories. They found that imagery resulted in fewer DRM illusions than a non-imagery condition. This finding is in stark contrast with research showing the potentially dangerous effects of imagery in other types of false memories (e.g. Foley, Wozniak, & Gillum, 2006). Also, Plancher and colleagues examined the effect of suggestion on DRM performance. They found that providing adult participants with false information about the existence of critical lures did not produce more DRM illusions than a control group without this information. Thus, although research shows that the provision of false information can result in elevated false memory levels (e.g. Otgaar et al., 2009), this seems not to occur with DRM false memories.

One potential caveat in the present study is that we did not use child-generated DRM lists to explore false memory rates. Recent studies have begun to use child-normed DRM list to examine developmental trends of false memories (Carneiro et al., 2007; Metzger et al., 2008). However, these studies showed that using child-generated DRM lists resulted in the same age-related increase of DRM illusions as when using adult-based DRM lists. Moreover, Metzger and colleagues showed that although child-generates lists led to an improved accurate retrieval of children, it did not affect false memory rates.

Our study has significant ramifications for the legal domain. Specifically, since children's DRM intrusions are not associated with children's suggestibility, one might wonder whether studies using DRM word list are appropriate to be generalized to legal cases in which suggestion (e.g. suggestive interview techniques) predominates. Obviously, our results show that in children a discrepancy exists between semantically-related false memories (i.e. DRM) and suggestion-based false memories. In legal cases in which the accuracy of children's claims of for example sexual abuse is questioned, suggestive interviewing techniques are often the motive for this mistrust (Bruck & Ceci, 1999). According to our findings, studies on the DRM illusions are not capable in explicating such cases. Specifically, in such cases, the ecological validity of the DRM paradigm is severely constrained.

As already stated, however, Wade and colleagues (2007) argued that results from different false memory paradigms can be generalized to real life situations since different false memory phenomena can be fostered through different stimuli and among a range of different participants. Although they correctly stated that 'research findings are often taken out of context and applied to situations to which they are minimally relevant' (Wade et al., p. 24), we raise serious doubts concerning their statement of generalizing false memory findings, *at least* with regard to false memory paradigms used with children. Even though false memories can be formed across a considerable number of situations, this does not denote that different false memory paradigms are equally appropriate to explain questionable accounts of children's claims of, for example, sexual abuse.

Of course, this does not imply that findings from the DRM paradigm are never valuable to be generalized to real life settings. There are situations in which DRM findings are absolutely useful. Holliday, Reyna, and Brainerd (2008, p. 76) for example state that '[f]alse memories induced by meaning related information embody several features of forensically relevant memories. For child witnesses of domestic violence, for example, such violence is not usually a single episode but rather a series of repeated events that are substantially similar but not exactly the same.' Then, they (p. 76) argue that 'in cases of repeated experiences of sexual abuse, young children because of limited gist-extraction abilities, will be less likely than older children and adults to incorporate gist-consistent events (that did not take place) in their memory reports.' However, we stress that when *children* are *suggestively* interrogated, expert witnesses can only rely on false memory studies in which *suggestion* was used (see also Freyd & Gleaves, 1996; Roediger & McDermott, 1996) when they are asked to indicate whether children's testimonies are reliable or not.

In sum, the pivotal point of this study is that, at least in children, different false memory paradigms reveal different results. Children's DRM performance is not associated with accepting suggestive information.

Notes

1. Since our recognition task did not include critical lures from unpresented list, we used semantically-related distractors as an approximation for calculating the *A'* value of the critical lures (see also Howe et al., 2004).
2. When we collapsed across age groups that did not significantly differ with respect to false recall and recognition on the one hand, and Yield, Shift, and Total suggestibility scale on the other hand, we did not find any significant correlations (ps >0.05).

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