

## Applying Retrieval-Induced Forgetting to Children's Testimony

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*Summary:* When a crime has been committed, investigators must obtain as much and as accurate information as possible from witnesses. Initial incomplete interviews may pose a potential cost to unretrieved information. We explored retrieval-induced forgetting (RIF) in children's autobiographical memory for related episodic events. Children experienced four related play sessions across 4 days, followed by word stem retrieval practice of half of the items, and a cued recall task that took place either 15 minutes or 2 hours later. Categorized details were experienced either within a single day or across multiple days. The emergence of RIF was dependent upon the length of delay between practice and test phases and the temporal distribution of the episodic events. Our observations demonstrate that RIF can be a subtle phenomenon whose occurrence depends upon whether the retrieval context supports an environment of retrieval interference. Copyright © 2012 John Wiley & Sons, Ltd.

Imagine that a young child has been repeatedly abused by her father. During the subsequent investigation, the young child is questioned about her memory for the abusive incidents. The investigative interviewers understandably focus on the recall of details they deem most relevant to charging the father with a criminal offense. Because memory retrieval is focused on particular details of the abuse and is inevitably incomplete, the child is not asked to report details currently deemed irrelevant to the investigation or about details of which the investigator is unaware. However, a well-established phenomenon, called retrieval-induced forgetting (RIF), may compromise this strategy of retrieving only relevant details. Anderson, Bjork, and Bjork (1994) demonstrated that targeting specific memories for retrieval may result in greater difficulty when subsequently attempting to retrieve previously non-retrieved memories. Thus, the investigators' attempts to access specific targeted details may make it difficult to recall other related details, details that could become a subsequent focus of the defense attorney. The child witness, by successfully retrieving a targeted subset of details and through no fault of her own, now may face a serious disadvantage that can be capitalized on by the defense.

Retrieval of a targeted memory frequently occurs in a competitive retrieval environment. Related non-targeted memories may be highly activated alongside highly activated targeted memories. In order to efficiently retrieve these targeted memories, Anderson et al. (1994) argued that the targeted memory inhibits non-targeted memories, thereby enhancing the distinction between targeted and non-targeted memories. This distinctiveness facilitates easy retrieval of the targeted memory but at the cost of *forgetting* non-targeted memories on subsequent retrieval attempts.

Anderson et al. (1994) developed a systematic method to study RIF. Their method involves four separate phases: study, practice, distraction, and test. The initial study phase involves participants studying category–exemplar pairs (e.g., FRUIT–apple, FRUIT–banana, DRINKS–scotch). Participants are then asked in the practice phase to retrieve and say aloud appropriate

exemplars (e.g., say 'apple') given the word stems of category–exemplar pairs (e.g., FRUIT–ap\_\_\_\_). This set of stimuli was referred to as the RP+ condition. In the practice phase, the stimuli used are half of the exemplars from half of the study phase categories. After a short distraction task, participants enter the final test phase in which they are asked to recall all the exemplars previously presented during the study phase. As expected, recall is greatest for exemplars that were retrieved during the practice phase (e.g., FRUIT–apple; RP+ condition). More intriguing is that exemplars from practiced categories not retrieved during the practice phase (e.g., FRUIT–banana; referred to as the RP– condition) are *less likely* to be successfully recalled when compared with the baseline (i.e., unpracticed category and unpracticed exemplars; e.g., DRINKS–scotch). This baseline was referred to as the Nrp condition. This difference in recall rates between non-retrieved exemplars from practiced categories (i.e., RP–) and the baseline is the RIF effect (i.e., Nrp).

Retrieval-induced forgetting is a robust phenomenon. Researchers have reported observing the signature marks of RIF in episodic (Anderson et al., 1994; Ciranni & Shimamura, 1999), semantic (Campbell & Phenix, 2009; Phenix & Campbell, 2004; Starns & Hicks, 2004), visuo-spatial (Ciranni & Shimamura, 1999), as well as in eyewitness (MacLeod, 2002) and autobiographical memory (Harris, Sharman, Barnier, & Moulds, 2010), and after short (Baran, Wilson, & Spencer, 2010; Chan, 2009; Saunders & MacLeod, 2002) and long delays (Ford, Keating, & Patel, 2004; Migueles & Garcia-Bajos, 2007) between practice and test phases. Thus, RIF has been reliably demonstrated in a variety of contexts.

Already well-established in the laboratory, Shaw, Bjork, and Handel (1995) were the first researchers to extend the relationship between the RIF phenomenon to eyewitness testimony. Since their pioneering work, other researchers have examined RIF in the context of eyewitness memory (Camp, Westein, & De Bruin, 2012; Garcia-Bajos, Migueles, & Anderson, 2009; MacLeod, 2002; Macrae & MacLeod, 1999; Migueles & Garcia-Bajos, 2007; Saunders & MacLeod, 2002). The implications of RIF for eyewitness memory are substantial. As argued elsewhere (Macrae &

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MacLeod, 1999; Migueles & Garcia-Bajos, 2007; Shaw et al., 1995), RIF may be a natural yet highly unfortunate consequence of a hurried or incomplete initial interview. The implication is that if not retrieved in an initial attempt, certain details may become less available or even unavailable in subsequent recall attempts even if later recognized as crucial.

In observing RIF, in eyewitness memory, some clear results have emerged. Most notably, RIF appears robust to stimuli akin to everyday experiences (Migueles & Garcia-Bajos, 2007) and to retrieval techniques used in police investigations (Camp et al., 2012). Mirroring the boundary conditions observed in the standard paradigm (see Goodmon & Anderson, 2011), Migueles and Garcia-Bajos (2007) found that in an eyewitness context, a lack of integration of the stimuli (i.e., making meaningful connections between targeted and related memory details) was critical to observing RIF. That is, if stimuli were highly integrated, RIF was not observed. After viewing a video of two offenders committing a crime together, the authors found no RIF for the actions of the offenders because their actions were so closely linked (Experiment 1). However, RIF was observed for offender characteristics (Experiment 2) because characteristics of offenders were not integrated. Similarly, Camp et al. (2012) showed participants a video in which two offenders committed a crime together. Participants then retrieved partial descriptions of the characteristics of one of the offenders. Camp et al. found evidence for RIF in recall of similar offender characteristics, for both a retrieval-practiced offender and an unpracticed offender. Importantly, practice in the Camp et al. study did not involve standard word stems, but rather ecologically valid cued recall questions akin to what may take place in an actual investigation.

Despite the relevance of RIF for eyewitness testimony, the study of RIF in eyewitness memory is in its infancy. Thus, it is not surprising that RIF in children's eyewitness memory has yet to be investigated. The phenomenon of RIF has been explored in child samples with adaptations of the standard laboratory procedure (e.g., Conroy & Salmon, 2005). However, the application to autobiographical memory in children has not yet been made. As suggested earlier, when children serve as witnesses in the justice system, it is often as the victims of crime. As a victim of crime, the to-be-remembered event(s) is autobiographical in nature. Particularly for child victims of abuse, the experience is often not a unique occurrence. Children are often repeatedly abused over extended periods of time (e.g., sexual abuse; Connolly & Read, 2006). The repeated experience of abuse provides a real-world example of related information with conceptually linked memories to recall. Thus, an autobiographical experience that occurs several times, but each time in a slightly different way, offers the unique opportunity to explore RIF in an applied context. The aim of the present study was to examine the possibility that such memories in children may also be subject to RIF.

Anyone who has been around young children will have noticed that children can be impulsive. Oftentimes, this impulsivity will improve with age as their capacity to inhibit or control their impulses improves. Because children are developing inhibitory control (e.g., Bjorklund & Harnishfeger, 1990), it is essential to consider developmental differences in RIF. Recent research into the RIF effect in children has revealed that school-age children have sufficient inhibitory

control to produce a RIF effect in both recall and recognition tasks (Aslan & Bauml, 2010). Several studies have been conducted with children to explore RIF (Conroy & Salmon, 2005; Ford et al., 2004; Lechuga, Moreno, Pelegrina, Gomez-Ariza, & Bajo, 2006; Zellner & Bauml, 2005). Collectively, researchers have found children as young as 7 years old evince a robust RIF effect and that they do not differ in the size of the RIF effect from their older peers (Ford et al., 2004). In the present experiment, we explore RIF in children's repeated autobiographical experiences in children aged 7- to 8 and 9- to 10 years. We opted to explore children who we anticipated would evince a RIF effect, as exploration of a new paradigm was the primary concern in the present work.

In a typical RIF paradigm, a single study phase or event takes place, followed by a partial retrieval task, distraction, then the final recall test. The single presentation of the study phase typically includes presentations of related items. However, we applied the typical RIF paradigm to autobiographical memory in which we staged several separate structured activity sessions for children. We are only aware of RIF research that has presented all stimuli in a single session; thus, the present paradigm differs in an important way from prior research. This deviation from the standard paradigm was deliberate. We believe that for RIF to be a concern for many child witnesses, the phenomenon must apply to details experienced across multiple sessions. As such, children in Grades 2 and 4 engaged in one structured play activity session each day for four consecutive days. Each play activity the children engaged in corresponded to a categorical theme (e.g., coloring different animal pictures) and different exemplars of each categorical theme were presented once per day. These category-activity events correspond to the category-exemplar pairs presented during the study phase in the standard RIF paradigm. On the fifth consecutive day, children performed the practice phase retrieving select exemplars from some categories using word stems as retrieval cues (e.g., when presented with the category 'COLORING' and the word stem 'LI\_\_', children retrieve the word 'lion'). That same day, in the concluding test phase, children attempted to recall all of the exemplars associated with all categories.

The current paradigm was developed to allow the opportunity to investigate RIF in a forensically relevant way. Thus, we deliberately spaced the autobiographical events across multiple days to more closely mirror the experience of children who are repeatedly abused. To explore the possibility that RIF may be more laboratory- condition-bound, we also included a manipulation in which we could examine RIF occurring within a single instance. Further, we conducted our retrieval practice after either a short (15 minutes) or long (2 hour) delay. This manipulation was also included to increase the forensic relevance of the design and allow for a comparison of standard laboratory procedures with slightly more generalizable conditions. We did not develop specific hypotheses about the observation of RIF in either of these conditions because there is virtually no research for us to rely upon in the application of RIF in this setting. However, our interest was in whether or not we would observe RIF in children's memory for repeated autobiographical events and to explore the specific conditions under which this may occur.

## METHOD

### Participants

We recruited 148 children (78 Grade 2  $M_{age}=90.32$  months,  $SD=5.63$ , 33 girls; 70 Grade 4  $M_{age}=117.51$  months,  $SD=3.99$ , 36 girls) to participate in this study. In addition to verbal assent obtained from the children, consent was also obtained from the school board, principals, and parents for all participants in this study.

### Procedure

In their classrooms, children participated in a series of structured play activities that took place over four consecutive days. Each activity session lasted approximately 15 to 20 minutes and occurred only once each day. The first activity session occurred on a Monday, and the final activity session occurred on the Thursday of a regular school week. Sessions involved all children (both participants and non-participants) who attended the class. A research assistant facilitated play with seven distinct exemplars for the children (e.g., pretending to be sad, pretending to play hockey) during each activity session. To increase the association between exemplars, exemplars for each category were selected from Price and Connolly's (2006) category norms for children.

Because we elected to present the items in four distinct sessions instead of within a single session, this design differs in an important way from prior RIF work. To be consistent with the existing research on RIF, we added a manipulation related to the temporal spacing of the to-be-remembered exemplars. Half of the exemplars were manipulated within

a single session (i.e., within a single day), and half of the exemplars took place across the multiple sessions (i.e., one related exemplars for each of the four distinct days), a within-subjects manipulation. For example, in a single day, a child may have pretended to be happy and then grumpy. Conversely, a child may have pretended to play football on Monday, tennis on Tuesday, hockey on Wednesday, and soccer on Thursday. Of the seven distinct exemplars performed each day, three exemplars occurred once for each of the days (for a total of four examples per category across all sessions), and the remaining four exemplars were performed only on one specific day (for a total of two exemplars per category each day). Across the four sessions, there were a total of 16 single day exemplars (two exemplars for each of eight categories) and 12 multiple day exemplars (four examples for each of three categories). There were two orders of exemplars, counterbalanced across participants, with approximately half of the children receiving each order. Although a full counterbalancing of items across multiple and single conditions was not possible because of the differing number of categories in each condition, items were counterbalanced as much as practically possible. The same pattern of results was observed in both orders. Refer to Table 1 for the list of exemplars experienced in a set of four sample activity sessions.

On Friday, children who both had parental permission and verbally agreed to participate engaged in a 5-minute practice session. Two letter word-stems (e.g., H O \_ \_ \_ \_) were used during the practice session to serve as retrieval cues for targeted exemplars of categories. The child was asked to only think about and report exemplars that occurred during the structured play session when saying aloud an exemplar

Table 1. Activity session details

	Day 1	Day 2	Day 3	Day 4	Practice test
Order 1					
Single day categories with exemplars	Song: Old MacDonald Jingle Bells	Hide under a cup: Apple Grapes	Pretend to be an animal: Bird Tiger	Pretend to ride: Train Plane	Practice 1 item for each
Multiple days categories with exemplars	Emotion: Happy Grumpy	Pretend job: Lawyer Teacher	Draw: House Tent	Juggling: Couch Table	Baseline—no practice
	Weather: Sunny	Weather: Snowy	Weather: Windy	Weather: Rainy	Practice 2 of 4 (random)
	Sport: Football	Sport: Tennis	Sport: Hockey	Sport: Soccer	Practice 2 of 4 (random)
	Pretend friend: Jesse	Pretend friend: Terry	Pretend friend: Erin	Pretend friend: Patty	Baseline—no practice
Order 2					
Single day categories with exemplars	Emotion: Happy Grumpy	Pretend friend: Jesse Erin	Draw: House Tent	Juggling: Couch Table	Practice 1 item for each
Multiple days categories with exemplars	Song: Old MacDonald Jingle Bells	Weather: Rain Snow	Sport: Tennis Football	Pretend to ride: Train Plane	Baseline—no practice
	Pretend animal: Bird	Pretend animal: Tiger	Pretend animal: Frog	Pretend animal: Elephant	Practice 2 of 4 (random)
	Pretend job: Doctor	Pretend job: Police officer	Pretend job: Lawyer	Pretend job: Teacher	Practice 2 of 4 (random)
	Hide under a cup: Grapes	Hide under a cup: Apple	Hide under a cup: Orange	Hide under a cup: Banana	Baseline—no practice

that completed the word stem (e.g., say 'Hockey'). For example, a research assistant would say to the child, 'When Ashley was here, you pretended to play a sport. Which sport was it?' The child was then presented with the word stem to complete (e.g., H O \_ \_ \_ \_). If the child had difficulty, the research assistant sounded out the beginning of the word to assist the child in retrieving the appropriate word. A total of eight word-stems were presented during this practice session: four corresponding to the single-day category group and two sets of two exemplars corresponding to the multiple-day category group. Thus, of the 16 single-day category group, four exemplars of four categories were practiced and four exemplars of the corresponding categories were not practiced. The remaining eight exemplars were not practiced. For the multiple-day category group, two out of the three categories had half of the exemplars practiced and half were unpracticed, whereas the third category served as a baseline. Each practiced item was practiced only once; Macrae and MacLeod (1999) found that RIF was not influenced by the number of rounds of retrieval practice.

Children then went back to class for either a 15-minute (short) or a 2-hour (long) delay period and then completed a 10-minute category cued recall session. Two random orders of cued recall categories were created and children were randomly assigned to receive one order. Thus, the final design was a 2 (delay: 15 minutes, 2 hours)  $\times$  2 (spacing: single, multiple days)  $\times$  3 (set: RP+, RP-, Nrp). These conditions represent the standard RIF paradigm set conditions in which RP+ = practiced items, RP- = nonpracticed competitors, and Nrp = no retrieval practice.

Consequently, for exemplars performed on single days, there were the following sets: practiced category–practiced exemplar (RP+S), practiced category–unpracticed exemplar (RP-S), and unpracticed category–unpracticed exemplar (NrpS). For activities performed on multiple days, there were the following sets: practiced category–practiced exemplar (RP+M), practiced category–unpracticed exemplar (RP-M) and unpracticed category–unpracticed exemplar (NrpM). All sets had a maximum correct score of four with the exception of the maximum score of 8 for the NrpS condition to maintain counterbalancing. A RIF score was computed by taking the difference between proportions of RP-S and NrpS as well as RP-M and NrpM. For example, a difference score of .15 resulted from taking the difference from the RP-M (.35) and NrpM (.50) conditions.

## RESULTS

No differences between age groups were observed (consistent with prior work; Ford et al., 2004), thus all analyses are collapsed across the two age groups. Table 2 presents the proportional recall rates across short and long delays for each set condition. The total number of correct retrievals was determined for each participant in all three sets for exemplars occurring within single or across multiple days; specifically, there were three stimulus sets across two category-spacing types. As anticipated, the highest recall rates were observed for exemplars belonging in the RP+ condition regardless of whether the delay was short or long and whether the practiced

Table 2. Mean recall rates across short and long delays in multiple and single day categories

	Delay	
	Short	Long
Set condition		
Multiple day categories		
RP+	0.70 (0.27)	0.75 (0.24)
RP-	0.41 (0.24)	0.35 (0.21)
NRP	0.43 (0.34)	0.50 (0.38)
RIF	0.02	0.15*
Single day categories		
RP+	0.74 (0.24)	0.74 (0.27)
RP-	0.47 (0.24)	0.55 (0.25)
NRP	0.56 (0.55)	0.54 (0.23)
RIF	0.09*	-0.01

Note: RIF = NRP - RP-;

\*denotes statistical significance at  $p < .05$ . Values in brackets represent standard deviations.

exemplar occurred within a single day or across multiple days (Table 2). In order to determine whether there were statistically significant differences in recall rates across the other more theoretically interesting conditions, we analyzed proportion recall rates as a function of the within-subjects factors of set (RP-, Nrp) and category-spacing (single, multiple days) along with the between-subjects factor of delay (short, long), through a 2  $\times$  2  $\times$  2 mixed-model analysis of variance.

The Nrp condition was recalled better than the RP- condition that resulted in an effect of set [ $F(1, 145) = 8.22$ ,  $MSE = 1.15$ ,  $p = .01$ ]. Exemplars experienced within a single day were recalled better than exemplars experienced over multiple days, producing an effect of category-spacing [ $F(1, 145) = 35.73$ ,  $MSE = 0.69$ ,  $p < .001$ ], but there was no effect of delay [ $F(1, 145) = 0.32$ ,  $MSE = 1.68$ ,  $p = .57$ ].

These main effects were qualified by a set  $\times$  category-spacing  $\times$  delay three-way interaction [ $F(1, 145) = 6.07$ ,  $MSE = 1.16$ ,  $p = .015$ ]. Further analyses using paired-samples  $t$ -tests helped elucidate this interaction. When all exemplars of a category were experienced during a single day, RIF was observed (Table 2) when there was a brief delay between retrieval practice and test phases [ $t(73) = 2.73$ ,  $MSE = 0.13$ ,  $p = .01$ ] but not when there was a long delay between retrieval practice and test phases [ $t(73) = 0.19$ ,  $MSE = 0.15$ ,  $p = 0.85$ ]. However, when the exemplars of a category were experienced across multiple days, the opposite pattern was observed. Specifically, no RIF was observed with a short duration between the retrieval practice and test phases [ $t(72) = 0.47$ ,  $MSE = 0.20$ ,  $p = .64$ ], but RIF was observed during a long delay [ $t(73) = 2.73$ ,  $MSE = 0.21$ ,  $p = .01$ ]. Refer to Figure 1 for an illustration of RIF effects using mean recall rates.

## DISCUSSION

The purpose of this study was to determine whether RIF would be observed in children with related autobiographical memories. Our findings allow us to decisively answer this question. Children in Grades 2 and 4 were susceptible to RIF using related episodic memories of details that occurred both within a single day and across multiple days. Importantly,

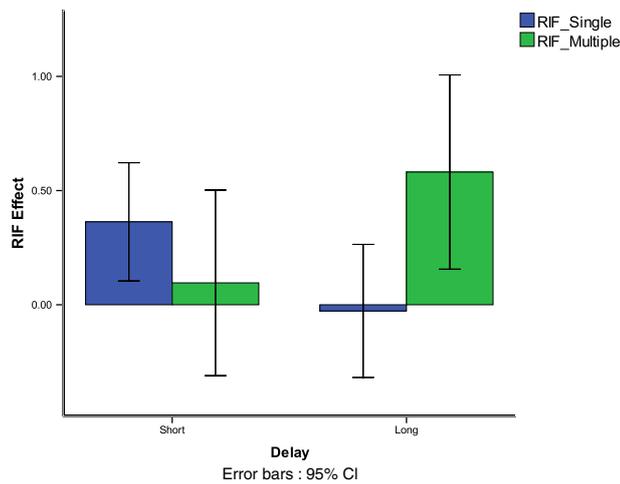


Figure 1. Retrieval-induced forgetting (RIF) effects using mean recall as a function of delay and spacing

RIF emergence was dependent upon the length of delay between practice and test phases and the temporal distribution of the events.

Our question was motivated by the possibility that retrieving targeted memories of abuse may induce the forgetting of related abuse memories. From a pragmatic perspective, this may not be much of a concern if the RIF effect is short-lived. In that instance, a child would still be able to retrieve related abuse memories after waiting a short period. However, if the RIF effect is not short-lived, then the implications of retrieving targeted abuse memories would be more dire. We found that after a short delay, our findings replicated previous research by observing RIF with related details that occurred within a single day (see Anderson, 2003). The short delay condition was closest to the standard RIF paradigm. When we extended the delay between partial retrieval and cued recall to 2 hours, details occurring in a single day produced no RIF effect. This result suggests that even when RIF in children is present, it may be a short-lived phenomenon if the related memories are of details occurring within a single day.

The more interesting finding was the observation of RIF in the long delay condition when critical details occurred over multiple days. This condition was of particular interest to us because it is the most ecologically valid condition for eyewitness testimony: an event that takes place on several different days with a long delay between retrieval attempts. That RIF was present in this condition is an indication that this phenomenon is potentially problematic as a forgetting mechanism for children's recall of repeated victimization. This finding implies that the risks associated with partial retrieval must be considered when retrieval strategies are developed for children.

Although the long delay—multiple days finding of RIF was interesting, it was somewhat surprising to note that for details occurring across several days, RIF was not observed after a short delay. Although replication is certainly required, one possibility is that differing contexts either facilitated or hindered episodic integration. Anderson and McCulloch (1999) discovered that RIF is eliminated when participants integrate exemplars of a category whether as a result of explicit instructions or are self-initiated (see Goodmon &

Anderson, 2011 for additional refining of this observation). This integration effect occurs when associations are made between targeted memories and their competitors. Within this context, retrieving a targeted memory no longer encounters retrieval interference from its related competitors (Anderson & McCulloch, 1999). Additional research has confirmed these observations and has gone further to demonstrate that organized memory structures can eliminate RIF (Conroy & Salmon, 2006; Migueles & Garcia-Bajos, 2007). It may be the case that no RIF was observed in details experienced over multiple days in the short delay condition because memory traces spread over multiple days may initially have been encoded as discrete events—removed from the broader thematic context of the activity category. However, the recent retrieval practice phase primed enough of the critical details such that participants were able to associate these details together (e.g., pictures that I drew), thereby enabling episodic integration (Anderson & McCulloch, 1999). The notion that unique experiences are initially encoded discretely and then subsequently integrated is supported by at least two theories related to memory for repeatedly occurring events (i.e., Script theory, Nelson, 1986; Fuzzy-trace theory; Brainerd & Reyna, 1995). We surmise that once episodic integration occurred, no RIF was observed because episodic integration is a boundary condition of RIF. In contrast, enough time elapsed in the long delay condition that priming could not facilitate the episodic integration process and, consequently, competition among related traces still existed. Inhibition was used to resolve this competition, thereby producing the reported RIF effect. This explanation is certainly speculative, but we believe it provides a starting point for understanding the application of RIF to child victims and witnesses.

The present data also allow us to add to the ongoing debate in the RIF literature regarding the durability of RIF. RIF has been found to be a rather short-lived phenomenon by some researchers (Chan, 2009; MacLeod & Macrae, 2001; Saunders & MacLeod, 2002), whereas other researchers have found the effect to persist as long as 24 hours or a week (Garcia-Bajos et al., 2009; Migueles & Garcia-Bajos, 2007; Saunders et al., 2009; Storm, Bjork, Bjork, & Nestojko, 2006). The present design allowed us only to examine a delay of up to 2 hours, and we did observe RIF after this delay when the details occurred across multiple days. However, we were able to demonstrate that the process of encountering the stimuli itself can be extended for longer periods of time and that RIF applies—albeit in a complex way—to details encountered across several different days. It is critical that the present work be extended for much longer delays than used in the present study if we wish to apply these findings to retrieval of children's autobiographical memory in a forensic context.

Finally, the present study contributes to a growing consensus among researchers that an understanding of developmental and cognitive processes is critical to conducting informed investigative interviews with children (e.g., Lamb, La Rooy, Katz, & Malloy, 2011; Poole & Lamb, 1998). Whether related memories are from a single day or occur over multiple days, retrieving episodic memories causes forgetting of related memories when a context exists that supports retrieval interference. Further research is needed to determine precise

temporal distributions of related memories and delays that attenuate levels of retrieval interference, and resulting RIF effects. Even without a complete understanding of the circumstances supporting retrieval interference, the present findings provide yet another reason that initial exhaustive recall is crucial for preserving fragile memory evidence.

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