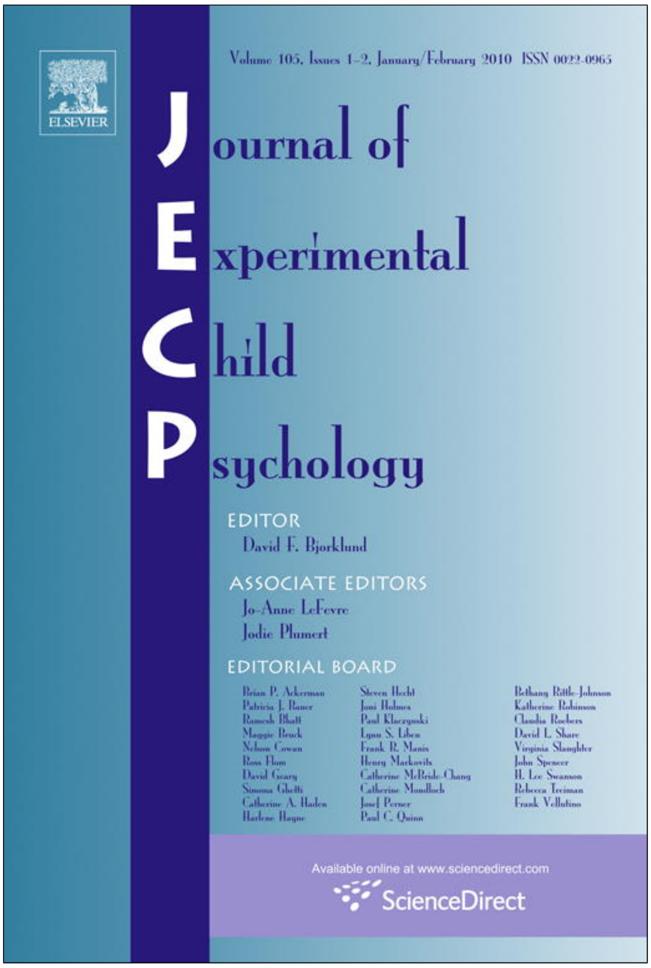
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Developmental differences in the impact of contextual factors on susceptibility to retroactive interference

Einat Levy-Gigi [a,*], Eli Vakil [a,b]

[a] Leslie and Susan Gonda (Goldschmied) Multidisciplinary Brain Research Center, Bar-Ilan University, Ramat-Gan 52900, Israel
[b] Department of Psychology, Bar-Ilan University, Ramat-Gan 52900, Israel

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ABSTRACT

The influence of contextual similarity on children's recognition memory performance was examined using a retroactive interference paradigm. In the study, 9- and 12-year-olds were randomly assigned to one of two contextual conditions. In both conditions, target and interfering information were presented in distinctive contexts by using different modalities (pictures and words, respectively). However, in one condition the test was presented in the same context as the target information (picture–word–picture [PWP] condition), whereas in the other condition the test was presented in the same context as the interfering information (picture–word–word [PWW] condition). Performance in these conditions was compared with performance in a noninterference control condition (picture–word [P-W]). As predicted, overall recognition performance in the PWP condition was significantly better than in the PWW condition. However, whereas in the PWP condition there was no age difference in performance, in the PWW condition the 12-year-old group produced significantly more hits and fewer false alarms than the 9-year-old group. The theoretical implications of the results are discussed in reference to the effortful engagement of developmentally dependent executive control processes.

Any perceptual experience is composed of a number of stimuli. Some are more salient and therefore attended; others remain at the periphery of our attention, serving as the context of our focally attended experience (Mayes, Macdonald, Donlan, Pears, & Meudell, 1992). Such context plays a major role in memory. According to the encoding specificity principle (Tulving & Thomson, 1973), the retrie-

* Corresponding author.
E-mail address: levygigie@gmail.com (E. Levy-Gigi).

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val of information from memory depends on the process by which it was encoded. Consequently, the probability of remembering a stimulus in a context different from that in which it was learned is lower than that of remembering a stimulus in the same context. This is referred to in the literature as *context effect* (e.g., Memon & Bruce, 1985; Smith, Glenberg, & Bjork, 1978; Vakil, Golan, Grunbaum, Groswasser, & Aberbuch, 1996a).

Context effects have been demonstrated in laboratory settings as well as in environmental studies in adults (e.g., Vakil, Raz, & Levy, 2007) and children (e.g., Ackerman, 1981, 1985; Holliday & Albon, 2004; La Rooy, Pipe, & Murray, 2007; McCauley & Fisher, 1995). Studies investigating age differences in context effects report that children and adults demonstrate similar context effects (Nittrouer & Boothroyd, 1990) and that children as young as 4 years of age can benefit from context reinstatement at retrieval (Bowen & Howie, 2002; Hershkowitz, Orbach, Lamb, Sternberg, & Horowitz, 2002). However, in these studies recognition was tested after study without interference between these two stages, whereas in everyday life children, like adults, may be exposed to experiences that can interfere with memory for learned information. Such situations are modeled by retroactive interference (RI) studies in which the presentation of target information (Stage 1) is followed by exposure to interfering information (Stage 2), and only then is memory of target information tested (Stage 3) (e.g., Postman & Underwood, 1973).

Studies investigating children's memory performance after exposure to interfering information have usually focused on the similarity in presentation between target and interfering information and its influence on memory performance. It was found that when target and interfering information share similar perceptual and semantic features, the tendency to confuse them is higher relative to conditions in which there is less featural similarity (e.g., Day, Howie, & Markham, 1998; Lindsay, Johnson, & Kwon, 1991; for a review, see Roberts, 2002). However, to provide a more complete picture of this context similarity effect, contextual similarity across all three stages (target study, interferer study, and test) should be considered.

The goal of this study was to further the understanding of developmental influences on context effects in an RI paradigm by examining the effects of contextual similarity among target–interferer, target–test, and interferer–test stages. Because target–interferer contextual similarity effects have been demonstrated convincingly (see studies cited above), the current study focuses on the other two similarity relations (target–test and interferer–test similarities). Two contextual conditions were created by the use of different modalities (pictures vs. words), a context manipulation that has been found to affect remembering (e.g., Gallo, McDermott, Percer, & Roediger, 2001; Kellogg, 2001; Kirsner, 1974; Vakil, Melamed, & Even, 1996b). Targets and interferers were presented in distinctive contexts (pictures and words, respectively), whereas the test stimuli were presented either in the same context as the targets (i.e., as pictures: picture–word–picture [PWP] condition) or in the same context as the interferers (i.e., as words: picture–word–word [PWW] condition). In the current study, targets were always presented as pictures and interferers were always presented as words because in a pilot study that manipulated the learning modality (pictures vs. words) while using the opposite conditions (word–picture–word [WPW] and word–picture–picture [WPP]), besides the advantage of memory for pictures over words (i.e., the picture superiority effect), there were no significant effects of learning modality.

The difference between the study contexts of the targets and interferers distinguishes them at encoding. In the PWP condition, the similarity in study–test context (i.e., both are presented as pictures) facilitates recognition of the targets, whereas the distinctive context of the interferers helps to differentiate between them and the other two stages. This condition enables participants to use contextual information both in recognition (study–test similarity) and in discrimination (target study vs. interferer study difference). Conversely, in the PWW condition, the contextual dissimilarity between target study and test stages reduces recognition relative to a same contextual condition, whereas the contextual similarity between the interfering information and the test stimuli may lead to increasing incorrect endorsement of the interferers (Roebers & McConkey, 2003). In this condition, participants not only must recognize target information despite the target–test dissimilarity but also must correctly reject the interfering items at test despite the interferer–test similarity. Therefore, it was predicted that the overall performance in the PWP condition would be significantly higher relative to performance in the PWW condition.

In the current study, we compared the memory performance of 9- and 12-year-olds. It is assumed that the basic reading skills of 9-year-olds are well established. At the same time, they are young enough to have immature mnemonic strategies (Cowan, Saults, & Morey, 2006). There is evidence that mnemonic strategies improve during the elementary school years (Bjorklund & Douglas, 1997; Ornstein & Naus, 1978). This improvement can be attributed to, among other things, frontal lobe maturation. Studies that compared 8- and 11-year-olds found marked developmental advances in cognitive control and executive functions among the older children (Davidson, Amso, Anderson, & Diamond, 2006; for a review, see Diamond, 2006).

Context effects at retrieval as found in the PWP condition are not dependent on frontal lobe function. This assertion is supported by studies that demonstrated advantage of context reinstatement at retrieval among participants with frontal lobe deficits. Patients with frontal lobe damage (Vakil et al., 1996b), as well as elderly individuals (Vakil, Openheim, Falck, Aberbuch, & Groswasser, 1997; Vakil et al., 1996a), exhibit normal benefit from contextual cues at retrieval. This advantage was found even when participants failed in a direct test of memory for the contextual information (e.g., whether a specific item was studied as a picture or as a word). Hence, it is considered as an indirect measure of memory that is not frontal lobe dependent (Manier, Apetroaia, Pappas, & Hirst, 2004). Therefore, it was predicted that despite the difference in frontal lobe maturation, both younger and older children would show context effects to the same extent; that is, they would benefit equally from the contextual similarity between target and test stages (i.e., in the PWP condition).

In contrast, in the PWW contextual condition, recollecting target information while distinguishing it from interfering information seems to require the use of executive functions and hence frontal lobe mediation. First, it demands inhibition to reject the interferer items at test despite the contextual similarity between their study format and that of the test items. In addition, successful performance in the PWW contextual condition might require cognitive flexibility to switch between different representations of the same target item at study and test because the target information was presented as pictures, whereas the test employed words. Finally, in the PWP condition, contextual similarity between target information and test probe serves as a retrieval cue, whereas direct memory for context is not required to successfully recognize the target information (whether this picture was presented before). On the other hand, in the PWW condition, participants must directly remember the context of each test item (whether it was presented as picture or as word) to correctly choose the target information and reject the interference stimuli. In that respect, this condition is similar to source memory tasks mediated by the frontal lobe (de Chastelaine, Friedman, & Cycowicz, 2007). Given the delayed maturation of frontal lobe development through childhood into young adulthood (e.g., Sowell et al., 2003), it might be surmised that such processes will be diminished to varying degrees in young children, as demonstrated in source monitoring skills (for a review, see Roberts, 2002). Accordingly, it was predicted that recognition performance in the PWW condition would show greater decrements in younger children relative to older children.

It may be argued that poorer performance of the younger children in the PWW condition results exclusively from the shift from pictures (at study) to words (at test). However, we claim that in the PWW condition the performance is affected not only by the contextual dissimilarity between target and test information but also by the exposure to interfering information in the same test context. To differentiate between these two mechanisms, we added a control contextual condition (picture–word [P-W]). In this condition, participants viewed the target information as pictures and, after a numeric filler task, performed a verbal memory test without being exposed to any interfering verbal information. Because the filler task is numeric, the assumption is that it causes minimal interference. Performance differences between P-W and PWW conditions would indicate that specifically verbal interfering information presented in the same context as the test affects memory performance.

Experiment 1

Method

Participants and design

There were 192 participants (94 girls and 98 boys) from the Ilan Ramon elementary school in Israel. All children participated with written parental consent and their own assent. Half of the participants

($n = 96$) were pupils in Grade 3 (mean age = 8.52 years), and the remaining 96 were pupils in Grade 6 (mean age = 11.61 years). Participants younger or older than 2 standard deviations from the mean age were excluded. The participants were randomly assigned to one of three contextual conditions (PWP, P-W, or PWW) that served as a between-participants factor. This resulted in a 3 (Contextual Condition) $\times$ 2 (Age Group) factorial design.

Materials

A total of 85 object pictures and their corresponding word names served as the experimental stimuli. Picture–name correspondence was corroborated in a separate group of 23 participants in Grade 2. The items were randomly assigned to target, interference, and test lists. The target and interference lists contained 35 items that were presented either as pictures (target items) or as words (interferer items) on a white background. The items were presented on a 15-inch computer screen in a 7 $\times$ 6.5-cm box. The test list contained 15 items from the target presentation, 15 items from the interference presentation, and 15 new foil items. Recognition memory for the targets was tested in a three-alternative forced-choice (3-AFC) paradigm with 15 trials. In each trial, participants were presented with a target, an interferer, and a new foil (see Appendix for samples of questions). It was found that when using a yes/no recognition test (e.g., Hockley, 2008), a study–test contextual similarity caused a bias effect by increasing not only the rates of hits but also the rates of false alarms. The forced-choice test enables participants to make a relative recognition judgment by comparing target and interferer items during the test, whereas the new item serves as a baseline for memory performance. In this manner, the bias effect is eliminated. Performance was analyzed in terms of the percentage of hits and two types of false alarms (interferer and new foil). In the 3-AFC paradigm, every false alarm can also be considered as a miss of the target item. However, we use this terminology to stress the dissociation between interferers and new foil items.

Procedure

Participants were tested individually in the presence of an experimenter. Instructions were presented in writing on the computer screen and were accompanied by the experimenter's oral instructions. Participants were given the following instructions: "In this study, memory for words and pictures will be compared. You will be presented with two different item lists. Please pay close attention to these lists." The lists were titled as list numbers one and two. Each title was presented on a separate slide for 6 s. The items in both lists were presented serially for 3 s each using SuperLab (Cedrus, San Pedro, CA, USA). After viewing the target and interference lists, in the PWP and the PWW conditions, the participants were given a 3-min filler task in which they needed to count down from 100 by 3. Participants in the P-W condition were given an additional 2-min digit cancellation filler task to maintain a study–test interval constant in all experimental conditions. This was followed by the memory test. The following instructions were given:

> Now you are going to be tested on the *first* items list *only*. You will be presented with three items each time. Only *one* of them was presented in the first list. You have to indicate whether the item shown in the first list appeared on the left-hand side, the middle, or the right-hand side of the screen by using the keys indicated on the keyboard.

The experimenter ascertained that participants understood the instructions before they started the test. After completing the test, participants were debriefed.

Results and discussion

Hit rates

The percentage of hits (Fig. 1) was analyzed in a 3 (Contextual Condition: PWP, P-W, or PWW) $\times$ 2 (Age Group: Grade 3 or Grade 6) two-way analysis of variance (ANOVA). A significant main effect of contextual condition was found, $F(2, 186) = 37.99$, $p < .001$, $\eta_p^2 = .29$. Because the study applied a between-participants design, a Scheffé post hoc test was used. The test revealed hierarchical relations with significant differences among the three contextual conditions (PWP > P-W > PWW). In addition, a significant main effect of age group was found, $F(1, 186) = 11.57$, $p < .005$ $\eta_p^2 = .06$, indicating that

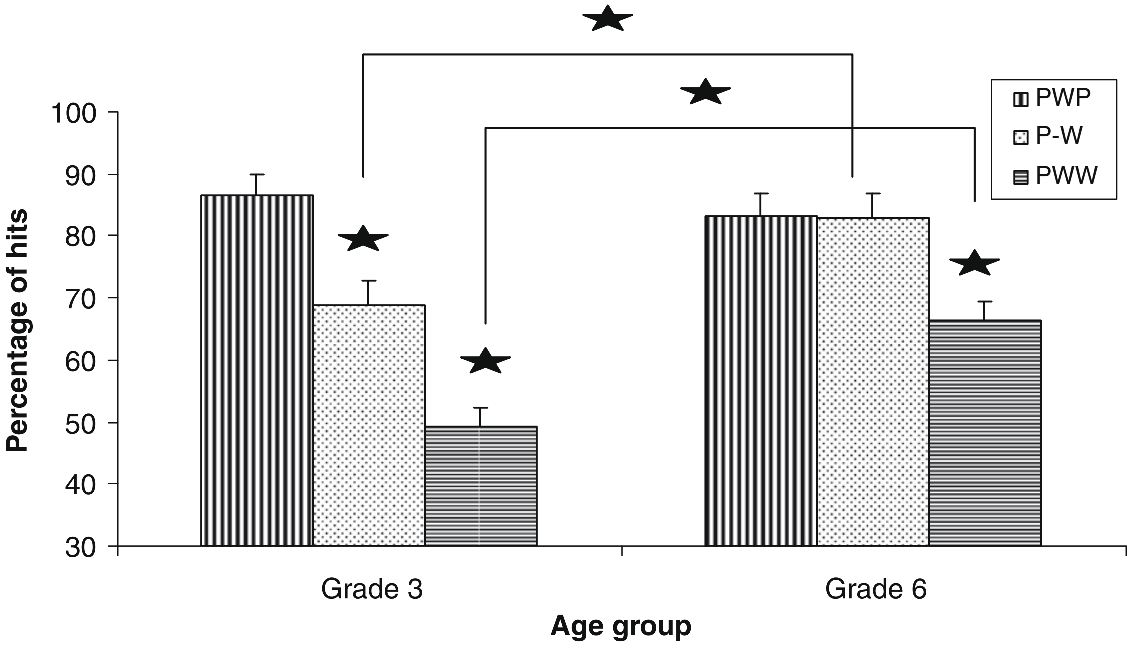


Fig. 1. Mean percentages of hits as a function of age group and contextual condition. Error bars show standard errors. Stars represent significance $p < 0.005$.

the hit rate of the older children ($M = 77.51$, $SE = 1.85$) was significantly higher than that of younger children ($M = 68.61$, $SE = 1.85$). These effects should be treated with caution because a significant interaction between contextual condition and age group was found, $F(2,\ 186) = 5.55$, $p < .01$, $\eta_p^2 = .06$. Simple analyses conducted to explore the source of the interaction revealed that whereas in the PWP condition there was no significant difference in hit rates as a function of age, $F(1, 186) = 0.52$, $p > .05$, in the P-W and PWW conditions there was a significant difference between the groups, $F(1, 186) = 8.35$, $p < .005$, $\eta_p^2 = .04$, and $F(1, 186) = 14.59$, $p < .001$, $\eta_p^2 = .07$, respectively. It appears that whereas both age groups performed equally in the PWP condition, the performance of the older children was significantly better than that of the younger children in the P-W and PWW conditions. In addition, the simple analysis reveals that there were significant differences between contextual conditions in both age groups: Grade 3, $F(2,\ 186) = 34.95$, $p < .001$, $\eta_p^2 = .27$; Grade 6, $F(2, 186) = 9.27$, $p < .001$, $\eta_p^2 = .09$. However, as can be seen in Fig. 1, the children in Grade 6 performed equally in the PWP and P-W contextual conditions (PWP = P-W > PWW), whereas the performance of the younger children in the PWP condition was significantly better than that in the P-W condition (PWP > P-W > PWW). However, in both age groups, the performance in the P-W condition was significantly better than that in the PWW condition. These results indicate that presenting interfering information impairs performance of both age groups.

To determine whether there was a difference in sensitivity to interfering information as a function of age (interference by age interaction), a 2 (Contextual Condition: P-W or PWW) $\times$ 2 (Age Group: Grade 3 or Grade 6) ANOVA was conducted with hit rates as the dependent variable. It revealed no significant interaction between these two variables, $F(1, 127) = 0.44$, $p > .05$. The results suggest that both age groups were equally sensitive to interference. The absolute decrease in performance (P-W − PWW) did not significantly differ as a function of age ($69.95 - 49.22 = 20.73$ for the younger children; $82.94 - 66.25 = 16.69$ for the older children). A proportional comparison of hit rates in the P-W and PWW conditions (P-W − PWW/P-W) showed a pronounced decrease of 29.64% in performance among the younger children compared with only 20.12% among the older children. However, because we used a between-participants design, there is no way to ascertain whether this difference is significant.

False alarm rates

The percentage of false alarms (Fig. 2) was analyzed in a mixed-design ANOVA with the between-participants factors of contextual condition (PWP or PWW) and age group (Grade 3 or Grade 6) and the

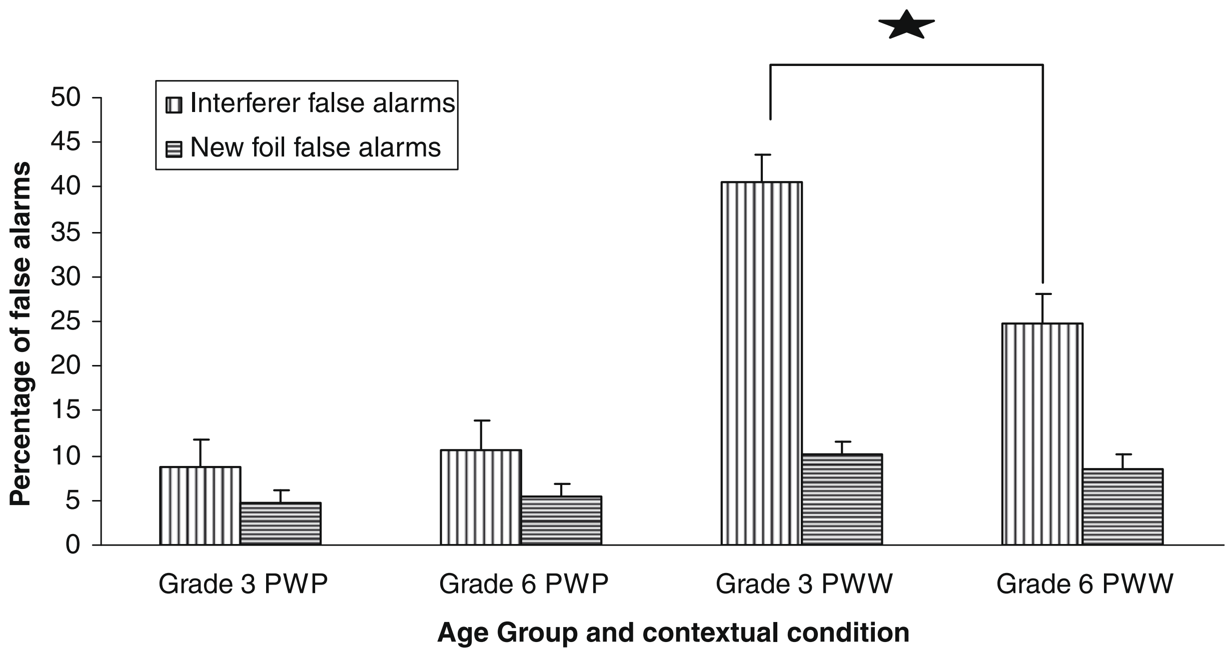


Fig. 2. Mean percentages of false alarms as a function of age group, contextual condition, and error type. Error bars show standard errors. Star represents significance $p < 0.05$.

within-participants factor of error type (interferer false alarm or new foil false alarm). Note that the P-W contextual condition was not included in the analysis because without an interference phase it can produce only one type of error. The analysis revealed a significant error type main effect, $F(1, 123) = 70.73$, $p < .001$, $\eta_p^2 = .37$, indicating that, as expected, the percentage of errors in which participants endorsed interferers was significantly higher than the percentage of false alarms in which participants endorsed new foil items. The main effects of contextual condition (PWP < PWW) and age group (Grade 3 > Grade 6) are redundant and present a mirror image of the effects that were obtained in the hit rates analysis. The only interactions to reach significance were Contextual Condition × Error Type, $F(1, 123) = 32.05$, $p < .001$, $\eta_p^2 = .21$, and Age Group × Contextual Condition × Error Type, $F(2, 123) = 5.45$, $p < .05$, $\eta_p^2 = .04$. Simple analyses were conducted to explore the source of the triple interaction by comparing the performance in the two contextual conditions separately in 2 (Age Group) × 2 (Error Type) mixed-design ANOVAs. In both contextual conditions (PWP and PWW), there was a significant main effect of error type, $F(1, 59) = 11.59$, $p < .05$, $\eta_p^2 = .16$, and $F(1, 64) = 63.10$, $p < .001$, $\eta_p^2 = .50$, respectively. However, whereas in the PWP condition there was neither a significant main effect of age group $F(1, 59) = 0.26$, $p > .05$, nor an interaction, $F(1, 59) = 0.26$, $p > .05$, the PWW condition yielded both a significant age group main effect, $F(1, 64) = 10.93$, $p < .005$, $\eta_p^2 = .15$, and a significant interaction, $F(1, 64) = 5.77$, $p < .05$, $\eta_p^2 = .08$. Hence, in the PWW condition, the overall percentage of false alarms among the younger children was significantly higher than that among the older children. However, the significant interaction indicates that this difference is due exclusively to the percentage of interferer false alarms given that the percentage of new foil false alarms in both groups is statistically equal.

The results of the first experiment show that, as predicted, the performance in the PWP condition was significantly better than that in the PWW condition. Thus, target–test contextual similarity combined with contextual distinctiveness of interfering information helps to achieve better memory performance compared with the condition of target–test contextual dissimilarity accompanied by interference–test similarity. In addition, it was found that whereas both age groups performed equally in the PWP condition, there was a significant advantage of the older children over the younger children in the PWW condition. The performance in the PWW condition was affected by two different factors: the ability to switch context/modality between target and test (*PWW*) and the ability to remember the target information despite interference–test contextual similarity (P*WW*). Comparing the performance of the two age groups in the P-W condition revealed that younger children have significantly more difficulty in target–test switching context/modality than do older children. However, the effect of age on interference–test contextual similarity is not conclusive. The comparison of the P-W and PWW conditions showed no interaction of interference by age, suggesting that in absolute terms the effect of interference–test similarity was equal in both age groups. However, in proportional terms, the younger children showed a tendency that could be considered as a steeper decrease in performance between the P-W and PWW conditions relative to older children, possibly suggesting age-dependent differences in the influence of interference–test similarity. This finding and its theoretical implications are further elaborated in the General Discussion.

Another factor that might have caused age differences in the PWW condition is different labeling processes of the presented pictures. In contrast to the PWP condition, in which target–test similarity decreased the effect of labeling, in the PWW condition this effect might have been more significant due to target–test modality switching. It can be argued that older children use many more labels for each presented picture relative to younger children and that, therefore, their memory traces are more prominent. In addition, younger children may have difficulty in naming the studied pictures correctly and, hence, may experience more memory difficulties relative to older children. These differences may serve as an alternative explanation to the age-related differences that were observed in the PWW condition. Experiment 2 was conducted to control for possible different effects of labeling between the two age groups in the PWW condition.

Experiment 2

Method

Participants and design

There were 42 participants (22 girls and 20 boys) from the Ilan Ramon elementary school in Israel. All children participated with written parental consent and their own assent. Half of the participants ($n = 21$) were pupils in Grade 3 (mean age = 8.94 years), and the remaining 21 were pupils in Grade 6 (mean age = 11.74 years). Participants younger or older than 2 standard deviations from the mean age were excluded. The participants were tested on a verbalized version of the PWW contextual condition in which they were asked to loudly pronounce a one-word name for each presented picture and to read every presented written word aloud. The experimenter indicated whether the critical target items were named correctly. All other aspects of the procedure were the same as in Experiment 1.

Results and discussion

The percentages of erroneously named pictures were analyzed. It was found that there was a significant difference in picture naming as a function of age, $F(1, 40) = 4.96$, $p < .05$, $\eta_p^2 = .11$, with the younger children making significantly more naming mistakes ($M = 15.24\%$, $SE = 2.32$) than the older children ($M = 7.94\%$, $SE = 2.32$). However, it should be noted that most of the errors were due to minor mistakes (e.g., a rifle instead of a gun, a pot instead of a pan). A within-participants correlation indicated that there were no significant correlations between correct naming and percentage of hits, $r(41) = -.25$, $p > .05$, percentage of old false alarms, $r(41) = .26$, $p > .05$, or percentage of new false alarms, $r(41) = .03$, $p > .05$. Thus, performance in the naming task does not predict memory performance.

Nevertheless, to eliminate any naming effect, in the following analysis we used corrected measures of hits and false alarms in which all of the erroneously named items were excluded. Hence, the performance evaluation was based only on items that were named correctly. Unless stated otherwise, all of the results refer to the performance in the PWW contextual condition.

Mean percentages of hits, old false alarms, and new false alarms are shown in Table 1. As predicted, similar to Experiment 1, the performance of the older children was significantly better than that of the younger children: hits, $F(1, 40) = 4.65$, $p < .05$, $\eta_p^2 = .10$; false alarms: $F(1, 40) = 7.56$, $p < .01$, $\eta_p^2 = .16$. This was demonstrated in a higher percentage of hits and a lower percentage of interferer false alarms among the older children (hits: $M = 83.93\%$, $SE = 3.82$; false alarms: $M = 12.23\%$, $SE = 3.29$) as compared

Table 1
Mean percentages of hits, interferer false alarms, and new foil false alarms in the PWW condition (with verbalization) as a function of age.

	Grade 3	Grade 6
Hits	68.77 (2.16)	78.65 (1.72)
Interferer false alarms	25.04 (3.87)	12.23 (2.60)
New foil false alarms	2.67 (1.13)	3.84 (1.24)

Note. Standard errors are in parentheses.

with the younger children (hits: M = 72.28%, SE = 3.82; false alarms: M = 25.04%, SE = 3.29). However, as in Experiment 1, there was no significant difference in the percentage of new foil false alarms as a function of age, $F(1, 40) = 0.48$, $p > .05$, indicating that this difference cannot be related to general memory deficit but rather is due exclusively to exposure to interfering information.

Comparison between the two experiments

To evaluate the verbalization effect on memory, the data from Experiment 2 were directly compared with the equivalent data (PWW condition) from Experiment 1. A 2 (Age Group: Grade 3 or Grade 6) $\times$ 2 (Verbalization: without and with) multivariate ANOVA was conducted with hits, old foil false alarms, and new foil false alarms as the dependent variables. The comparison revealed that there were significant main effects of verbalization: hits, $F(1, 104) = 26.86$, $p < .001$, $\eta_p^2 = .21$; distracter false alarms, $F(1, 104) = 14.18$, $p < .001$, $\eta_p^2 = .12$; new foil false alarms, $F(1, 104) = 16.54$, $p < .001$, $\eta_p^2 = .14$; this indicates enhanced memory performance in the verbalized condition (Experiment 2) compared with the nonverbalized condition (Experiment 1). Main effects of age are redundant. Finally, there were no significant interactions of age group and verbalization for hits, for distracter false alarms, or for new foil false alarms, $F(1, 104) = 0.47$, $p > .05$, $F(1, 104) = 0.69$, $p > .05$, or $F(1, 104) = 0.35$, $p > .05$, respectively.

General discussion

The purpose of this study was to explore the influence of study–test contextual similarity in an RI paradigm for children of different age groups. We compared the performance of 9- and 12-year-olds in two contextual conditions that highlighted advantages and disadvantages of contextual constancy or change between target/interfering information and test. It was found that both age groups benefited equally from the advantages of target–test context constancy. However, younger children paid a significantly higher performance price, relative to older children, in cases of target–test contextual inconstancy accompanied by interference–test similarity.

As predicted, the advantages of study–test contextual constancy (the PWP condition) led to significantly better performance compared with the PWW condition. In both age groups, the hit rates in the PWP condition were significantly better than those in the PWW condition. These findings are consistent with the literature on typical context effects (e.g., Vakil et al., 2007). In addition, the percentage of interferer false alarms in the PWP condition was significantly lower than that in the PWW condition for both younger and older children. It appears that the unique context of the interfering list (PWP) helps to easily distinguish it from both the target list and the test list and, thus, decreases intrusion rates (in accordance with the literature, e.g., Howe, 2005). Finally, the performance in this condition did not differ as a function of age. This finding is consistent with the claim that the ability to benefit from target–test contextual constancy is not mediated by the frontal lobes and, hence, obtains independently of age (e.g., Vakil et al., 1996a, 1996b, 1997). Similarly, it suggests that the ability to benefit from contextual discrimination between target and interfering information is not age related.

In contrast to the PWP condition, in both the P-W and PWW conditions the performance of the older children was significantly better than that of the younger children. The findings support our claim that these tasks demand engagement of executive control processes and efficient learning and memory strategies that are not fully matured among young children. However, it should be noted that this study used a recognition memory test, whereas using a source memory test may add further confirmation to this conclusion.

The P-W condition does not contain an interfering phase; hence, it enabled us to isolate the effect of target–test contextual constancy from the effect of interference–test similarity. To examine the effect of target–test constancy, we compared the PWP (target–test constancy) and P-W (target–test inconstancy) conditions. The comparison showed that whereas there was no significant difference between these conditions among the older children, the younger children performed significantly better in the target–test constancy condition. The poorer performance of the younger children in the P-W condition can be explained in terms of context dependency; younger children are more context dependent than older children, and the mismatch of encoding and retrieval contexts decreases their ability to correctly retrieve items from the target list. Alternatively, it can be argued that the deficient performance of the younger children is due to a more specific difficulty in switching representations from pictures to words during the test.

To explore the effect of interference, we compared the P-W (without interference) and PWW (with interference) conditions. The comparison revealed that, in accordance with our prediction, both age groups performed significantly better when there was no interference between study and test. However, contrary to our prediction, there was no interaction of interference by age, suggesting that the effect of interference–test similarity was equal in both age groups, at least in absolute terms. Thus, the poor performance of the younger children relative to the older children in the PWW condition is not due exclusively to interference–test similarity as predicted; rather, it is due at least partly to the target–test inconstancy. However, it should be noted that when a comparison of proportional scores was done, the younger children showed a tendency toward a steeper decrease in performance between the P-W and PWW conditions relative to the older children, perhaps suggesting age-dependent differences in the influence of interference–test similarity.

Support for this assertion was provided by participants during debriefing; when asked about techniques that were used during the test, only older children in the PWW condition described recollection/rejection techniques (e.g., "I remembered I saw this word in the second list, so I knew it cannot be a correct answer") (e.g., Brainerd, Reyna, & Estrada, 2006), whereas younger children did not describe similar techniques. It is important to note that in the PWP condition, reactions did not differ as a function of age, with both older and younger children relating to the target–test contextual similarity when asked about their memory techniques. Therefore, it may be argued that interference–test similarity in the PWW condition does not help younger children to recollect the interfering items and correctly reject them during the test as it does for older children and adults. Instead, it may enhance their tendency to mistakenly attribute items from the interference list to the target list. However, further research is needed to reach a more decisive conclusion.

Additional support for an age-related effect of interference–test similarity can be found in studies with elderly individuals who may suffer from reduction of frontal lobe functioning that can parallel the immaturity of the frontal lobe among young children. These studies have shown that elderly individuals are more impaired in direct memory tasks (equivalent to the PWW condition) than in indirect memory tasks (equivalent to the PWP condition) (Vakil et al., 1996a, 1996b) as well as being more impaired in recall-to-reject measures than in recall-to-accept measures (Castel & Craik, 2003; Healy, Light, & Chung, 2005). Similarly, Cohn and colleagues found that older adults may use recollection successfully when good retrieval cues are provided but fail to do so when the task requires more efficient memory strategies (Cohn, Emrich, & Moscovitch, 2008).

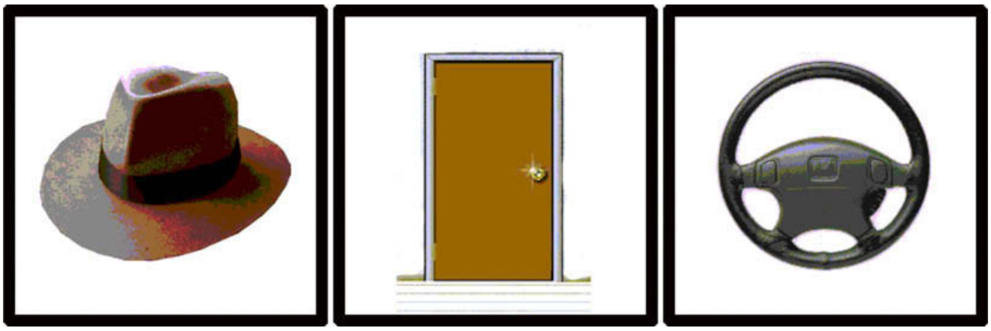
Finally, support for a differential effect of interference–test similarity can be found in the fact that whereas there was a significant difference between the age groups in rates of interferer false alarms, there was no significant difference in the rates of new foil false alarms. If the poor performance of the younger children was due only to target–test inconstancy, this tendency should have been observed in both the interferer and new foil false alarms. In addition, these results indicate that the difference between older and younger children is not due to a difference in response bias between the groups.

Experiment 2 was conducted to further investigate the reasons for age-related differences in the PWW condition. The results confirm the assertion that age-related differences in the PWW condition are not due to naming difficulties of the younger children. Although young children had more difficulty in labeling the target pictures, this did not affect their performance. In addition, controlling for the labeling process did not change the general pattern of the results.

The age dissociation among the three contextual conditions supports the claim that context effects on memory are complex and based on different cognitive processes involving direct and indirect expressions of memory (Levy, Rabinyan, & Vakil, 2008). It appears that further research is needed to reach more conclusive results regarding the reasons underlying age differences in the PWW condition and the differential effect of interference–test similarity. One option is to use a within-participants paradigm that allows deducting the influence of modality mismatch for each participant. Another option is to manipulate a type of context different from modality (e.g., background of stimuli, presentation environment) so as to eliminate modality mismatch effects. In this manner, it would be possible to determine whether young children are more context dependent in general or have more specific difficulty in switching between different modality representations (i.e., pictures to words). In addition, using a source memory test (whether an object was presented as picture or as a word) could help to detect whether the age differences in the PWW condition are due to source confusion. For example, it is possible that after seeing pictures (as part of the target list), younger children experience visual images for items presented as words and then use visual cues (based on pictures or images) as the basis for their recollection/rejection decisions. In this case, age differences may reflect confusion between pictures and images among the younger children. Finally, future research that applies the same paradigm to testing people with brain damage could provide further support for selective frontal lobe mediation in the PWW condition but not in the PWP condition.

Appendix. Samples of the 3-AFC questions (reduced in size)

Test items are presented as pictures—the PWP context condition



Test items are presented as words—the PWW context condition (the original words were presented in Hebrew)

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