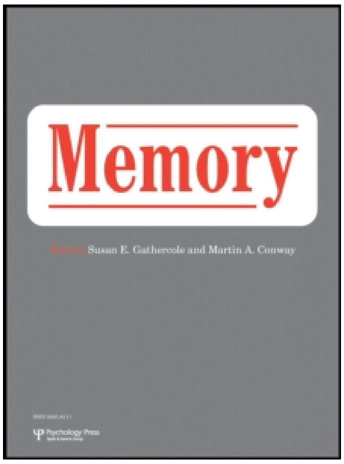


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# Working memory capacity predicts listwise directed forgetting in adults and children

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# Working memory capacity predicts listwise directed forgetting in adults and children

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In listwise directed forgetting, participants are cued to forget previously studied material and to learn new material instead. Such cueing typically leads to forgetting of the first set of material and to memory enhancement of the second. The present study examined the role of working memory capacity in adults' and children's listwise directed forgetting. Working memory capacity was assessed with complex span tasks. In Experiment 1 working memory capacity predicted young adults' directed-forgetting performance, demonstrating a positive relationship between working memory capacity and each of the two directed-forgetting effects. In Experiment 2 we replicated the finding with a sample of first and a sample of fourth-grade children, and additionally showed that working memory capacity can account for age-related increases in directed-forgetting efficiency between the two age groups. Following the view that directed forgetting is mediated by inhibition of the first encoded list, the results support the proposal of a close link between working memory capacity and inhibitory function.

***Keywords:*** Episodic memory; Directed forgetting; Individual differences; Working memory capacity; Inhibition; Cognitive development.



Working memory capacity (WMC), as measured by complex span tasks, is an important individual-differences variable that accounts for a significant portion of inter-individual variability in many cognitive tasks (for reviews, see Conway et al., 2005, or Kane & Engle, 2002). In particular, it has been argued that WMC is related to the efficiency of inhibitory processes, so that individuals with higher WMC are better able to deal with interference and inhibit task-irrelevant information than individuals with lower WMC (Redick, Heitz, & Engle, 2007). Consistently, WMC has been found to predict performance in a number of inhibitory tasks, including dichotic listening (Conway, Cowan, & Bunting, 2001), negative priming (Conway, Tuholski, Shisler, & Engle, 1999), the Stroop task (Kane & Engle, 2003), and the antisaccade task (Kane, Bleckley, Conway, & Engle, 2001).

This study examines the role of WMC in listwise directed forgetting (DF), a memory task that measures an individual's capability for intentional forgetting. In this task participants study two lists of items. After presentation of the first list, they receive a cue to either forget or continue remembering the list before studying the second list. When later asked to recall all of the previously presented items, including those originally cued to forget, forget-cued participants typically show impaired recall of List 1 (List-1 forgetting) and improved recall of List 2 (List-2 enhancement), compared to participants cued to remember both lists of items (for reviews see Bäuml, 2008; MacLeod, 1998). The two effects of the forget cue are often explained by inhibition. The proposal is that forget-cued participants engage in active inhibitory processes that reduce accessibility of the "irrelevant" List 1 and, due to the resulting

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decrease in these items' interference potential, simultaneously improve memory for the ''relevant'' List 2 (Geiselman, Bjork, & Fishman, 1983; for alternative accounts, see Bjork, 1970, or Sahakyan & Kelley, 2002). Following the inhibitory account of DF and the view that WMC is related to inhibitory efficiency, the prediction arises that individuals with higher WMC should show more efficient DF—i.e., higher amounts of List-1 forgetting and List-2 enhancement—than individuals with lower WMC.

Two recent studies addressed the role of WMC in DF. In the first study, Delaney and Sahakyan (2007) examined young adults and manipulated cue condition (remember vs forget) between groups of participants. They found that higher WMC was associated with slightly higher (Experiment 1) or equal (Experiment 2) List-1 recall in the remember group, but was associated with slightly lower List-1 recall in the forget group. The finding was taken as evidence that individuals with higher WMC show more efficient List-1 forgetting than individuals with lower WMC. However, Delaney and Sahakyan did not find any effect of the forget cue on List-2 recall in their experiments, and they did also not find an interaction between WMC and cue condition with respect to this list, leaving it open whether WMC affects List-2 enhancement.

In the second study, Soriano and Bajo (2007) examined relatively small samples of young adults and manipulated cue condition (remember vs forget) within participants. In the remember condition high-WMC and low-WMC individuals did not differ in recall performance, regarding both List-1 and List-2 recall. In the forget condition high WMC was associated with higher (Experiment 1), equal (Experiment 2), or slightly lower (Experiment 3) List-1 recall, and was associated with enhanced List-2 recall in all three experiments. In contrast to the Delaney and Sahakyan (2007) results, these findings suggest that WMC may affect List-2 enhancement but may not affect List-1 forgetting.[1]

[1] Using the difference in recall between List 2 and List 1 in the forget condition, the authors reported results from additional correlational analyses, indicating a negative relationship between WMC and DF efficiency in one experiment (Experiment 1), and a positive relationship between WMC and DF efficiency in the other two experiments (Experiments 2 and 3). Because such analysis ignores performance in the remember condition and does not allow to measure List-1 forgetting and List-2 enhancement separately, the correlational results per se are silent about whether the reported effects reflect List-1 forgetting or List-2 enhancement.

It is important, both theoretically and empirically, to understand what caused the difference in results between the two previous studies. A factor that may account for the inconsistency in results is the testing procedure employed in the two studies. While Delaney and Sahakyan (2007) asked participants to recall List-1 items before List-2 items, in Soriano and Bajo's (2007) study participants were free to recall the items of the two lists in any order they wished, which should have induced a tendency to recall the more recent List-2 items before the List-1 items (e.g., Geiselman et al., 1983). Thus, Delaney and Sahakyan's measures of List-2 enhancement may have been contaminated by the previous recall of List-1 items, whereas Soriano and Bajo's measures of List-1 forgetting may have been contaminated by the previous recall of List-2 items. Because such contamination may mask possible effects of WMC on performance on the last-tested list, it might explain why the previous studies found WMC effects on List-1 forgetting (Delaney & Sahakyan, 2007) or List-2 enhancement (Soriano & Bajo, 2007), but not on both.

## EXPERIMENT 1

Because to date there are only two studies that addressed the role of WMC in DF, and the results of these studies show inconsistencies both within and between studies, the goal of the present research was to revisit the issue and extend on the prior work in several important ways. In particular, the goal of Experiment 1 was to examine whether the inconsistency between the two previous studies was resolved and an effect of WMC on both List-1 forgetting and List-2 enhancement emerged, if each of the two DF effects was measured uncontaminated by any previous recall of the interfering list. To achieve the goal, we examined young adults' DF and assessed each individual's WMC by means of the operation span task (Turner & Engle, 1989). Following previous work (e.g., Bäuml & Kuhbandner, 2009; Soriano & Bajo, 2007; Zellner & Bäuml, 2006), we manipulated cue condition (remember vs forget) within rather than between participants. Manipulating cue condition within participants enabled us to measure the two DF effects for each person individually and thus to examine the relationship between individual WMC and individual List-1 forgetting on the one hand, and individual WMC and individual List-2 enhancement on the other. Crucially, following Kimball and Bjork (2002), we counterbalanced testing order of the two lists across participants, reporting recall results only for the first-tested list in each cue condition. In doing so we hoped to come up with fairly "pure" measures of List-1 forgetting and List-2 enhancement, and thus with a clear-cut indication on the role of WMC for the two DF effects.

## Method

### *Participants*

A total of 144 adults ($M = 23.0$, $SD = 5.2$ years) took part in the study. They were tested individually.

### *Directed-forgetting task*

*Materials.* Four study lists were constructed, each consisting of 18 unrelated nouns drawn from the CELEX database (Duyck, Desmet, Verbeke, & Brysbaert, 2004).

*Design and procedure.* For each participant the experiment consisted of two blocks. In each block two lists were presented for study and test. The two blocks differed only in the CUE (remember or forget) participants received between the two lists. In each of the two blocks List-1 items were displayed on the computer screen in random order at a rate of 3 seconds per word. Following the last item, the interlist cue was provided. In the remember condition participants were told that the prior list should be remembered for the later test. In the forget condition the experimenter pretended that she had made a mistake and had presented a wrong list. Participants thus should try to forget the irrelevant list and concentrate on the upcoming relevant list. Following the interlist cue, List 2 was presented in the same way as List 1. After a 90-second backward-counting task, a recall test was conducted. Participants were asked to recall and write down all items from the two lists, regardless of which cue had been presented before. Half of the participants were asked to recall List 1 first, and half to recall List 2 first. Participants had 2 minutes per list, but were given extra time when needed. The order of the cue conditions was counterbalanced across participants, as was the assignment of lists to CUE (remember or forget) and list position (List 1 or List 2). After a 5-minute break the second block was carried out. With the exception of CUE condition (remember or forget) and two new lists, this second block was identical to the first block of the experiment (for a similar procedure, see Zellner & Bäuml, 2006). Following prior work (Kimball & Bjork, 2002), we only report recall results for the first-tested list in each CUE condition, thus controlling for possible testing order effects.

### *Working memory task*

After the DF experiment, participants' WMC was assessed with a German version of the operation span task (OSPAN; Turner & Engle, 1989). The OSPAN task required participants to solve arithmetic equations while trying to remember unrelated words. Each trial consisted of a certain number (varying between two and six) of successively presented equation/word pairs—e.g., $(8{:}4) + 3 = 5$? *horse*. Participants had to read each equation aloud, to verify whether it was correct by saying "yes" or "no", and to read the to-be-remembered word (*horse*) aloud. The task was experimenter paced, i.e., participants were asked to respond quickly and, immediately following the response, the next equation/word pair was presented. Following the last equation/word pair, participants were asked to recall the to-be-remembered words in correct order. There were three repetitions of each set size (2–6), leading to a maximum OSPAN score of 60. The span score was defined as the number of recalled words on correct sets. A set was counted as correct if all the presented words from that set were recalled in correct order (see Conway et al., 2005, for a review of scoring methods).

## Results and discussion

Paired *t*-tests revealed that the forget cue impaired recall of List 1 from 33.8% ($SD = 13.8\%$) in the remember condition to 24.9% ($SD = 13.9\%$) in the forget condition, $t(71) = 4.9$, $SE = 0.018$, $p < .001$, $d = 0.65$, and improved recall of List 2 from 29.1% ($SD = 14.6\%$) in the remember condition to 38.7% ($SD = 14.7\%$) in the forget condition, $t(71) = 5.4$, $SE = 0.018$, $p < .001$, $d = 0.65$. Regarding WMC, participants had a mean OSPAN score of 25.9 ($SD = 12.4$, range 2–56).

To examine the relationship between WMC and DF, individual List-1 forgetting and individual List-2 enhancement scores were regressed separately on the individual WMC score. The resulting scatterplots together with the best-fitting linear regression lines are shown in Figure 1a. The resulting best-fitting regression lines had positive slopes that differed significantly from zero, indicating that both List-1 forgetting and List-2 enhancement increased reliably with increasing WMC. The relevant statistics and regression coefficients are summarised in Table 1.

The results show that WMC predicts DF performance in young adults. Specifically, individuals scoring high on a measure of WMC showed higher amounts of both List-1 forgetting and List-2 enhancement than individuals scoring low on the same measure. The results regarding List 1 thus replicate previous work that found an effect of WMC on List-1 forgetting (Delaney & Sahakyan, 2007), and the results regarding List 2 replicate previous work that found an effect of WMC on List-2 enhancement (Soriano & Bajo, 2007). Going beyond the prior work, our results indicate that, if testing order is controlled and the two DF effects are measured uncontaminated by previous recall of the interfering list, WMC predicts List-1 forgetting and List-2 enhancement.

## EXPERIMENT 2

The goal of Experiment 2 was to investigate whether WMC predicts DF in individuals other than young adults and, in particular, whether WMC can account for differences in DF performance within and between groups of individuals. To achieve this goal we examined two groups of individuals known to differ largely in their DF performance, i.e., younger and older elementary school children. While older elementary school children, such as fourth or fifth graders, typically show efficient (adult-like) DF, younger elementary school children, such as first or second graders, often show no effect of the forget cue at all (Harnishfeger & Pope, 1996; Zellner & Bäuml, 2004; for a review, see Wilson & Kipp, 1998). Given that WMC is also reduced in

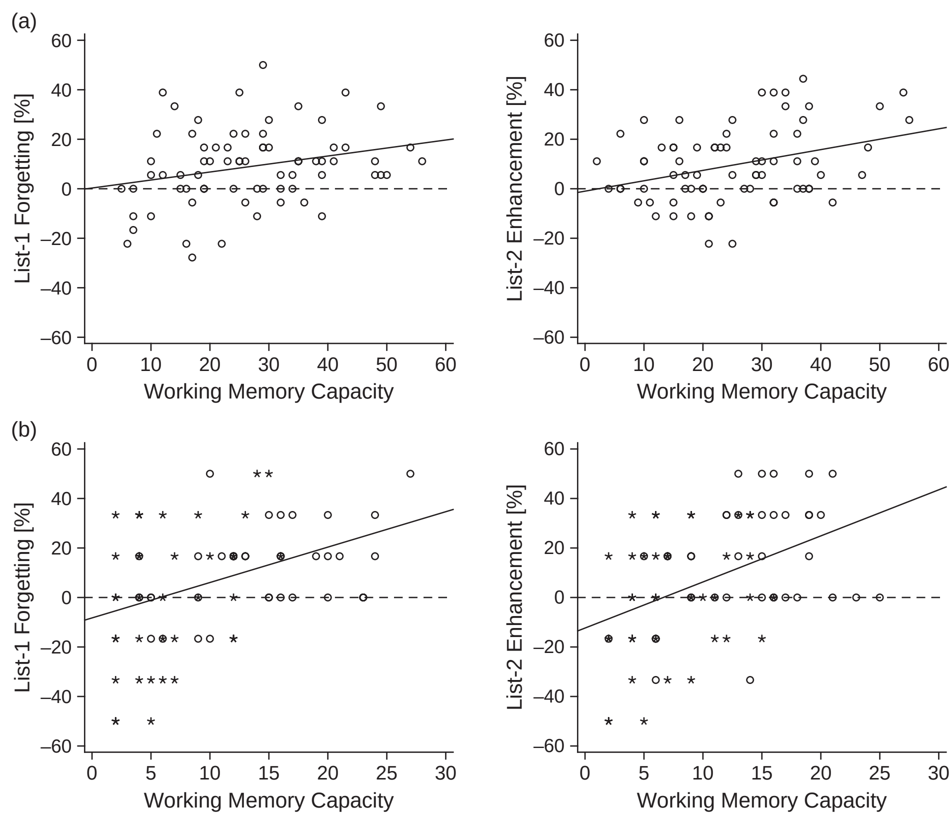


**Figure 1.** (a) Data from Experiment 1. Young adults' individual List-1 forgetting (left panel) and individual List-2 enhancement (right panel) as a function of their working memory capacity. The solid lines represent the best-fitting linear regression lines. The dashed lines represent the zero baselines. (b) Data from Experiment 2. Children's individual List-1 forgetting (left panel) and individual List-2 enhancement (right panel) as a function of their working memory capacity. Circles depict data from fourth-grade children; stars depict data from first-grade children. The solid lines represent the best-fitting linear regression lines. The dashed lines represent the zero baselines.

**TABLE 1**
List-1 forgetting and List-2 enhancement regressed on adults' (Experiment 1) and children's (Experiment 2) individual working memory capacity.

| | *df* | *F* | *p* | $R^2$ | Intercept *(a)* | Slope *(b)* |
|---|---|---|---|---|---|---|
| *Experiment 1* | | | | | | |
| List-1 Forgetting | (1,70) | 5.2 | .025 | .07 | 0.3 | 0.3 |
| List-2 Enhancement | (1,70) | 9.2 | .003 | .12 | −1.00 | 0.4 |
| *Experiment 2* | | | | | | |
| List-1 Forgetting | | | | | | |
| *First Graders* | (1,38) | 6.2 | .017 | .14 | −14.82 | 2.5 |
| *Fourth Graders* | (1,38) | 6.9 | .013 | .15 | −2.71 | 1.0 |
| *Overall* | (1,78) | 15.2 | .000 | .16 | −8.31 | 1.4 |
| List-2 Enhancement | | | | | | |
| *First Graders* | (1,38) | 4.2 | .047 | .10 | −14.01 | 1.9 |
| *Fourth Graders* | (1,38) | 5.9 | .020 | .14 | −6.21 | 1.5 |
| *Overall* | (1,78) | 18.0 | .000 | .19 | −12.41 | 1.9 |

Note: List-1 Forgetting = List-1 remember - List-1 forget, List-2 Enhancement = List-2 forget - List-2 remember



younger children, as compared to older children and adults, and shows remarkable progress over the elementary school years (Case, Kurland, & Goldberg, 1982; Siegel, 1994), a connection may exist between the development of DF and the development of WMC. To date, no study has yet examined the role of WMC in children's DF.

## Method

### *Participants*

A total of 80 first graders ($M = 6.7$, $SD = 0.45$ years) and 80 fourth graders ($M = 9.7$, $SD = 0.62$ years) took part in the experiment. They were recruited from two elementary schools in Regensburg, Germany. They participated on a voluntary basis and were tested individually.

### *Directed-forgetting task*

*Materials.* A total of 24 items were selected from German association norms for children (Hasselhorn & Grube, 1994). Two pairs of lists were constructed, each pair consisting of items associated to a common semantic category (*animals or clothes*). To facilitate list discrimination, a pair's two lists were selected such that each list contained six associates to a non-presented theme word (for *animals*: associates to *horse* and *owl*; for *clothes*: associates to *coat* and *boots*; see Zellner & Bäuml, 2005). The items of the four lists were spoken at a 2-second rate onto different CDs by a femaleperson.

*Design and procedure.* The design of the DF experiment was identical to Experiment 1 except that AGE GROUP (first graders vs fourth graders) was included as a between-participants factor. To make the task more suitable for children we followed Zellner and Bäuml (2005) and changed some features of the procedure. Depending on category, children were told a cover story about the content of the list. For the category *animals*, for instance, the story was: "Yesterday, Susanne visited her grandfather's farm. Thereafter, she recorded all the *animals* she had seen on the farm onto CDs. Please listen to Susanne's CDs now and try to remember all the *animals* that Susanne mentions." After presentation of the first CD, the interlist cue was provided. In the remember condition the children were told that the remainder of what Susanne had experienced would be presented on another CD and that all *animals* from both CDs should be remembered. In the forget condition the children were told that they should forget the so-far-heard *animals* because they were only imagined by Susanne, and did not really exist on her grandfather's farm. Rather, they should concentrate on the upcoming list on another CD, because this would be Susanne's true report. Following the presentation of the second CD, an irrelevant trail-making task was carried out for 2 minutes. Then the children were asked to successively recall the two lists' items, irrespective of whether the items had previously been declared as true or imagined. They had 1 minute per list, but were given extra time when needed. The verbal responses were noted by the experimenter.

### *Working memory yask*

After the DF experiment children's WMC was assessed with a German version of the listening-span completion task (LSPAN; Siegel & Ryan, 1989). Each trial consisted of a certain number (varying between two and five) of successively presented sentences in each of which the last word was omitted (e.g., the farmer is milking the . . .). The instruction was to complete each sentence with the missing word (cow), and to keep these words in mind for an upcoming test. As in Experiment 1, the task was experimenter-paced. Following the last sentence children were asked to recall the to-be-remembered words in correct order. Each set size was given three times, leading to a maximum LSPAN score of 42. The span score was calculated in the same way as in Experiment 1.

## Results and discussion

Regarding List-1 performance, first graders' recall was 31.7% ($SD = 19.9\%$) in the remember condition and 30.4% ($SD = 22.3\%$) in the forget condition; fourth graders' recall was 52.5% ($SD = 17.5\%$) in the remember condition and 40.8% ($SD = 16.4\%$) in the forget condition. A $2 \times 2$ analysis of variance with the between-participants factor of AGE GROUP (first graders vs fourth graders) and the within-participants factor of CUE (remember vs forget) revealed significant main effects of AGE GROUP, $F(1, 78) = 20.7$, $MSE = 0.047$, $p < .001$, $\eta_p^2 = .21$, and CUE, $F(1, 78) = 6.4$, $MSE = 0.026$, $p = .01$, $\eta_p^2 = .08$. These main effects reflect higher List-1 recall in the fourth graders than the first graders, and reduced List-1 recall in the forget condition compared to the remember condition. Importantly, there was a significant interaction between the two factors, $F(1, 78) = 4.1$, $MSE = 0.026$, $p < .05$, $\eta_p^2 = .05$, reflecting the fact that reliable List-1 forgetting was present only in the fourth graders (11.7%; $p < .001$), but not the first graders (1.3%; $p > .70$).

Regarding List-2 performance, first graders recalled 37.9% ($SD = 20.7\%$) in the remember condition and 38.3% ($SD = 20.7\%$) in the forget condition; fourth graders recalled 48.3% ($SD = 16.4\%$) in the remember condition and 63.3% ($SD = 19.7\%$) in the forget condition. A $2 \times 2$ analysis of variance revealed significant main effects AGE GROUP, $F(1, 78) = 26.5$, $MSE = 0.047$, $p < .001$, $\eta_p^2 = .25$, and CUE, $F(1, 78) = 8.4$, $MSE = 0.028$, $p < .01$, $\eta_p^2 = .10$. These main effects reflect higher List-2 recall in the fourth graders than the first graders, and higher List-2 recall in the forget condition compared to the remember condition. There was again a significant interaction between the two factors, $F(1, 78) = 7.5$, $MSE = 0.028$, $p < .01$, $\eta_p^2 = .09$, reflecting the fact that reliable List-2 enhancement was present only in the fourth graders (15.0%; $p < .001$), but not the first graders (0.4%; $p > .90$).

Regarding WMC, an independent $t$-test revealed that LSPAN scores were significantly higher in the fourth graders ($M = 14.0$, $SD = 5.9$, range 2–27) than the first graders ($M = 7.1$, $SD = 4.2$, range 2–16), $t(158) = 8.6$, $SE = 0.807$, $p < .001$, $d = 1.36$. Analysing the two age groups' data separately, we examined the relationship between children's WMC and DF by regressing children's individual List-1 forgetting and List-2 enhancement scores in each age group on the individual WMC score. The resulting best-fitting regression lines had positive slopes that differed significantly from zero, indicating that, in both first and fourth graders, List-1 forgetting and List-2 enhancement increased reliably with increasing WMC (see Table 1, for supporting statistics and regression coefficients).

Finally, to examine whether WMC can account for individual differences between groups of individuals, we analysed first and fourth graders' data simultaneously, and regressed (all) children's individual List-1 forgetting and List-2 enhancement scores on the individual WMC score (see Figure 1b). Mimicking the results from the separate analyses, the resulting best-fitting regression lines had positive slopes that differed significantly from zero, indicating that both List-1 forgetting and List-2 enhancement increased reliably with increasing WMC (see Table 1). In particular, entering an AGE GROUP and an AGE GROUP $\times$ WMC interaction term into the regression model did not explain more variance than the initial model with WMC as the only variable, (List-1 forgetting: $\Delta R^2 = .024$, $p > .30$; List-2 enhancement: $\Delta R^2 = .006$, $p > .70$), indicating that WMC alone can account for the age-related differences observed in the data.[2,3]

[2] In both experiments we analysed whether WMC also affected DF performance for second-tested lists. For both List-1 forgetting and List-2 enhancement, no reliable effect of WMC on DF arose, indicating that the effects of WMC on DF are restricted to first-tested lists.

[3] In both experiments we also regressed individuals' List-1 and List-2 recall scores (rather than their difference scores) on the individual WMC score. For all three participant groups, List-1 recall in the remember, but not the forget, condition increased with increasing WMC; and List-2 recall in the forget, but not the remember, condition increased with increasing WMC.

Consistent with prior work we found relatively high WMC and efficient DF in fourth graders, and relatively low WMC and no DF in first graders (Harnishfeger & Pope, 1996; Siegel, 1994). Going beyond the prior work, we found that children's WMC predicted their DF efficiency, both within and between the two age groups. Specifically, children scoring high on a measure of WMC showed more efficient DF than children scoring low on the same measure. Importantly, we found an effect of WMC on both List-1 forgetting and List-2 enhancement, thus replicating the finding of Experiment 1, and extending it to younger and older elementary school children.

## GENERAL DISCUSSION

Previous individual-differences work suggests a close link between WMC and the efficiency of inhibitory processes, with high-WMC individuals being better able to deal with interference and inhibit task-irrelevant information than low-WMC individuals (for a review, see Redick, Heitz, & Engle, 2007). In the present study we examined the role of WMC in listwise DF, a task supposed to measure an individual's ability to enhance memory for "relevant" (List-2) information by intentionally inhibiting interfering "irrelevant" (List-1) information. In Experiment 1 we found a positive relationship between WMC and each of the two DF effects in young adults. In Experiment 2 we replicated the finding with a sample of first and a sample of fourth graders, and showed that WMC can account for individual differences in children's DF, both within and between single age groups. These findings are consistent with both previous individual-differences research and the inhibitory view of DF.

The present results bridge the gap between two recent studies that also examined the role of WMC in DF. Testing List-1 items always before List-2 items, Delaney and Sahakyan (2007) found a positive relationship between WMC and List-1 forgetting but no relationship between WMC and List-2 enhancement; testing both lists simultaneously, and thus presumably inducing a bias towards early recall of List-2 items (Geiselman et al., 1983), Soriano and Bajo (2007) suggested a positive relationship between WMC and List-2 enhancement but no relationship between WMC and List-1 forgetting. Here, we followed Kimball and Bjork (2002) and counterbalanced testing order of the two lists across participants, scoring only the first-tested list in each cue condition. In doing so we resolved the inconsistency between the two previous studies, demonstrating that, with "pure" measures of List-1 and List-2 recall, WMC predicts both List-1 forgetting and List-2 enhancement.

The results of Experiment 2 complement previous developmental research on DF and WMC. This research demonstrated that both DF and WMC show remarkable developmental progress over the elementary school years (Case et al., 1982; Harnishfeger & Pope, 1996; Siegel, 1994; Zellner & Bäuml, 2004). Reporting relatively high WMC and efficient DF in fourth graders, and lower WMC and reduced DF in first graders, the present results thus replicate the previous developmental work. Going beyond the previous work, however, our results additionally show that individual differences in children's WMC can account for differences in children's DF, both within and between single age groups. These findings suggest that WMC is a major determinant of developmental changes in children's DF efficiency. This holds while factors other than WMC, such as, for example, individuals' metacognitive capability, may play a role in (the development of) DF as well (e.g., Hasselhorn & Richter, 2002).

The present results agree with previous findings from clinical research. This research reported reduced DF effects in certain clinical populations, like patients with frontal (but not temporal) lesions (Conway & Fthenaki, 2003), schizophrenia patients (Racsmány et al., 2008), and patients with attention-deficit/hyperactivity disorder (White & Marks, 2004). Because patients suffering from these disorders have also been associated with deficits in WMC (Curtis & D'Esposito, 2003; Lee & Park, 2005; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), the finding of inefficient DF in these groups of (low-WMC) individuals fits well with the present indication that WMC plays a crucial role for successful DF.

There is current debate in the literature about whether the two DF effects are mediated by a common (inhibitory) mechanism, or are caused by two different mechanisms. The latter view has been motivated by a number of dissociations that have recently been reported between List-1 forgetting and List-2 enhancement (e.g., Bäuml, Hanslmayr, Pastötter, & Klimesch, 2008; Pastötter & Bäuml, 2010; Sahakyan & Delaney, 2003, 2005), suggesting that List-1 forgetting is caused by a retrieval-based mechanism—such as inhibition (Bäuml et al., 2008) or an internal context change (Sahakyan & Delaney, 2003)—but List-2 enhancement is caused by an encoding-based mechanism—such as a change in people's encoding strategy (Sahakyan & Delaney, 2003) or a reset of encoding processes (Pastötter & Bäuml, 2010). Following such two-mechanism accounts, the present results indicate that both the retrieval-based and the encoding-based mechanism(s) depend on WMC, and that both mechanisms function more efficiently in individuals with high WMC than individuals with low WMC. However, because we found effects of WMC on both List-1 forgetting and List-2 enhancement, our results are basically consistent with one-mechanism accounts of DF as well.

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