Research Article

No Inhibitory Deficit in Older Adults' Episodic Memory

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ABSTRACT—*Selectively retrieving a subset of previously studied material can cause forgetting of the unpracticed material. Such retrieval-induced forgetting is attributed to an inhibitory mechanism recruited to resolve interference among competing items. According to the inhibition-deficit hypothesis, older people experience a specific decline in inhibitory function and thus should show reduced retrieval-induced forgetting. However, the results of the two experiments reported here show the same amount of retrieval-induced forgetting in younger and older adults. These results indicate that retrieval inhibition is intact in older adults' episodic recall. The findings suggest that the common view of a general inhibitory deficit in older adults needs to be updated and that older adults show intact inhibition in some cognitive tasks and deficient inhibition in others.*

Observations from both daily life and experimental situations indicate that as adults age, they experience more cognitive failures. Older people may perseverate on already-produced passages during discourse, may show increased rates of irrelevant intrusions, and may have trouble selectively attending to some information while ignoring other information (e.g., Hasher, Stoltzfus, Zacks, & Rypma, 1991; McDowd & Craik, 1988). Particularly salient are deficits in older adults' memory performance. Such deficits arise in older adults' working memory (e.g., Hasher, Quig, & May, 1997; Verhaeghen, Kliegl, & Mayr, 1997), but they are also present in older adults' episodic memory when an event is to be recalled with respect to its encoded spatiotemporal context (for reviews, see N.D. Anderson & Craik, 2000, and Balota, Dolan, & Duchek, 2000).

A particularly prominent theory that has been offered to explain reduced cognitive performance in older adults is the inhibition-deficit account (Hasher & Zacks, 1988). According to this account, older adults show difficulties in preventing irrelevant information from coming to mind or in suppressing no-longer-relevant information that has already entered working memory. As a result, cognitive deficits may arise because irrelevant material occupies resources that otherwise would be available for the processing of task-relevant information. Studies supporting this hypothesis have shown that older adults perform poorly in a number of inhibition tasks (for a review, see Hasher, Zacks, & May, 1999; for critiques of this view, see Burke, 1997, and McDowd, 1997).

Although the inhibition-deficit account has received support in several cognitive areas, its exact status in episodic memory has yet to be investigated. The present study addressed this issue by examining older adults' inhibitory capabilities using a paradigm that has been suggested to be particularly well suited to explore inhibitory mechanisms in episodic memory: the retrieval-practice paradigm (M.C. Anderson, Bjork, & Bjork, 1994). In this paradigm, participants first study a list of category-exemplar pairs (e.g., *fruit-apple*, *fruit-banana*, *drink-vodka*) and are then given category-plus-stem cues to practice retrieval on half of the exemplars from half of the categories (e.g., *fruit-ap___*). Relative to the unpracticed items from the unpracticed categories (*vodka*)—which serve as a baseline—practiced items (*apple*) later show improved recall and, more important, unpracticed items (*banana*) show impaired recall. The forgetting of the unpracticed material is referred to as retrieval-induced forgetting and is generally attributed to inhibition. The inhibition account assumes that the not-to-be-retrieved items interfere during retrieval practice and are inhibited so as to reduce interference and facilitate retrieval of the target (for a review, see M.C. Anderson, 2003; for a recent noninhibitory account, see Perfect et al., 2004).

A critical feature of the inhibition view is that it attributes the forgetting to active suppression of an item's representation itself rather than to changes in the item's associative structure. As a consequence, access to an inhibited item should be impaired irrespective of the retrieval cue and memory test used to probe the item. Consistently, retrieval-induced forgetting has been found not only in free recall, but also in word-stem completion,

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recognition, and implicit tests (M.C. Anderson et al., 1994; Hicks & Starns, 2004; Veling & van Knippenberg, 2004). Further, studies using the independent-probe procedure have shown retrieval-induced forgetting to be cue independent, that is, to generalize to cues other than those used at study or retrieval practice (M.C. Anderson & Spellman, 1995; Saunders & MacLeod, 2006). Accordingly, retrieval practice of *fruit-apple* induces forgetting of *banana* not only when *banana* is tested with the same cue as was used at study and retrieval practice (*fruit*), but also when it is probed with a new, independent cue (e.g., *monkey*). This property of cue independence is taken as strong support for the view that retrieval-induced forgetting is caused by inhibition (M.C. Anderson, 2003).

Despite the obvious relevance of this paradigm for studying inhibitory processes in episodic memory, to date there are just three published studies of retrieval-induced forgetting in older adults. In the first study, Koutstaal, Schacter, Johnson, and Galluccio (1999, Experiment 1) used a nonstandard variant of retrieval-induced forgetting, examining the effect of selectively reviewing photographs of a subset of previously learned events. For both younger and older adults, postevent review improved recall of the reviewed material but impaired recall of the nonreviewed events, relative to a no-review-at-all baseline. In a previous study using the same review procedure, however, Koutstaal, Schacter, Johnson, Angell, and Gross (1998) had failed to find the detrimental effect, in both younger and older adults.

Moulin et al. (2002) employed the standard retrieval-practice procedure and reported significant retrieval-induced forgetting in both healthy older adults and Alzheimer's patients. Unfortunately, because Moulin et al. did not address the question of age-related changes in inhibitory function, the study did not include younger adults as a control group. Thus, the results cannot speak to the issue of whether older adults show less inhibition than younger adults. Moreover, the forgetting in this study may not have been caused by inhibition. Because the items were tested with the same cue as was used at retrieval practice, arguably, the (stronger) practiced items may have come to mind persistently at test and, in this way, have blocked access to the (weaker) unpracticed items (Rundus, 1973). Although such a blocking account of retrieval-induced forgetting has been challenged by numerous findings in younger adults (M.C. Anderson, Bjork, & Bjork, 2000; M.C. Anderson & Spellman, 1995; Bäuml, 2002; Ciranni & Shimamura, 1999), discarding blocking as a possible mechanism of older adults' retrieval-induced forgetting might be premature. Indeed, the finding that older adults show an increased tendency to perseverate on strong, but no-longer-relevant information (Raz, 2000; Ridderinkhof, Span, & van der Molen, 2002) raises the possibility that the forgetting in this study was caused by blocking rather than inhibition.

To clarify the issue of whether older adults show efficient retrieval-induced inhibition, we report the results of two experiments. In Experiment 1, we examined the effects of retrieval practice in older adults using a standard category-cued recall test and included younger adults as a control. In Experiment 2, we compared the two age groups' retrieval-induced forgetting using independent probes as retrieval cues. This test would more clearly indicate that any observed forgetting in older adults was due to inhibition and was not the result of blocking effects at test.

EXPERIMENT 1

In Experiment 1, we examined the effects of retrieval practice in younger and older adults using a standard category-cued recall test. We expected to replicate the results of Moulin et al. (2002), that is, to find significant retrieval-induced forgetting in older adults. Going beyond this previous work, we included a younger control group to examine whether older adults' retrieval-induced forgetting differs from that of younger adults. An inhibitory deficit in older adults would be indicated if, compared with the young adults, the older adults showed significantly less retrieval-induced forgetting, or no forgetting at all.

Method

Subjects

Twenty-four younger and 24 older adults participated in the experiment. The younger participants were students at Regensburg University, Germany, and had a mean age of 22.5 years (range: 18–31 years). The older participants were residents of Regensburg and had a mean age of 66.4 years (range: 60–79 years). Both age groups had 15.1 years of formal education on average. All participants were administered the digit span and vocabulary tests of the German version of the Wechsler Adult Intelligence Scale–Revised (WAIS-R; Tewes, 1991). In the digit span test, the younger adults scored slightly higher than the older adults (16.2 vs. 14.8), $t(46) = 1.4$, $p_{rep} = .84$, $d = 0.41$. In the vocabulary test, the two groups achieved the same score (23.5).

Materials

The study list contained six exemplars of each of six categories (Mannhaupt, 1983; Scheithe & Bäuml, 1995). Because previous work had provided evidence that categories' high-frequency exemplars may be more susceptible to retrieval-induced forgetting than categories' low-frequency exemplars (M.C. Anderson et al., 1994; Bäuml, 1998), for each selected category the three exemplars with the highest word frequency were used as the target items (mean rank order of 14.8) and the three exemplars with the lowest word frequency were used as the nontarget items (mean rank order of 25.5). Within a category, each item had a unique word stem.

Design

The experiment had a mixed design, with the within-participants factor of item type and the between-participants factor of

age. All participants went through three main phases: a study phase, a test phase, and an intermediate retrieval-practice phase, in which the nontargets from half of the categories were practiced. Retrieval practice created four types of items. The practiced nontargets and the (unpracticed) targets from the practiced categories constituted the practiced (P+) and unpracticed (P−) items. The unpracticed nontargets and the (unpracticed) targets from the unpracticed categories served as control items for the P+ and P− items, respectively, and are referred to as C+ and C− items. Accordingly, the beneficial effect of retrieval practice is defined as the difference between P+ and C+ recall, whereas retrieval-induced forgetting is defined as the difference between P− and C− recall. Across participants, all nontargets served equally often as P+ and C+ items, and all targets served equally often as P− and C− items.

Procedure

Study Phase. The items on the study list were presented successively on index cards, at a 5-s rate. Each item was shown together with its category cue (e.g., *fruit-apple*). The order of presentation was randomized within six blocks. Each block included one randomly selected exemplar from each of the six categories, with the restriction that a block's last item never belonged to the same category as the next block's first item; the resulting sequence was presented to one half of the participants, and the other half saw the same sequence in reversed order. Following the last item of the study list, participants engaged in a 30-s backward-counting task as a recency control.

Retrieval-Practice Phase. A category-cued word-stem completion test was administered in this phase. Participants were successively presented the word stems of nine nontarget items (three items from each of three categories); each stem was printed on an index card with its category cue (e.g., *fruit-ap___*). For each card, participants were given 5 s to recall the corresponding item from the study list. The verbal responses were noted by the experimenter. The order of the word stems was random, with the restriction that no two items from the same category were practiced in succession. Two such practice cycles were completed, with no delay between the cycles. Following the last item of the second cycle, a second distractor task was performed for 60 s.

Test Phase. In this phase, recall for all items was tested. Each category name was presented for 40 s, and participants were asked to recall as many of that category's studied exemplars as possible. Again, the verbal responses were noted by the experimenter. The order of the categories was counterbalanced such that the mean position of practiced and unpracticed categories was equal across participants.

Results

In the retrieval-practice phase, younger adults completed 86.6% of the word stems, and older adults completed 85.7%, $t(46) < 1$.

The results of the final category-cued recall test are depicted in the upper half of Table 1. Addressing the detrimental effect of retrieval practice, a 2 × 2 analysis of variance with the between-participants factor of age group (younger or older adults) and the within-participants factor of item type (P− or C− items) showed a significant main effect of age, $F(1, 46) = 13.1$, $p_{rep} > .99$, $\eta^2 = .22$, and a significant main effect of item type, $F(1, 46) = 11.8$, $p_{rep} > .98$, $\eta^2 = .21$. These main effects reflect the higher overall recall of the younger adults and the existence of retrieval-induced forgetting. The interaction between the two factors was not significant, $F(1, 46) < 1$, indicating that the amount of retrieval-induced forgetting was the same in the two participant groups.

Addressing the beneficial effect of retrieval practice, an additional 2 × 2 analysis of variance with the factors of age (younger or older adults) and item type (P+ or C+ items) revealed main effects of age, $F(1, 46) = 14.4$, $p_{rep} > .99$, $\eta^2 = .24$, and item type, $F(1, 46) = 56.9$, $p_{rep} > .99$, $\eta^2 = .55$. These main effects reflect the higher overall recall of the younger adults and show a beneficial effect of retrieval practice on the practiced

TABLE 1

Mean Percentage of Correctly Recalled Items as a Function of Age and Item Type

Experiment and age group	Item type				Retrieval-induced forgetting
	P+	C+	P−	C−	
Experiment 1					
Younger adults	79.6 (3.4)	58.8 (3.9)	56.0 (4.9)	65.3 (4.0)	9.3 (3.7)
Older adults	65.7 (4.1)	40.7 (3.3)	36.6 (4.2)	48.6 (3.4)	12.0 (5.0)
Experiment 2					
Younger adults			64.4 (2.5)	72.2 (2.6)	7.8 (3.2)
Older adults			49.1 (2.9)	55.9 (3.1)	6.9 (2.9)

Note. Standard errors are given in parentheses. P+ and C+ are the practiced nontargets from the practiced categories and the unpracticed nontargets from the unpracticed categories, respectively (i.e., the retrieval-practiced items and their controls); P− and C− are the (unpracticed) targets from the practiced categories and the unpracticed targets from the unpracticed categories, respectively (i.e., the non-retrieval-practiced items and their controls). Nontarget items (P+ and C+) were not tested in Experiment 2. Retrieval-induced forgetting was calculated as the difference between C− and P− recall.

items themselves. The interaction between age and item type was not significant, $F(1, 46) < 1$.

Discussion

Using the standard retrieval-practice procedure and a category-cued recall test, the present experiment replicated prior work by showing significant retrieval-induced forgetting in older adults. Extending prior work, the results additionally show that the amount of retrieval-induced forgetting in older adults does not differ from the amount in younger adults. This finding suggests that the retrieval inhibition mediating retrieval-induced forgetting is intact in older adults. However, because we tested items with the same category cue as was used at study and retrieval practice, in principle, the observed forgetting in older adults may have been caused by blocking rather than inhibition. This possibility arises because older adults are well known to show an increased tendency to perseverate on strong, but no-longer-relevant information. Thus, the older adults' retrieval-induced forgetting might have been induced because perseveration on the (stronger) practiced items blocked access to the (weaker) unpracticed items. We addressed this possibility in Experiment 2.

EXPERIMENT 2

In Experiment 2, we examined the effects of retrieval practice in younger and older adults using the independent-probe procedure. Participants studied category-exemplar pairs and performed standard category-cued retrieval practice. Unlike in Experiment 1, however, at test, the unpracticed targets were probed with (independent) cues not used at study or retrieval practice. Arguably, the independent-probe procedure should provide a relatively pure measure of inhibition, as the use of independent cues should circumvent any blocking of unpracticed items arising from the practiced items. Thus, if blocking was responsible for the older adults' retrieval-induced forgetting in Experiment 1, then older adults would not be expected to exhibit forgetting in Experiment 2. If, however, inhibition, rather than blocking, was the mechanism mediating older adults' retrieval-induced forgetting in Experiment 1, then the same pattern of retrieval-induced forgetting in younger and older adults would be expected to arise again, suggesting that older adults show no inhibitory deficit in this type of task.

Method

Subjects

Forty younger and 40 older adults participated in the experiment. The younger participants were students at Regensburg University and had a mean age of 22.2 years (range: 20–33 years). The older participants were recruited from the community. Their mean age was 68.4 years (range: 60–82 years). The younger adults had 14.9 years of formal education on average, and the older adults had 13.1 years, $t(78) = 3.6$, $p_{rep} > .99$, $d = 0.80$. All participants were given the digit span subtest of the WAIS-R (Tewes, 1991) and a German vocabulary test (Mehrfach-Wortschatz-Intelligenztest; Lehrl, 1991) that measures adults' crystallized intelligence. The younger participants outperformed the older participants in the digit span test (17.8 vs. 13.9), $t(78) = 5.0$, $p_{rep} > .99$, $d = 1.12$, but there was no difference between the two age groups in the vocabulary test (31.8 vs. 31.7), $t(78) < 1$.[1]

Materials and Design

Four items were drawn from each of eight semantic categories (M.C. Anderson & Spellmann, 1995; Mannhaupt, 1983). Within a category, no two items began with the same letter. A category's items were divided into two subsets, the two target items and the two nontarget items. A category's two target items were selected such that each was (implicitly) related to another, independent cue. For instance, the item *grenade*, an exemplar of the category *weapon*, was also related to the independent cue *loud*; the item *lettuce*, an exemplar of the category *green*, was also related to the independent cue *vegetable*.[2] The independent cues were not presented at study or retrieval practice. In nearly all other aspects, the design of the experiment was identical to that of Experiment 1.

Procedure

Study Phase. Except for the difference in materials, the study phase was identical to that in Experiment 1.

Retrieval-Practice Phase. Except for the difference in materials, the retrieval-practice phase was identical to that in Experiment 1.

Test Phase. In this phase, recall for the target items only was tested. Items were tested successively, with the independent probe and the first two letters of each to-be-recalled item as retrieval cues (e.g., *loud-gr___*, given that *grenade* was studied under the category *weapons*). Participants were instructed to try to remember a previously studied word that fit each cue and were given 4 s per item. Across participants, the mean testing positions of target items from practiced categories and target items from unpracticed categories were equal.

Results and Discussion

Success rates in the retrieval-practice task were 95.3% in the younger adults and 93.1% in the older adults, $t(78) = 1.2$, $p_{rep} = .79$, $d = 0.26$.

The results of the final test are depicted in the bottom half of Table 1. A 2 × 2 analysis of variance with the between-partic-

[1] In both Experiment 1 and Experiment 2, the two age groups matched on vocabulary scores. This suggests that our older adults did not show very high cognitive functioning. Thus, a finding that the older adults showed the same amount of retrieval-induced inhibition as the younger adults would not be attributable to a highly selected, anomalous sample of older adults.

[2] English translations of the list items (originally in German) are available on request via e-mail to the authors.

ipants factor of age (younger or older adults) and the within-participants factor of item type (P− or C− items) revealed significant main effects of age, $F(1, 78) = 22.7$, $p_{rep} > .99$, $\eta^2 = .23$, and item type, $F(1, 78) = 11.5$, $p_{rep} > .99$, $\eta^2 = .13$. These main effects reflect the higher overall recall of the younger adults and the existence of retrieval-induced forgetting. The interaction between age and item type was not significant, $F(1, 78) < 1$, indicating that the amount of retrieval-induced forgetting was the same in the two participant groups.

Replicating prior work, we found retrieval-induced forgetting in younger adults when using the independent-probe method. More important, we found retrieval-induced forgetting in older adults as well. To our knowledge, this is the first demonstration of cue-independent retrieval-induced forgetting in older adults. Not only do older adults show retrieval inhibition in this type of task, but the fact that the amount of forgetting did not vary between the two age groups suggests that older adults also show no inhibitory deficit in this type of task.

Further Analyses

To increase statistical power for the critical Age × Item Type interaction, we also pooled the data from the two experiments. Across the two experiments, the younger adults recalled 61.2% of the P− items and 69.6% of the C− items (measure of forgetting = 8.4%), whereas the older adults recalled 44.4% of the P− items and 53.2% of the C− items (measure of forgetting = 8.8%). A 2 × 2 analysis of variance yielded a significant main effect of age, $F(1, 126) = 33.6$, $p_{rep} > .99$, $\eta^2 = .21$, and a significant main effect of item type, $F(1, 126) = 23.4$, $p_{rep} > .99$, $\eta^2 = .16$, but no interaction between these two factors, $F(1, 126) < 1$. These results mirror those from the separate analyses in Experiments 1 and 2.

We also conducted a power analysis to determine the probability with which an effect of a given size could be detected in the present data set. A review of the literature suggests that the typical detrimental effect found in studies on retrieval-induced forgetting is of a medium to large size according to Cohen's (1988) effect size conventions. Given a pooled sample size of 128 and an alpha level of .05, a medium-sized interaction effect (f^2) of 0.15 (cf. Cohen, 1988) could be detected with a probability of .99, and a large-sized interaction effect of 0.35 (cf. Cohen, 1988) could be detected with a probability of 1.0.[3]

GENERAL DISCUSSION

The aim of the present study was to examine whether older adults' retrieval-induced forgetting differs from that of younger adults. Because retrieval-induced forgetting is generally assumed to be mediated by retrieval inhibition (M.C. Anderson, 2003), addressing this issue can cast light on the question of whether inhibition in older adults' episodic recall is deficient. In both experiments, we found significant retrieval-induced forgetting in older adults' recall, thus replicating the results from prior work (Moulin et al., 2002). Extending this prior work, the results additionally revealed that the older adults showed the same amount of retrieval-induced forgetting as the younger adults, irrespective of whether the items were tested with the same category cue as was provided during retrieval practice (Experiment 1) or with a new, independent cue (Experiment 2). The results thus indicate that in older adults, retrieval-induced forgetting is mediated by an inhibitory mechanism, and that this mechanism does not decline in older age.

The results from the present study challenge the view that older adults show a general inhibitory deficit and instead indicate that they show intact retrieval inhibition in episodic recall. In this sense, the present results are in line with recent work on list-method directed forgetting. In list-method directed forgetting, participants are cued to intentionally forget a previously learned list before studying a second list (for a review, see MacLeod, 1998). Although previous work indicated reduced list-method directed forgetting in older adults (Zacks, Radvansky, & Hasher, 1996), two very recent studies failed to find age-related differences and, instead, reported the same amount of directed forgetting in younger and older adults (Sego, Golding, & Gottlob, 2006; Zellner & Bäuml, 2006). This latter finding indicates that the age equivalence in episodic inhibition supported by the present study also holds when conscious control is involved, as it supposedly is in directed forgetting (N.D. Anderson & Craik, 2000).

List-method directed forgetting is often explained in terms of purely episodic inhibition that leaves the semantic information of inhibited items largely unimpaired (e.g., Kimball & Bjork, 2002). In contrast, retrieval-induced forgetting is assumed to affect the semantic representation of inhibited items (e.g., M.C. Anderson, 2003). These views are supported by the fact that directed forgetting has been found mostly in free-recall tests, but has rarely been demonstrated in recognition or implicit tests (MacLeod, 1998), whereas retrieval-induced forgetting has been found over a wide range of memory tests, including recognition and implicit tests (M.C. Anderson, 2003). Thus, the recent findings of no age-related decline in list-method directed forgetting suggest that older adults show intact inhibition of episodic information. The present finding of no age-related decline in retrieval-induced forgetting extends this suggestion and indicates that older adults show intact inhibition of semantic information as well.

Retrieval inhibition in list-method directed forgetting and retrieval inhibition in retrieval-induced forgetting differ in young children. First and third graders fail to show directed forgetting, though normal directed-forgetting performance is present from fifth grade on (Harnishfeger & Pope, 1996). In contrast, first and second graders do show retrieval-induced forgetting and show about the same amount of forgetting as do

[3]For all power analyses, GPower software was used (Erdfelder, Faul, & Buchner, 1996).

fourth graders or younger adults (Zellner & Bäuml, 2005). Thus, whereas retrieval inhibition in retrieval-induced forgetting develops fairly early in life, retrieval inhibition in list-method directed forgetting develops relatively late. A corresponding developmental dissociation does not seem to hold in older age. Rather, the results of the present and previous studies indicate that the two types of retrieval inhibition, though they emerge at different ages, remain intact for most of the life span.

The present results challenge the inhibition-deficit account by indicating that older adults show intact retrieval inhibition in their episodic recall. However, there is evidence that older adults show deficient inhibition in other cognitive tasks (Hasher et al., 1999). Thus, it seems that the inhibitory deficit in older adults is not general, but rather is task dependent, such that older adults show intact inhibition in some tasks and deficient inhibition in others (see also Moulin et al., 2002). Specifying which inhibitory mechanisms remain intact with older age and which become deficient is a high priority for future research on older adults' inhibitory function.

Acknowledgments—This research was supported by a grant from the German Research Foundation (Deutsche Forschungsgemeinschaft) to Karl-Heinz Bäuml (Ba-1382/6). We thank F. Craik and one anonymous referee for their comments on a previous version of the manuscript.

REFERENCES

Anderson, M.C. (2003). Rethinking interference theory: Executive control and the mechanism of forgetting. *Journal of Memory and Language*, *49*, 415–445.

Anderson, M.C., Bjork, E.L., & Bjork, R.A. (2000). Retrieval-induced forgetting: Evidence for a recall-specific mechanism. *Psychonomic Bulletin & Review*, *7*, 522–530.

Anderson, M.C., Bjork, R.A., & Bjork, E.L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*, 1063–1087.

Anderson, M.C., & Spellman, B.A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review*, *102*, 68–100.

Anderson, N.D., & Craik, F.I.M. (2000). Memory in the aging brain. In E. Tulving & F.I.M. Craik (Eds.), *The Oxford handbook of memory* (pp. 411–425). Cambridge, England: Oxford University Press.

Balota, D.A., Dolan, P.O., & Duchek, J.M. (2000). Memory changes in healthy older adults. In E. Tulving & F.I.M. Craik (Eds.), *The Oxford handbook of memory* (pp. 395–410). Cambridge, England: Oxford University Press.

Bäuml, K.-H. (1998). Strong items get suppressed, weak items do not: The role of item strength in output interference. *Psychonomic Bulletin & Review*, *5*, 459–463.

Bäuml, K.-H. (2002). Semantic generation can cause episodic forgetting. *Psychological Science*, *13*, 357–361.

Burke, D.M. (1997). Language, aging, and inhibitory deficits: Evaluation of a theory. *Journal of Gerontology: Psychological Sciences*, *52B*, P254–P264.

Ciranni, M.A., & Shimamura, A.P. (1999). Retrieval-induced forgetting in episodic memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*, 1403–1414.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Erdfelder, E., Faul, F., & Buchner, A. (1996). G*Power: A general power analysis program. *Behavior Research Methods, Instruments, & Computers*, *28*, 1–11.

Harnishfeger, K.K., & Pope, R.S. (1996). Intending to forget: The development of cognitive inhibition in directed forgetting. *Journal of Experimental Child Psychology*, *62*, 292–315.

Hasher, L., Quig, M.B., & May, C.P. (1997). Inhibitory control over no-longer-relevant information: Adult age differences. *Memory & Cognition*, *25*, 286–295.

Hasher, L., Stoltzfus, E.R., Zacks, R.T., & Rypma, B. (1991). Age and inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 163–169.

Hasher, L., & Zacks, R.T. (1988). Working memory, comprehension, and aging: A review and a new view. In G.H. Bower (Ed.), *The psychology of learning and motivation, 22* (pp. 193–225). San Diego, CA: Academic Press.

Hasher, L., Zacks, R.T., & May, C.P. (1999). Inhibitory control, circadian arousal, and age. In D. Gopher & A. Koriat (Eds.), *Attention and performance XVII: Cognitive regulation of performance: Interaction of theory and application* (pp. 653–675). Cambridge, MA: MIT Press.

Hicks, J.L., & Starns, J.J. (2004). Retrieval-induced forgetting occurs in tests of item recognition. *Psychonomic Bulletin & Review*, *11*, 125–130.

Kimball, D.R., & Bjork, R.A. (2002). Influences of intentional and unintentional forgetting on false memories. *Journal of Experimental Psychology: General*, *131*, 116–130.

Koutstaal, W., Schacter, D.L., Johnson, M.K., Angell, K.E., & Gross, M.S. (1998). Post-event review in older and younger adults: Improving memory accessibility of complex everyday events. *Psychology and Aging*, *13*, 277–296.

Koutstaal, W., Schacter, D.L., Johnson, M.K., & Galluccio, L. (1999). Facilitation and impairment of event memory produced by photograph review. *Memory & Cognition*, *27*, 478–493.

Lehrl, S. (1991). *Mehrfachwahl-Wortschatz-Intelligenztest: MWT-A*. Balingen, Germany: Spitta.

MacLeod, C.M. (1998). Directed forgetting. In J.M. Golding & C.M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 1–57). Mahwah, NJ: Erlbaum.

Mannhaupt, H.-R. (1983). Produktionsnormen für verbale Reaktionen zu 40 geläufigen Kategorien. *Sprache & Kognition*, *2*, 264–278.

McDowd, J.M. (1997). Inhibition in attention and aging. *Journal of Gerontology: Psychological Sciences*, *52B*, P265–P273.

McDowd, J.M., & Craik, F.I.M. (1988). Effects of aging and task difficulty on divided attention performance. *Journal of Experimental Psychology: Human Perception and Performance*, *14*, 267–280.

Moulin, C.J.A., Perfect, T.J., Conway, M.A., North, A., Jones, R.W., & James, A.N. (2002). Retrieval-induced forgetting in Alzheimer's disease. *Neuropsychologia*, *40*, 862–867.

Perfect, T.J., Stark, L.-J., Tree, J.J., Moulin, C.J.A., Ahmed, L., & Hutter, R. (2004). Transfer appropriate forgetting: The cue-dependent nature of retrieval-induced forgetting. *Journal of Memory and Language*, *51*, 399–417.

Raz, N. (2000). Aging of the brain and its impact on cognitive performance: Integration of structural and functional findings. In

F.I.M. Craik & T.A. Salthouse (Eds.), *Handbook of aging and cognition* (2nd ed., pp. 1–90). Mahwah, NJ: Erlbaum.

Ridderinkhof, K.R., Span, M.M., & van der Molen, M.W. (2002). Perseverative behavior and adaptive control in older adults: Performance monitoring, rule induction, and set shifting. *Brain and Cognition*, *49*, 382–401.

Rundus, D. (1973). Negative effects of using list items as recall cues. *Journal of Verbal Learning and Verbal Behavior*, *12*, 43–50.

Saunders, J., & MacLeod, M.D. (2006). Can inhibition resolve retrieval competition through the control of spreading activation? *Memory & Cognition*, *34*, 307–322.

Scheithe, K., & Bäuml, K.-H. (1995). Deutschsprachige Normen für Vertreter von 48 Kategorien. *Sprache & Kognition*, *14*, 39–43.

Sego, S.A., Golding, J.M., & Gottlob, L.R. (2006). Directed forgetting in older adults using the item and list methods. *Aging, Neuropsychology, and Cognition*, *13*, 95–114.

Tewes, U. (1991). *Hamburg-Wechsler-Intelligenztest für Erwachsene, Revision 1991*. Bern, Switzerland: Huber.

Veling, H., & van Knippenberg, A. (2004). Remembering can cause inhibition: Retrieval-induced inhibition as cue-independent process. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*, 315–318.

Verhaeghen, P., Kliegl, R., & Mayr, U. (1997). Sequential and coordinative complexity in time-accuracy functions for mental arithmetic. *Psychology and Aging*, *12*, 555–564.

Zacks, R.T., Radvansky, G.A., & Hasher, L. (1996). Studies of directed forgetting in older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 143–156.

Zellner, M., & Bäuml, K.-H. (2005). Intact retrieval inhibition in children's episodic recall. *Memory & Cognition*, *33*, 396–404.

Zellner, M., & Bäuml, K.-H. (2006). Inhibitory deficits in older adults—list-method directed forgetting revisited. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *32*, 290–300.

(Received 12/22/05; Revision accepted 3/29/06;
Final materials received 4/7/06)