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BRIEF REPORT

Aging and the Memorial Consequences of Catching Contradictions With Prior Knowledge

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This experiment tested the possibility that older adults are less susceptible to semantic illusions because they are more likely to notice contradictions with stored knowledge. Older and young adults encoded stories containing factual inaccuracies; critically, half the participants were instructed to mark any errors they noticed. Older adults reproduced fewer story-errors on a later general knowledge test, but there were no age differences in marking errors during encoding. However, older adults were better able to recover and answer correctly after failing to notice errors during story-reading. Implications for false memories and semantic illusions are discussed.

Keywords: aging, suggestibility, error detection, knowledge, false memories

Even in healthy aging, there are declines in memory. Not only do older adults remember less about individual events in their lives, but some of what they recall is distorted. Across a variety of situations and to-be-remembered materials, older adults tend to make more memory errors than young adults. Whether being asked to remember a list of highly related words (the Deese-Roediger-McDermott paradigm; Norman & Schacter, 1997), famous names (Dywan & Jacoby, 1990), videos (Loftus, Levidow, & Duesing, 1993), or actions (Cohen & Faulkner, 1989), older adults are more suggestible.

Given this large literature showing that older adults tend to be more suggestible than young adults, it is important to understand when aging may *not* be associated with heightened suggestibility. One possibility involves whether age differences are reduced when the suggestions contradict general knowledge. Given that older adults have preserved semantic memories, even outscoring young adults on vocabulary and general knowledge measures (Craik, 2000; Light, 1991, 1992; Salthouse, 1991), they may be less likely to accept suggestions involving this type of knowledge. Prior work has shown that young adults are vulnerable to suggestion when exposed to errors about the world (Fazio & Marsh, 2008; Marsh & Fazio, 2006; Shafto & MacKay, 2000, 2010). For example, when answering distorted questions like, "How many animals of each kind did Moses take on the ark?", young adults often fail to notice the contradiction with demonstrated knowledge (previously showing that they knew it was *Noah* who took animals on the ark) and answer "two." They also later reproduce these contradictions when answering related general knowledge questions (answering "Who is said to have taken two animals of each kind on the ark?" with "Moses;" Bottoms, Eslick, & Marsh, 2010). Thus, young adults' prior knowledge does not protect them from acquiring semantic errors that they should be able to avoid.

We can find only one data-point that speaks to the susceptibility of older adults to such semantic illusions: Older adults are *less* likely to reproduce inaccuracies from fictional stories when answering later general knowledge questions (Marsh, Balota, & Roediger, 2005). In this study, young and older adults read stories containing both correct information like "Jupiter is the largest planet in our solar system," as well as errors such as "St. Petersburg is the capital of Russia." Later, they took a general knowledge test containing questions that could be answered with story facts. Young adults showed robust suggestibility, using story errors to answer the questions, whereas older adults were less likely to reproduce the misinformation. This reduced suggestibility in older adults was attributed to their well-documented episodic memory deficit (Craik & Jennings, 1992; Nebes, 1994), which likely reduced memory for the stories overall. Neuropsychological test data supported this hypothesis, with preserved episodic memory ability (measured with the Logical Memory and Associate Learning tests) predicting suggestibility. At least one other study supports the claim that age-related deficits in episodic memory may result in reduced memory for suggestion, as older adults were less able to later recognize postevent misinformation in an eyewitness memory paradigm (Mitchell, Johnson, & Mather, 2003). More generally, to the extent that older adults have poorer episodic memory for stories, questions, or other material containing factual inaccura-

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cies, they may be less likely to reproduce the semantic misinformation therein.

However, a second possibility is that older adults may be less vulnerable to semantic illusions than young adults because older adults are better able to catch errors that contradict their considerable general knowledge. Prior research shows that young adults are quite poor at noticing such contradictions (as described earlier), but when they do catch these errors, suggestibility is reduced (Eslick, Fazio, & Marsh, 2011; Marsh & Fazio, 2006). Older adults' preserved knowledge bases mean that they have the knowledge necessary to notice the errors, which could consequently reduce suggestibility. Previous work in attentional error detection tasks also demonstrates that older adults are often as adept at detecting errors as young adults, if not more so (e.g., MacKay, Abrams, & Pedroza, 1999). When identifying errors in rhythm synchronization of beat sequences (Turgeon, Wing, & Taylor, 2010) and correcting their mistakes in detecting particular digits on a screen (Rabbitt, 1979), older adults performed as well as young adults. Furthermore, in a visual change detection task (Madden et al., under revision) and on Sternberg-like memory search tasks (Strayer & Kramer, 1994), older adults outperformed young adults in monitoring for and correcting errors.

The present experiment tests the possibility that older adults may show reduced semantic illusions because they are better able to notice contradictions with preexisting general knowledge. Young and older adults read stories containing errors; we manipulated whether errors contradicted well-known versus more obscure facts as this should have consequences for error detection. The stories also contained neutral references to facts without naming them explicitly, allowing us to estimate prior knowledge (that must be used to answer the related final questions, since the stories did not furnish the answers). Critically, half the subjects were explicitly instructed to mark errors, so that we could evaluate older and young adults' ability to detect errors, with consequent differences in suggestibility on the final general knowledge test.

Method

Subjects

Seventy-nine Duke University undergraduates participated for course credit, and 50 older adults, recruited through Duke University's Center for Aging database, participated for monetary compensation. Older adults were at least 65 years of age.

Design

A 2 (Age: Young, Older Adult) × 2 (Instruction: Control, Detection) × 2 (Fact Knowledge: Well-Known, Obscure) × 3 (Fact Framing: Correct, Neutral, Misleading) mixed design was used. Age and instruction were between-subjects factors while fact knowledge and fact framing were manipulated within subjects.

Materials

Two fictional stories, previously used with older adults (Marsh et al., 2005), were adapted from Marsh (2004). Each was ~1,200 words and included characters, dialogue, and plot, as well as 18 references to facts from the Nelson and Narens (1980) norms. Half of these references corresponded to well-known facts: An average of 70% of Nelson and Narens' subjects correctly answered questions probing these facts. The others corresponded to obscure facts, with an average of 15% of Nelson and Narens' subjects answering related questions correctly. Within each story, one third of the facts were presented in a correct frame providing the correct fact, one third in a neutral frame making a general reference to the fact without naming it explicitly, and one third in a misleading frame making a plausible but incorrect reference. For example, for a given fact, one subject read, "paddling across the largest ocean, the Pacific," another simply read a reference to "paddling across the largest ocean," and the third read, "paddling across the largest ocean, the Atlantic." The facts were rotated through the frame types across subjects. The general knowledge test consisted of 36 critical and 36 filler questions.

Procedure

Participants were told that they would read and listen to two fictional stories, similar to a book-on-tape. The study was programmed using MediaLab and DirectRT experimental software (Jarvis, 2008a, 2008b). All participants received a general warning before hearing the stories, explaining that authors often take liberties with facts and that some information that they read and heard in the stories could be incorrect. One sentence at a time appeared on the screen accompanied by a voiceover. Control participants were simply instructed to press the "next" key when ready to move on. Participants in the detection condition were asked to press one of two keys to advance to the next sentence: One key indicated readiness to move on; the other key indicated that the just-read sentence contained a factual inaccuracy. Before starting, participants read several practice sentences, including one with an error. If the subject missed the error, the experimenter pointed it out at the end of the practice session.

Participants then encoded the two experimental stories. To ensure attentiveness, 10 catch trials were included on noncritical sentences where subjects were prompted to type what they just read and heard. Processing each story took about 15 min and was followed by a filler task. After solving visuospatial puzzles for 10 min, participants took the general knowledge test. They were asked not to guess and to type "I don't know" if they could not answer a question. Finally, the participants were debriefed and received a list of the corrected facts on which they were misled. To ensure processing of the corrected versions, participants rated how surprising each one was on a 3-point scale. The entire experiment took about 1 hr.

Results

All results, unless otherwise stated, were significant at the .05 α level. Pairwise comparisons were Bonferroni-corrected to the .05 level. A Geisser-Greenhouse correction was used for violations of the sphericity assumption of analysis of variance (ANOVA).

Error Detection During Story Reading

To see whether there were age differences in participants' ability to catch errors while reading, a 2 (Age) × 2 (Fact Knowledge) × 3 (Fact Framing) mixed ANOVA was computed on the proportion of critical sentences marked as containing errors. As shown in Table 1, partic-

Table 1
Proportion of Story Sentences Labeled as Containing Errors, as a Function of Age, Fact Knowledge, and Fact Framing

Fact knowledge	Fact framing		
	Correct	Neutral	Misleading
Older Adults			
Well-known	.09	.07	.52
Obscure	.23	.08	.47
M	.16	.08	.50
Young Adults			
Well-known	.14	.12	.41
Obscure	.32	.12	.44
M	.23	.12	.43

Note. The *SE* was .04 for older adults and .03 for young adults.

ipants caught some of the errors but missed more than half of them (54%). Participants discriminated factual inaccuracies from nonerrors, $F(2, 122) = 105.28$, $MSE = .04$, $\eta_p^2 = .63$, correctly pressing the error key more for sentences containing misinformation ($M = .46$) than they false alarmed to sentences containing correct facts [$M = .20$; $t(62) = 9.04$, $SEM = .03$] or neutral references [$M = .10$; $t(62) = 12.68$, $SEM = .03$]. Participants were more likely to press the error key when sentences referred to obscure facts, $F(1, 61) = 8.60$, $MSE = .03$, $\eta_p^2 = .12$. Critically, this was qualified by an interaction with fact framing, $F(2, 122) = 9.57$, $MSE = .28$, $\eta_p^2 = .14$: Participants were just as good at catching contradictions of obscure facts as contradictions of well-known ones (both *M*s = .46), but they were more likely to mistakenly press the error key for correct references to obscure facts ($M = .28$) than for correct references to well-known facts ($M = .11$), $t(62) = -4.58$, $SEM = .04$.

Of critical importance were any age differences in the ability to catch errors. Older and young adults pressed the error key equally often ($F < 1$), and did so most often when sentences actually contained misinformation. Although the interaction between age and fact-framing was significant, $F(2, 61) = 4.36$, $MSE = .04$, $\eta_p^2 = .07$, older and young adults were equally good at catching story errors, $t(61) = 1.17$, $SEM = .06$, $p = .25$. However, young adults were slightly more likely to false alarm to correct statements than were older adults, $t(61) = -1.82$, $SEM = .04$, $p = .07$, and this did not depend on whether the facts were obscure or well-known, $F < 1$.

Performance on the Final General Knowledge Test

The next two sections examine performance on the final general knowledge test; two 2 (Age) × 2 (Instruction) × 2 (Fact Knowledge) × 3 (Fact Framing) mixed ANOVAs were computed, one on the proportion of questions answered correctly and the second on the proportion answered with misinformation. However, because fact knowledge did *not* affect successful error detection or the critical conclusions about age, the results that follow collapse over fact knowledge for simplicity. The complete data are shown in Tables 2 and 3 for the interested reader.

Correct Answers on the Final General Knowledge Test

As expected, participants were affected by what they had read in the stories, as reflected in a main effect of fact framing, $F(2, 250) = 106.77$, $MSE = .02$, $\eta_p^2 = .46$. Participants answered more questions correctly after reading correct facts ($M = .64$) than after reading neutral references [$M = .43$; $t(128) = 12.45$, $SEM = .02$]. Importantly, reading misinformation dropped later performance ($M = .39$) below the neutral baseline, $t(128) = 2.63$, $SEM = .02$, indicating that exposure to story errors reduced participants' ability to correctly answer final questions to below the level of their preexisting knowledge. Critically, the interaction between fact framing and instruction was significant, $F(2, 250) = 4.78$, $MSE = .02$, $\eta_p^2 = .04$, reflecting that only control subjects were affected by misinformation; subjects who were asked to mark errors via keypress answered just as many questions correctly after reading misinformation as after reading neutral references, $t < 1$.

Most important was whether any of the effects of story reading differed across age groups. Reflecting their greater semantic knowledge, older adults answered more questions correctly than did young adults, $F(1, 125) = 27.95$, $MSE = .06$, $\eta_p^2 = .18$. Thus, it is crucial to consider the effects of story-reading in relation to each group's baseline prior knowledge, as reflected in the neutral condition where the stories did not provide any final test answers. Older and young adults showed similar costs from having read misinformation, both dropping 5% from their neutral baselines after reading misinformation. While participants benefited from

Table 2
Proportion of Correctly Answered Questions on the Final General Knowledge Test, as a Function of Age, Instruction, Fact Knowledge, and Fact Framing

	Control			Detect		
	Correct	Neutral	Misleading	Correct	Neutral	Misleading
Older Adults						
Well-known	.73	.63	.53	.83	.68	.68
Obscure	.53	.37	.27	.63	.39	.41
M	.63	.50	.40	.73	.54	.55
Young Adults						
Well-known	.79	.51	.34	.75	.52	.53
Obscure	.48	.18	.15	.36	.18	.18
M	.64	.35	.25	.56	.35	.36

Note. The *SE* was .04 for older adults and .03 for young adults.

reading correct answers in the stories (OA: $t(49) = 6.53$, $SEM = .02$; YA: $t(78) = 10.96$, $SEM = .02$), the interaction between age and fact framing was significant, $F(2, 250) = 4.04$, $MSE = .02$, $\eta_p^2 = .03$, showing that this benefit was greater in young adults than older adults.

To better understand how the detection instruction helped subjects avoid the costs of reading misinformation (as described above), we did an additional analysis linking success at error detection (while reading) to performance on corresponding general knowledge questions. This analysis was limited to subjects in the detection condition and items for which participants had read misinformation, and collapsed over questions about well-known versus obscure facts (because fact knowledge did not affect the cost of story-reading). We computed a 2 (Age: YA, OA) × 2 (Error Detected During Story-Reading: Successful, Missed) mixed ANOVA on the proportion of questions answered correctly. Participants answered significantly more questions correctly following successful error detection ($M = .60$) than after missing errors [$M = .29$; $F(1, 50) = 37.02$, $MSE = .05$, $\eta_p^2 = .43$]. Interestingly, regardless of whether individual errors were caught or missed, older adults were more likely to answer general knowledge questions correctly ($M = .54$) than young adults ($M = .36$), $F(1, 50) = 9.44$, $MSE = .07$, $\eta_p^2 = .16$. That is, even after missing an error, older adults were more likely to later correctly answer the corresponding general knowledge question. To ensure that it was not simply that older adults knew more facts (reflected in their higher performance on questions that tapped neutrally framed story facts), we repeated the analysis covarying out performance on the neutral questions. The main effect of age was still significant, $F(1, 60) = 14.68$, $MSE = .06$, $\eta_p^2 = .20$, indicating that when matched for prior knowledge, older adults were still better able to recover from exposure to misinformation than young adults, regardless of whether they had detected the story errors.

Misinformation Production

Of critical interest was participants' use of story errors to answer the final general knowledge questions (e.g., answering "What is the capital of Russia?" with "St. Petersburg"). As shown in Table 3, replicating prior work, participants were far more likely to answer questions with misinformation if they had read the errors in the stories, as opposed to reading correct, $t(128) = 13.08$, $SEM = .02$, or neutral references, $t(128) = 9.49$, $SEM = .02$; $F(2, 250) = 103.69$, $MSE = .03$, $\eta_p^2 = .45$. Detection instructions lessened the effects of having read misinformation in the stories, $F(2, 250) = 5.85$, $MSE = .03$, $\eta_p^2 = .05$: Misinformation production dropped from .31 in the control condition to .22 in the detection condition, $t(127) = 3.00$, $SEM = .03$.

More important for present purposes, as reflected in a significant interaction between age and fact framing, $F(2, 250) = 5.97$, $MSE = .03$, $\eta_p^2 = .05$, older adults were less suggestible than young adults. After reading correct or neutral references, older and young adults were equally likely to answer with misinformation ($ts < 1$), albeit quite rarely (see Table 3). However, older adults were significantly less likely to answer general knowledge questions with misinformation they had read in the stories ($M = .22$) than were young adults [$M = .31$; $t(127) = -3.01$, $SEM = .03$]. Critically, the three-way interaction between age, instruction, and fact framing was not significant, $F(2, 250) = 1.24$, $MSE = .03$, $\eta_p^2 = .01$, $p = .29$. Instruction did not change the conclusions about age and suggestibility: Attempting to detect story errors reduced later suggestibility equally for both older and young adults.

To further explore the age difference in suggestibility, an additional analysis linked success at error detection (while reading) to later reproduction of those errors on corresponding general knowledge questions. This analysis was limited to subjects in the detection condition and items for which participants had read misinformation, and collapsed over questions about well-known versus obscure facts. Errors caught during the story-phase were less likely to be produced as answers on the general knowledge test. Only 9% of correctly identified errors were reproduced on the final test, whereas 36% of missed errors were later used as answers. This was confirmed statistically with 2 (Age: YA, OA) × 2 (Error Detected During Story-Reading: Successful, Missed) mixed ANOVA on reproduced errors, which revealed a main effect of error detection, $F(1, 48) = 30.93$, $MSE = .05$, $\eta_p^2 = .39$. No other effects were significant, $Fs < 1$.

Discussion

The present study investigated whether age differences in the ability to detect contradictions with stored knowledge underlie age differences in susceptibility to semantic illusions. First, consistent

Table 3
Proportion of Misinformation Answers on the Final General Knowledge Test as a Function of Age, Instruction, Fact Knowledge, and Fact Framing

	Control			Detect		
	Correct	Neutral	Misleading	Correct	Neutral	Misleading
Older Adults						
Well-known	.05	.13	.24	.05	.07	.17
Obscure	.03	.07	.25	.05	.10	.21
M	.04	.10	.25	.05	.09	.19
Young Adults						
Well-known	.02	.10	.39	.05	.10	.21
Obscure	.01	.09	.35	.06	.11	.28
M	.02	.10	.37	.06	.11	.25

Note. The *SE* was .02 for older adults and .02 for young adults.

with prior research (Marsh et al., 2005), older adults were less suggestible than young adults; after reading errors in stories, older adults were significantly less likely to answer general knowledge questions with story errors. However, older adults were no better at detecting errors as they encoded the stories; both groups showed some ability to distinguish falsehoods from facts, pressing the error key more for misinformation than for correct references, but still missed more than half of the errors. Subjects were no better at catching contradictions of well-known facts than obscure ones (missing 54 vs. 55%, respectively). This result is in line with other demonstrations of *knowledge neglect*, whereby people fail to catch contradictions with stored knowledge and extends this phenomenon to older adults.

The explicit error detection task likely increased the chances that subjects noticed the errors during encoding, thereby yielding the consequent reduction in later suggestibility (as marked errors were less likely to be reproduced). Because this detection instruction had similar effects (in magnitude) across ages, it suggests that spontaneous detection of errors (in the control group) did not vary as a function of age. That is, if older adults in the control condition were already noticing a large number of errors, the detection instruction should have had little impact. Thus, the age reversal in suggestibility is unlikely to be due to differences in detection ability.

However, the data are also inconsistent with the idea that age-related declines in episodic memory drove the age differences in suggestibility. In the detection condition, we examined the probability that errors were reproduced on the final test, given that they were caught versus missed during story-reading. Of particular interest are missed errors; the episodic memory account would predict that missed errors would be more likely to persist for young adults, who would be better able to remember the new associations than would older adults. However, no age difference occurred: Missed story errors were equally likely to persist, regardless of age.

Rather, the data support a third possibility: Older adults' bias to rely on their prior knowledge protected them from repeating the story errors. That is, in numerous situations, older adults are inclined to rely on prior knowledge, as opposed to more recent experiences. For example, older adults tend to mis-remember recently learned word-pairs to reflect standard semantic (meaning-based) pairings (Rabinowitz, Craik, & Ackerman, 1982), struggle to reproduce recently studied misspellings (instead reverting to the correct spellings; MacKay et al., 1999), and forget unrealistic grocery store prices (but show no deficits in remembering realistic ones; Castel, 2005). Furthermore, Dalla Barba, Attali, and La Corte (2010) found that older adults had such robust knowledge of famous fairy tales that they had difficulty learning and remembering modified versions. This result was not simply due to an episodic memory deficit, as there were no age differences in learning novel fairytales. Combined, the data suggest that older adults may be unable to disregard related prior knowledge that contradicts recent learning (consistent with age-related deficits in inhibition; Anderson, Reinholz, Kuhl, & Mayr, 2011; Hasher & Zacks, 1979, 1988). Returning to the present study, this account correctly predicts that older adults would be biased to answer the general knowledge questions with their preexisting knowledge, regardless of what they read in the stories and moreover, whether or not they noticed the errors.

These results contribute to a growing literature that highlights differences between errors of episodic and semantic illusions. Warnings (Greene, Flynn, & Loftus, 1982; Loftus, 1979; Marsh & Fazio, 2006), instructions to attend to the sources of one's memories (Lindsay & Johnson, 1989; Marsh, Meade, & Roediger, 2003), and exposure time (Fazio & Marsh, 2008; Tousignant, Hall, & Loftus, 1986) all have different effects on false memories for episodes than for semantic illusions. The present work highlights another difference, with older adults being less vulnerable to semantic illusions, in contrast to their greater susceptibility to episodic false memories in other paradigms. Older adults' strong bias to rely on prior knowledge cannot help them when the task requires recollecting the details of a recent episode, even when knowledge supported initial encoding. For example, in the DRM paradigm, semantic memory is a prerequisite for "sleep" to be activated upon hearing "bed, rest, tired," but deciding if "sleep" was presented is an episodic memory task involving recollection. In contrast, in the present work, older adults' bias to rely on prior knowledge protects them from reproducing factual inaccuracies. In short, healthy aging is associated with suggestibility in many situations, but older adults' bias to rely on their semantic memories also means they are less suggestible to erroneous claims about the world.

References

Anderson, M. C., Reinholz, L., Kuhl, B. A., & Mayr, U. (2011). Intentional suppression of unwanted memories grows more difficult as we age. *Psychology and Aging, 26,* 397–405. doi:10.1037/a0022505

Bottoms, H. C., Eslick, A. N., & Marsh, E. J. (2010). Memory and the Moses illusion: Failures to detect contradictions with stored knowledge yielded negative memorial consequences. *Memory, 18,* 670–678. doi:10.1080/09658211.2010.501558

Castel, A. D. (2005). Memory for grocery prices in younger and older adults: The role of schematic support. *Psychology and Aging, 20,* 718–721. doi:10.1037/0882-7974.20.4.718

Cohen, G., & Faulkner, D. (1989). Age differences in source forgetting: Effects on reality monitoring and on eye witness testimony. *Psychology and Aging, 4,* 10–17. doi:10.1037/0882-7974.4.1.10

Craik, F. I. M., & Jennings, J. M. (1992). Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *Handbook of aging and cognition* (pp. 51–110). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Craik, F. I. M. (2000). Age-related changes in human memory. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer* (pp. 75–92). New York, NY: Psychology Press.

Dalla Barba, G., Attali, E., & La Corte, V. (2010). Confabulation in healthy aging is related to interference of overlearned, semantically similar information on episodic memory recall. *Journal of Clinical and Experimental Neuropsychology, 32,* 655–660.

Dywan, J., & Jacoby, L. (1990). Effects of aging on source monitoring: Differences in susceptibility to false fame. *Psychology and Aging, 5,* 379–387. doi:10.1037/0882-7974.5.3.379

Eslick, A. N., Fazio, L. K., & Marsh, E. J. (2011). Ironic effects of drawing attention to story errors. *Memory, 19,* 184–191. doi:10.1080/09658211.2010.543908

Fazio, L. K., & Marsh, E. J. (2008). Slowing presentation speed increases illusions of knowledge. *Psychonomic Bulletin and Review, 15,* 180–185. doi:10.3758/PBR.15.1.180

Greene, E., Flynn, M. S., & Loftus, E. F. (1982). Inducing resistance to misleading information. *Journal of Verbal Learning and Verbal Behavior, 21,* 207–219. doi:10.1016/S0022-5371(82)90571-0

Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General, 108,* 356–388. doi:10.1037/0096-3445.108.3.356

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* (Vol. 22, pp. 193–225). San Diego, CA: Academic Press.

Jarvis, B. G. (2008a). *DirectRT (Version 2008.1.0.13)* [Computer software]. New York, NY: Empirisoft Corporation.

Jarvis, B. G. (2008b). *MediaLab (Version 2008.1.33)* [Computer software]. New York, NY: Empirisoft Corporation.

Light, L. L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology, 42,* 333–376. doi:10.1146/annurev.ps.42.020191.002001

Light, L. L. (1992). The organization of memory in old age. Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *Handbook of aging and cognition* (pp. 111–165). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Lindsay, D. S., & Johnson, M. K. (1989). The eyewitness suggestibility effect and memory for source. *Memory & Cognition, 17,* 349–358.

Loftus, E. F., Levidow, B., & Duesing, S. (1992). Who remembers best? Individual differences in memory for events that occurred in a science museum. *Applied Cognitive Psychology, 6,* 93–107.

Loftus, E. F. (1979). Reactions to blatantly contradictory information. *Memory & Cognition, 7,* 368–374.

MacKay, D. G., Abrams, L., & Pedroza, M. J. (1999). Aging on the input versus output side: Theoretical implications of age-linked asymmetries between detecting versus retrieving orthographic information. *Psychology and Aging, 14,* 3–17.

Madden, D. J., Mitroff, S. R., Shepler, A. M., Fleck, M. S., Costello, M. C., & Voss, A. (under revision). Adult age differences in top-down attentional control during rare target search.

Marsh, E. J., Balota, D. A., & Roediger, H. L., III (2005). Learning facts from fiction: Effects of healthy aging and dementia of the Alzheimer type. *Neuropsychology, 19,* 115–129.

Marsh, E. J., & Fazio, L. K. (2006). Learning errors from fiction: Difficulties in reducing reliance on fictional stories. *Memory & Cognition, 34,* 1140–1149.

Marsh, E. J., Meade, M. L., & Roediger, H. L., III (2003). Learning facts from fiction. *Journal of Memory and Language, 49,* 519–536.

Marsh, E. J. (2004). Story stimuli for creating false beliefs about the world. *Behavior Research Methods, Instruments, & Computers, 36,* 650–655.

Mitchell, K. J., Johnson, M. K., & Mather, M. (2003). Source monitoring and suggestibility to misinformation: Adult age-related differences. *Applied Cognitive Psychology, 17,* 107–119.

Nebes, R. D. (1994). Cognitive dysfunction in Alzheimer's disease. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 373–446). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Nelson, T. O., & Narens, L. (1980). Norms of 300 general-information questions: Accuracy of recall, latency of recall, and feeling-of-knowing ratings. *Journal of Verbal Learning and Verbal Behavior, 19,* 338–368.

Norman, K. A., & Schacter, D. L. (1997). False recognition in younger and older adults: Exploring the characteristics of illusory memories. *Memory & Cognition, 25,* 838–848.

Rabbitt, P. (1979). How old and young subjects monitor and control responses for accuracy and speed. *British Journal of Psychology, 70,* 305–311.

Rabinowitz, J. C., Craik, F. I. M., & Ackerman, B. P. (1982). A processing resource account of age differences in recall. *Canadian Journal of Psychology, 36,* 325–344.

Salthouse, T. A. (1992). *Theoretical perspectives on cognitive aging.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Shafto, M., & MacKay, D. G. (2000). The Moses, mega-Moses, and Armstrong illusions: Integrating language comprehension and semantic memory. *Psychological Science, 11,* 372–378.

Shafto, M. A., & MacKay, D. G. (2010). Miscomprehension, meaning, and phonology: The unknown and phonological Armstrong illusions. *European Journal of Cognitive Psychology, 22,* 529–568.

Strayer, D. L., & Kramer, A. F. (1994). Aging and skill acquisition: Learning-performance distinctions. *Psychology and Aging, 9,* 589–605.

Tousignant, J. P., Hall, D., & Loftus, E. F. (1986). Discrepancy detection and vulnerability to misleading postevent information. *Memory & Cognition, 14,* 329–338.

Turgeon, M., Wing, A. M., & Taylor, L. W. (2010). Timing and aging: Slowing of fastest regular tapping rate with preserved timing error detection and correction. *Psychology and Aging, 26,* 150–161.

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