

RESEARCH ARTICLE

Reducing suggestibility to additive versus contradictory misinformation in younger and older adults via divided attention and/or explicit error detection

Sharda Umanath¹  | François Ries¹ | Mark J. Huff²

¹Department of Psychological Sciences, Claremont McKenna College, Claremont, California

²Department of Psychology, The University of Southern Mississippi, Hattiesburg, Mississippi

Correspondence

Sharda Umanath, Department of Psychological Sciences, Claremont McKenna College, Claremont, CA 91711.

Email: sumanath@cmc.edu

Funding information

National Institute on Aging, Grant/Award Number: T32 AG0000-0-39

Summary

Younger and older adults are more suggestible to additive (not originally included) versus contradictory (a change to the original) misleading details. Only suggestibility to contradictory misinformation can be reduced with explicit instructions to detect errors during exposure to misinformation. The present work examines how to reduce suggestibility to additive misinformation and whether attentional resources at exposure similarly influence additive and contradictory misinformation. During the misleading question phase, attention and error detection were manipulated. Participants answered the questions under full or divided attention, and some were instructed to mark detected errors. On the final test, additive misinformation was endorsed more than contradictory misinformation despite equivalent error detection. However, dividing attention reduced suggestibility for additive misinformation, whereas successful error detection showed evidence of reducing contradictory misinformation, providing further evidence for the dissociation between these types of misinformation. Additionally, dividing younger adults' attention did not consistently result in a pattern paralleling older adults.

KEYWORDS

aging, divided attention, error detection, false memory, misinformation

1 | INTRODUCTION

Numerous studies have shown that our memories are susceptible to misleading information—a fact demonstrated through the now classic misinformation paradigm. The misinformation paradigm can be deconstructed into three steps designed to echo real-world experiences of events and subsequent exposure to errors. Participants are first exposed to an original event, often presented in videos (e.g., Takarangi, Parker, & Garry, 2006), slides (e.g., Loftus, Miller, & Burns, 1978), or a narrative (e.g., Huff & Umanath, 2018). Second, participants are exposed to misleading details about the original event, via narratives (e.g., Okado & Stark, 2005; Takarangi et al., 2006), photographs (e.g., Loftus et al., 1978), postevent interviews (e.g., Mueller-Johnson & Ceci, 2004), or even social others (e.g., Roediger, Meade, & Bergman, 2001). Finally, participants' memory about the original

event is tested, frequently using recognition tests wherein participants are asked to discriminate information between the original event and later introduced errors (e.g., Frost, Ingraham, & Wilson, 2002; Mitchell, Johnson, & Mather, 2003; Okado & Stark, 2005; Zhu et al., 2010). Across all materials, participants routinely falsely report misleading details as part of the original event (for a review, see Loftus, 2005), even despite explicit warnings to dismiss incorrect details (see Ecker, Lewandowsky, & Tang, 2010; Loftus, 2005).

1.1 | Additive and contradictory misinformation

What makes misleading details more or less seductive in terms of later suggestibility? Prior research has examined qualitative characteristics of misleading content that can influence subsequent suggestibility,

such as how central versus peripheral the misleading details are to the original event (Luna & Migueles, 2009; Wilford, Chan, & Tuhn, 2014; Wright & Stroud, 1998). Here, we also examine qualitative characteristics of misleading items by contrasting two types of misinformation that have been studied less frequently (Frost, 2000; Huff & Umanath, 2018; Moore & Lampinen, 2016; Nemeth & Belli, 2006): contradictory and additive. Contradictory misinformation refers to suggested misleading details that are discrepant with specific details that were originally presented (e.g., the stop/yield sign discrepancy in the classic misinformation paradigm). Additive misinformation, however, involves misleading details that are supplementary to an original event but do not contradict any one detail. For example, Loftus (1975) showed participants a film of an auto accident on a country road. Later, it was suggested that the accident took place near a barn despite no barn appearing in the film. In this case, the misleading barn supplements, but does not change, a specific detail from the film.

Until recently (Huff & Umanath, 2018; Moore & Lampinen, 2016), differences between contradictory and additive misinformation had not been systematically compared despite both types producing large misinformation effects (Frost, 2000; Nemeth & Belli, 2006; Saunders & Jess, 2010). Huff and Umanath (2018) presented younger and older adults with a fictional story followed by misleading questions that contained additive and contradictory details that were systematically counterbalanced across misinformation type and participants. Additive misinformation was falsely recognized as being in the original narrative at a much higher rate than contradictory misinformation across age groups (see also, Moore & Lampinen, 2016), but interestingly, older adults were *less* susceptible to contradictory misinformation than were younger adults. The authors reasoned that older adults were vigilant towards misinformation by successfully detecting contradictory misinformation (e.g., MacKay, Abrams, & Pedroza, 1999; Schwartz, 2002; Umanath & Marsh, 2012), even without instructions to do so. In a second experiment, younger and older adults were presented with varying levels of warnings about errors at the outset of the misleading question phase (cf. Eakin, Schreiber, & Sergent-Marshall, 2003). One of these pre-exposure warnings included strong error-detection instructions in which participants were provided with examples of both misinformation types and were asked to report any misinformation encountered. Suggestibility to additive misinformation was again greater across age groups, but younger adults were able to successfully reduce contradictory misinformation selection (down to the level of older adults) with the strong-detection instructions. Though misinformation types were initially detected at similar rates, these same heavy-handed instructions did not reduce subsequent suggestibility to additive misinformation. This suggests that contradictory and additive misinformation is processed differently during the misleading question (at exposure) and/or final test phase (at retrieval).

1.2 | Targeting suggestibility to additive misinformation: The role of attention

Given the immunity of additive misinformation to strong error-detection instructions, a critical question is how can suggestibility to additive misinformation be reduced? Loftus (2005) theorized that

suggestibility to misinformation is based on the likelihood that an individual is aware of discrepancies between misleading details and original event details (i.e., the *discrepancy detection* principle). In accordance, Putnam, Wahlheim, and Jacoby (2014) showed that awareness of a changing contradictory detail later reduced acceptance of contradictory information, suggesting the presence of a detect-and-reject process. However, such detection may occur at two different points—during the misinformation exposure phase, the final test phase, or both. Interestingly, Huff and Umanath (2018) observed that successful detection of additive misinformation was equivalent to that of contradictory misinformation despite subsequent elevated rates of additive misinformation endorsement on the final test. However, detecting additive and contradictory errors may hinge on very different processes both at exposure and at retrieval due to the basic nature of the error types—one, a novel detail and, another, a changed detail. For example, Moore and Lampinen (2016) found that recollection rejection, a metacognitive process wherein participants recollect specific details from the original event to reject misinformation, is more likely to occur for contradictory than additive misinformation.

Aside from qualitative details of misinformation items themselves, suggestibility can be influenced by a combination of various nonmemory processes such as the task's attentional demands, strategy effects, and response biases (see Ayers & Reder, 1998, for a review). As such, we chose to examine the role that attentional resources might play when first exposed to misinformation as divided attention at encoding is known to affect subsequent memory performance (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996). At exposure, for contradictory misinformation, detection may require fewer attentional resources because discrepancies (vs. a lack of a detail) are more distinctive (Moore & Lampinen, 2016; Putnam et al., 2014). Consistent with this possibility, Huff and Umanath (2018) showed that older adults, who often show breakdowns in attentional control (Craik & Anderson, 1999), were just as good at detecting errors as younger adults. Moreover, older adults were more successful at later rejecting contradictory misinformation than were younger adults. Thus, full attentional resources during exposure may not be needed to mitigate suggestibility to contradictory misinformation because the discrepancy will be well remembered, consistent with discrepancy detection and recollection-rejection processes (Moore & Lampinen, 2016; Putnam et al., 2014). Therefore, provided a baseline threshold of attention is reached, initial detection and subsequent rejection of contradictory misinformation may remain constant. For additive misinformation, however, diminished attention might simply restrict the encoding of misinformation, rendering it less available at test and reducing suggestibility. Although such theory-driven experimentation is unlikely to lead to a practical intervention for reducing suggestibility to additive misinformation, exploring this idea is important because decreased attention may counterintuitively provide a benefit by reducing suggestibility for individuals with compromised attentional capacities.

As mentioned above, our prior work (Huff & Umanath, 2018) showed that older adults were less suggestible to contradictory misinformation than were younger adults across conditions with the exception of when participants were given heavily emphasized error-detection instructions. The exact cause of older adults' reduced

suggestibility to contradictory errors is not clear, though it may reflect age-related differences in conscientiousness or vigilance towards errors in general. Another possibility is that older adults' reduced attentional resources may contribute to their performance. Dividing younger adults' attention at encoding has been a commonly used method to equate younger and older adults' cognitive resources (e.g., Craik, 1982; Craik & Byrd, 1982). This manipulation allows us to target the role of attention at encoding by examining subsequent memory performance. Thus, a secondary goal was to examine whether reducing attentional resources of younger adults during the misinformation exposure phase would lead them to perform similar to older adults.

1.3 | The present study

The present work aimed to better understand the processes underlying suggestibility to the highly potent additive misinformation by targeting attentional resources available during misinformation exposure. Additionally, we examined the influence of explicit detection instructions. Participants read a fictional story containing critical details, answered a series of misleading questions containing additive and contradictory misinformation details (see Section 2.3 for further information and Table 1 for examples), and completed a final three-alternative-forced-choice (3-AFC) test. During the misinformation phase, younger adults were randomly assigned to one of four groups: full attention (FA), full-attention detection (FA-D), divided attention (DA), and divided-attention detection (DA-D). To divide attention, DA and DA-D participants completed an auditory digit-monitoring task while answering a questionnaire about the story containing misinformation items. Participants in the detection conditions (FA-D and DA-D) were further asked to report errors that were encountered during the misleading question phase. Additionally, a fifth group of older adults under full attention and with detection instructions completed the study to provide an age comparison.

We expected that suggestibility to contradictory misinformation would be lower than additive misinformation due to contradictory misinformation being more likely to be detected and subsequently rejected, consistent with prior work (Huff & Umanath, 2018; Moore & Lampinen, 2016). We further expected that suggestibility to contradictory (vs. additive) misinformation would be less likely to be affected when attention was diminished. This is because the detection of contradictory misinformation during the misinformation phase is likely to

occur even when attentional resources are taxed. In contrast, one method to reduce the potency additive misinformation may be to reduce the likelihood that the misinformation is initially encoded given detection and rejection of additive misinformation is more difficult. Regarding age-related differences, we suspected that reduced attentional resources do not explain older adults' low suggestibility to contradictory misinformation and, therefore, predicted that they will perform similarly to younger adults with full (vs. divided) attention.

2 | METHODS

2.1 | Participants

One hundred twenty-six ($M_{\text{age}} = 19.79$ years, standard deviation [SD] = 1.25; 51 females) undergraduate participants (YAs) from Claremont McKenna College and Washington University in St. Louis and 53 ($M_{\text{age}} = 74.80$ years, $SD = 6.07$; 40 females) community-dwelling older adults from Southern California (OAs) participated for course credit or \$25, respectively. Average reported years of education was 13.48 ($SD = 1.09$) for YAs and 16.04 ($SD = 2.44$) for OAs. OAs were tested for healthy cognitive abilities using the Shipley (1946) vocabulary test ($M = 36.13$, $SD = 3.19$) and Mini-Mental State Examination (MMSE: Folstein, Folstein, & McHugh, 1975; $M = 27.64$, $SD = 1.75$) after the experiment. One was removed as an outlier on the Shipley test (greater than 3 SD below the mean), four failed to follow instructions in the misinformation phase, and seven scored below the standard cognitively normal cutoff (24) on the MMSE. One younger adult had incomplete data. Analyses were conducted on 125 YAs and 41 OAs.

2.2 | Design

The present study utilized a 2 (Error-Detection Instruction: Control, Detection) \times 2 (Attention: Full, Divided) \times 3 (Misinformation Type: Neutral, Additive, Contradictory) mixed design. Error-detection instruction and attention were manipulated between subjects and misinformation type within subjects. OAs were all in a full-attention-detection condition and constituted a dangling control group to compare against YAs in the detection condition under full and divided attention. This comparison is discussed in greater detail below.

TABLE 1 Sample additive, contradictory, and neutral item types across study, misleading question, and final three-alternative-forced-choice (3-AFC) test phases

Phase/item type	Study phase	Misleading question	Final 3-AFC test options
Additive	"I'm off to find the legendary city that floated off into space."	"The man in the bar was going to search for <i>Waterston</i> , a city that was legendary for what?"	"Tomad" "Waterston" "I don't know/Neither"
Contradictory	"I'm off to find <i>Tomad</i> , the legendary city that floated off into space."	"The man in the bar was going to search for <i>Waterston</i> , a city that was legendary for what?"	"Tomad" "Waterston" "I don't know/Neither"
Neutral	"I'm off to find the legendary city that floated off into space."	"The man in the bar was going to search for a city that was legendary for what?"	"Tomad" "Waterston" "I don't know/Neither"

Note. Test question for final 3-AFC test was "I'm off to find _____, the legendary city that floated off into space."

2.3 | Materials

The study phase was based on the fictional story entitled *The Art Thief* used previously in Huff and Umanath (2018) and modified from Marsh (2004). The story depicted the conversation between a tourist and an art thief in a pub and included dialogue, characters, and a plot line. The 2,000-word story was broken down into 201 lines presented one by one on a computer screen. Thirty-six critical statements were placed throughout the story (see Berger, Hall, & Bahrck, 1999). Each statement included a target detail that could be substituted later during the test phase with a misinformation detail. All target details were purely fictional to prevent participants from using prior knowledge that could affect their memory processes (Umanath & Marsh, 2014). For instance, the sentence “Bumbaru palace in Zambari is where the Monarch of Konkali lives” contains the target *Bumbaru* that could be substituted with other fictional names such as *Simfara* and used later as a misleading detail to produce a misinformation item.

Target details were subdivided into three groups of 12 items belonging to different categories: additive, contradictory, and no-misinformation controls. These critical statements were distributed at one approximately every six sentences within the story. The type of misinformation (i.e., additive, contradictory, or no misinformation) was then randomized among target details, and three different versions of the story were created to ensure that each critical statement would fall in one of the three categories at least once.

For the misleading question phase, 36 corresponding cued-recall questions were created on the basis of the critical items in the story with 12 containing additive misinformation, 12 contradictory misinformation, and 12 neutral no-misinformation questions. Questions were presented in one of three random orders. For all misinformation questions, target details were embedded within cued-recall questions such that their presence had no influence on the participant's ability to correctly answer the question (see Table 1). For example, the question “In what city was the palace where the monarch of Konkali lives?” would serve as a neutral question, providing no misleading information. However, for misleading questions, information about the palace name that was not in the story would also be provided (e.g., *Simfara*). Additive misinformation questions presented false details that were completely

absent from the original story but did not contradict any specific detail. Contradictory misinformation questions presented false details that directly contrasted a specific detail presented in the original story. Note that the questions were identical during this phase. Whether a question was additive versus contradictory depended on what participants read in the original story (see Table 1). Neutral items did not present any false details about the original story. The questions were answered with pencil and paper with written instructions (see below) reiterated at the top of the first page.

To evaluate participants' memory of the original story and suggestibility from the misleading question phase, a 48-item 3-AFC test was used. The test included 12 items pertaining to additive misinformation, 12 items to contradictory misinformation, 12 neutral items, and 12 comprehension items to assess participants' memory of basic story details. An example depicting each of the misinformation types and how they were presented is displayed in Table 1. For neutral, additive, and contradictory items, a fill-in-the-blank-type line was presented from the original story with the critical detail missing. Participants were provided with three response options: Two options were details that could fit in the blank. For additive items, one was the misinformation detail and the other was a not previously presented foil item. For contradictory items, one was the correct detail from the original story, but the other was the misinformation detail from the misleading question phase. For neutral items, both items were new foils, because no detail was presented in either the original story or the misleading questions. The third option across all item types was an “I don't know/Neither” response to be used if the correct answer was unknown or if neither of the other answers were considered correct. Comprehension questions probed plot details from the story (e.g., The protagonist was staying at a _____) with the correct response (e.g., a hostel), a plausible distractor (e.g., a hotel), and “I do not know/Neither” response options.

2.4 | Procedure

The individually read fictional story and final memory test were presented using E-Prime software (Schneider, Eschman, & Zuccolotto,

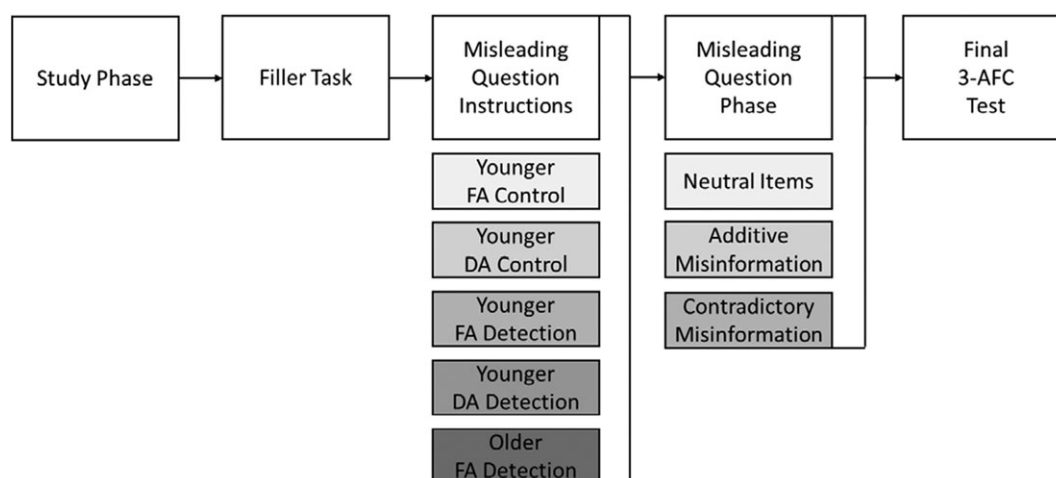


FIGURE 1 Study design. Misleading question instructions were manipulated between subjects. The items presented in the Misleading Question Phase were manipulated within subjects. FA, full attention; DA, divided attention; 3-AFC Test, three-alternative-forced-choice test

2002). Responses were recorded via the keyboard. The misleading question phase was completed using pencil and paper.

Figure 1 depicts the study design. After providing informed consent and completing a demographics questionnaire, we asked participants to read, at their own pace, a fictional story. The self-pacing was a methodological choice aimed at equating encoding of the story between conditions. Participants then had 3 min to complete an arithmetic filler task. Following the filler, younger adults were randomly assigned to one of four conditions: full-attention control (FA), full-attention detection (FA-D), divided attention control (DA), and divided attention detection (DA-D). During the misleading question phase, participants answered questions about the story via paper and pencil. At the outset of this phase, the two detection groups received written and oral instructions to particularly look for errors that contradicted the story, following the “Detection Plus” group in Huff and Umanath (2018). Both groups were also presented with an example of a hypothetical detail in which additive and contradictory misinformation was presented as well as a corresponding misleading question. Specifically, participants were given a statement of an original detail in which a rose was exchanged between two characters. Participants were informed that they may see a misleading additive statement in which a white rose was presented with an incorrect added detail (color of the rose), or they may see a contradictory detail in which a tulip was exchanged. Detection participants were instructed to monitor for and report either error type. Before starting this phase, the experimenter verbally reminded participants a second time that some questions could potentially contain such errors.

Full-attention groups were asked to complete the misleading question phase at their own pace. Divided-attention groups were asked to complete an additional task alongside answering the questions during the misleading question phase. Specifically, they were instructed to complete a digit-monitoring task in which a series of randomly generated numbers ranging from 0 to 9 were presented auditorily, and participants were to note each time three successive odd numbers were presented by pressing the spacebar. Participants in the control conditions were simply asked to complete the misleading question phase, without any specific mention of potential errors. During this phase, all groups had two options when answering the misleading questions: answer the question or write “IDK” for “I don’t know.” The detection groups could also respond “error” to identify a question as containing a detail that differed from the original story.

Following the misleading question phase, all conditions answered a final 48-item 3-AFC test. Participants were instructed to select one

of three response options to complete partially blanked lines from a sentence of the fictional story. They were told that two options would be possible details to fill in the blank and the third option would be “I don’t know/Neither” that could be used if they did not know the answer or if neither of the other responses were considered correct. The response options were presented on the computer screen beneath each question and were each yoked to a specific key on the keyboard. Participants were asked to press the key that corresponded to the detail from the original story. Like the misleading question phase, the final test was self-paced. OAs then completed the Shipley vocabulary test and the MMSE. On average, the study took between 60 and 90 min to complete.

3 | RESULTS

For all results reported, a $p < 0.05$ significance level was used except as noted. Effect sizes for significant comparisons were calculated using partial eta squared (η_p^2) for analyses of variance (ANOVAs) and using Cohen’s d for t tests. We further tested all nonsignificant comparisons reported using a Bayesian estimate of the strength of evidence supporting the null hypothesis (Masson, 2011; Wagenmakers, 2007). This analysis compares two models: one that assumes an effect and another that assumes a null effect. This analysis produces a Bayesian estimate that the null effect is retained and produces a p value termed p_{BIC} (Bayesian information criterion). The estimate is sensitive to sample size and can therefore serve as a power analysis to increase confidence in reported null effects. We therefore report p_{BIC} analyses to supplement all null effects found using traditional null-hypothesis-significance testing.

Two major questions were addressed with each set of analyses: (a) How do detection instructions and attention affect memory for the original story and susceptibility to misinformation? (b) Does dividing younger adults’ attention result in performance similar to that of older adults under full attention? To answer these questions, given the design of the study with a single older adult group, we compared groups as one factor with five levels: older adults with full attention and detection (OA FA-D), younger adults with full attention (YA FA), younger adults with full attention and detection (YA FA-D), younger adults with divided attention (YA DA), and younger adults with divided attention and detection (YA DA-D). This approach allowed us to examine critical comparisons with as few repeated analyses of the same conditions as possible.

TABLE 2 Mean (*SD*) proportion of correct responses and errors detected during the misleading question phase

	OA full attention	YA full attention		YA divided attention	
	Detect	Control	Detect	Control	Detect
N	41	32	33	30	30
Proportion correct	0.27 (0.16)	0.33 (0.15)	0.43 (0.18)	0.38 (0.17)	0.32 (0.15)
Errors detected					
Neutral	0.13 (0.14)	—	0.17 (0.14)	—	0.17 (0.14)
Additive	0.36 (0.24)	—	0.33 (0.20)	—	0.28 (0.19)
Contradictory	0.37 (0.24)	—	0.39 (0.17)	—	0.26 (0.21)

Note. Proportion of errors detected for neutral items are false alarms because no misinformation was presented for these items.

3.1 | Misleading question phase: Cued-recall test

Mean proportions of correct responses on the misleading question phase cued-recall test are reported in Table 2 as a function of age, detection instructions, and attention condition. Proportion correct was computed by taking the number of correct responses divided by the total number of questions. Items marked as containing an error in the detection groups were excluded. Only items given a memory response or "I don't know" were included in the calculation; "I do not know" responses were counted as incorrect.

A one-way ANOVA on correct responses to misleading questions revealed reliable differences across groups, $F(4, 161) = 4.61$, mean square error (MSE) = 0.03, $\eta_p^2 = 0.10$. Post hoc comparisons showed that correct responses were greatest for younger adults, but only when given detection instructions under full attention. Specifically, correct responses for YA FA-D were greater than those for YA FA (0.43 vs. 0.33), $t(63) = 2.33$, standard error of the difference (SED) = 0.04, $d = 0.58$, demonstrating a benefit of detection instructions, and were also greater for YA FA-D than for YA DA-D (0.43 vs. 0.32), $t(61) = 2.41$, $SED = 0.04$, $d = 0.61$, indicating a benefit of full attention. YA DA-D and YA FA were equivalent (0.32 and 0.33), $t < 1$, $p_{BIC} = 0.88$, revealing that *both* detection instructions and full attention are necessary to produce a benefit in younger adults. Further, an age-related difference was also found where correct responses were greater in YA FA-D relative to the OA FA-D (0.43 vs. 0.27), $t(72) = 3.88$, $SED = 0.04$, $d = 0.90$, an age difference also reported by Huff and Umanath (2018). However, older adults performed no differently than did YA DA-D, $t(69) = 1.39$, $p = 0.17$, $p_{BIC} = 0.76$. All other group comparisons were not significant, $t_s < 1.34$, $p_s > 0.19$, $p_{BIC_s} > 0.75$.

3.1.1 | Error detection

We then examined misinformation detection rates across the three detection groups during the cued-recall test as a function of item type (see Table 2). A 3 (Misinformation Type: Additive, Contradictory, Neutral) \times 3 (Detection Group: OA FA-D, YA FA-D, YA DA-D) mixed ANOVA was conducted on the proportion of errors reported during the misleading question phase. Note that errors reported for neutral items are false alarms. More errors were successfully detected for both additive and contradictory items than false detections for neutral items, $F(2, 202) = 53.68$, $MSE = 0.02$, $\eta_p^2 = 0.35$; $t(103) = 8.25$, standard error of the mean (SEM) = 0.02, $d = 0.97$ for neutral versus additive items; $t(103) = 8.65$, $SEM = 0.02$, $d = 1.06$ for neutral versus contradictory items. Successful detection of additive versus contradictory errors was equivalent, $t(103) = 1.04$, $SEM = 0.02$, $p = 0.30$, $p_{BIC} = 0.85$, demonstrating that errors were detected similarly (see Huff & Umanath, 2018), regardless of the qualitative differences in how those errors were introduced.

The effect of Detection Group was not reliable, $F(2, 101) = 1.53$, $MSE = 0.07$, $p = 0.22$, $p_{BIC} = 0.96$, but a significant Misinformation Type \times Group interaction was found, $F(4, 202) = 3.18$, $MSE = 0.02$, $\eta_p^2 = 0.06$. We deconstructed this interaction by using 3 one-way ANOVAs to compare across groups within each item type. No

differences were found in false alarm rates (neutral items) across the three detection groups, $F < 1$, $p_{BIC} = 0.98$, or for additive items, $F(2, 101) = 1.17$, $MSE = 0.05$, $p = 0.32$, $p_{BIC} = 0.97$. However, for contradictory items, an effect of Detection Group was found, $F(2, 101) = 3.81$, $MSE = 0.16$, $\eta_p^2 = 0.07$. Follow-up tests revealed that successful error detection was lower for YA DA-D relative to YA FA-D (0.26 vs. 0.39), $t(69) = 3.00$, $SED = 0.05$, $d = 0.76$, and OA FA-D (0.26 vs. 0.37), $t(69) = 2.07$, $SED = 0.05$, $d = 0.51$, demonstrating that divided attention reduced participant's ability to detect contradictory errors. There was no difference between YA FA-D and OA FA-D (0.39 vs. 0.37), $t(72) = 1.09$, $SED = 0.03$, $p = 0.28$, $p_{BIC} = 0.83$, demonstrating that older adults were better able to detect contradictory errors than younger adults under divided attention.

Overall, dividing attention during the misleading question phase had a greater effect on participants' ability to detect contradictory errors, reducing successful detection of these items, than additive ones. Furthermore, unlike other work in the area of memory and aging (Craik, 1982; Craik & Byrd, 1982), dividing younger adults' attention did not yield equivalent performance between younger and older adults.

3.2 | Final 3-AFC test

Neither detection instructions nor dividing attention affected general story comprehension as older adults remembered equivalent plot details as younger adults, $F < 1$.

3.2.1 | Suggestibility to misinformation

For misinformation selection on the final test, neutral items were not included in the analyses because no false details were presented for these items. Suggestibility to additive and contradictory misinformation was computed as the proportion of questions for which the misleading detail was selected. A 2 (Misinformation Type: Additive, Contradictory) \times 5 (Group: OA FA-D, YA FA, YA FA-D, YA DA, YA DA-D) mixed ANOVA was used to examine selection of misinformation. These data are presented in Figure 2.

Across groups, participants endorsed additive misinformation ($M = 0.56$) more frequently than contradictory misinformation, $M = 0.39$, $F(1, 161) = 68.89$, $MSE = 0.04$, $\eta_p^2 = 0.29$. No overall effect of Group emerged, $F < 1$, $p_{BIC} = 1.00$, but a significant Misinformation Type \times Group interaction was found, $F(4, 161) = 4.14$, $MSE = 0.04$, $\eta_p^2 = 0.09$. On the basis of our established line of inquiry and in an effort to reduce repeated tests of the same data, we probed the interaction to address three questions: (a) Does dividing attention during the misleading question phase differentially influence subsequent misinformation selection? (b) Does previously being asked to detect errors differentially influence misinformation selection? (c) Does dividing younger adults' attention alongside detection instructions during the misleading question phase lead them to show suggestibility effects like that of older adults? Because the main effect of Misinformation Type has been discussed above, we do not revisit it while answering these three questions with targeted analyses.

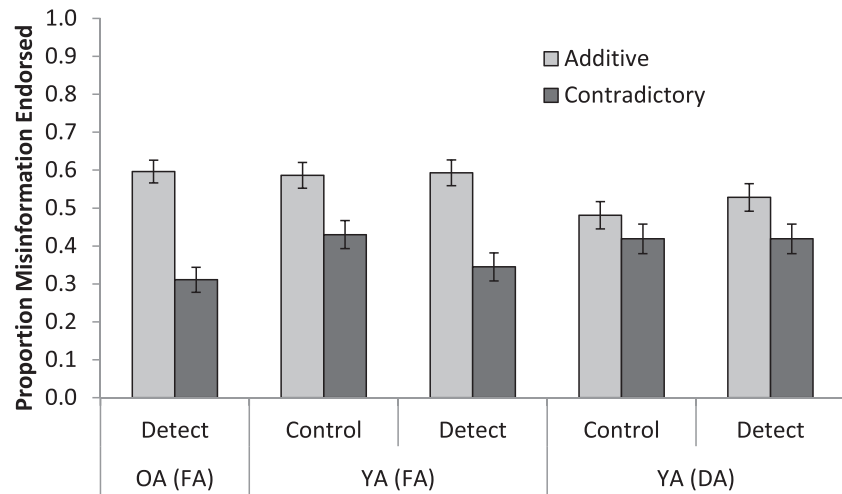


FIGURE 2 Proportions of additive and contradictory misinformation falsely endorsed during the final testing phase (mean \pm SE). FA, full attention; DA, divided attention; OA, older adult; YA, younger adult

First, to examine whether dividing attention influenced subsequent misinformation selection, a 2 (Misinformation Type: Additive, Contradictory) \times 2 (Attention: Full, Divided) mixed ANOVA was conducted on only younger adult participants' misinformation selections. A significant interaction was found, $F(1, 123) = 6.60$, $MSE = 0.03$, $\eta_p^2 = 0.05$, which showed that dividing attention had no impact on endorsement of contradictory misinformation (0.39 vs. 0.42, $t < 1$, $p_{BIC} = 0.88$), but it significantly reduced younger adults' selection of additive details, 0.59 versus 0.50, $t(123) = 2.49$, $SED = 0.03$, $d = 0.44$. That is, dividing attention reduced participants' suggestibility to additive, but not contradictory, misinformation.

Second, to examine whether detection instructions differentially influenced misinformation selection, a 2 (Misinformation Type: Additive, Contradictory) \times 2 (Error-Detection Instruction: Control, Detect) mixed ANOVA was conducted on only younger adult participants' misinformation selection. No additional effects were found: No effect of Detection Instructions, $F < 1$; the interaction failed to reach significance, $F(1, 123) = 2.32$, $MSE = 0.03$, $p = 0.13$. However, to directly evaluate the present results relative to patterns found in Huff and Umanath (2018), we probed suggestibility in full-attention participants as a function of detection instructions. Replicating prior findings, we found no difference in the proportions of additive misinformation endorsed for Detect and Control participants (0.59 vs. 0.59). However, a marginally significant effect was found for a reduction in contradictory details following detection than control instructions (0.35 vs. 0.43), $t(63) = 1.82$, $SED = 0.05$, $d = 0.34$, $p = 0.07$, $p_{BIC} = 0.84$, a numerical effect consistent with the notion that contradictory items are easier to detect and thereby reject on the final test.

Third, regarding whether dividing younger adults' attention in the detection group led them to perform similar to older adults, a 2 (Misinformation Type: Additive, Contradictory) \times 3 (Detection Group: OA FA-D, YA FA-D, YA DA-D) mixed ANOVA was conducted on misinformation selection. There was no main effect of Detection Group, $F < 1$, $p_{BIC} = 0.99$. However, a significant interaction emerged, $F(2, 101) = 3.98$, $MSE = 0.04$, $\eta_p^2 = 0.07$. Neither of the follow-up one-way ANOVAs conducted for additive and contradictory misinformation reached significance, for additive, $F(2, 101) = 1.11$, $p = 0.33$, $p_{BIC} = 0.97$; for contradictory, $F(2, 101) = 2.34$, $p = 0.10$, $p_{BIC} = 0.91$.

Instead, YA DA-D endorsed less additive and more contradictory misinformation than either the OA, for additive, 0.53 versus 0.60, $t(69) = 1.34$, $p = 0.13$, $p_{BIC} = 0.74$; for contradictory, 0.42 versus 0.31, $t(69) = 1.98$, $SED = 0.06$, $d = 0.48$, $p = 0.05$, or YA Full Attention Detection groups, for additive, 0.53 versus 0.59, $t(61) = 1.23$, $p = 0.22$, $p_{BIC} = 0.78$; for contradictory, 0.42 versus 0.35, $t(61) = 1.58$, $p = 0.12$, $p_{BIC} = 0.74$. Though these effects were mostly unreliable on their own, the pattern produced a significant interaction between Detection Group and Misinformation Type. In addition, no differences occurred in misinformation selection between OA FA-D and YA FA-D, $t_s < 1$, $p_{BIC} > 0.85$. Thus, older adults' performed similar to younger adults with full attention rather than younger adults under divided attention. Note that when prior work was replicated, older adults (FA-D) showed reduced suggestibility for contradictory items ($M = 0.31$) than did YA FA, $M = 0.43$, $t(71) = 2.20$, $SED = 0.05$, $d = 0.52$.

Therefore, in summary of our research questions above, (a) dividing attention reduced younger adults' suggestibility to additive misinformation, but not contradictory; (b) detection instructions did not seem to have a strong influence on younger adults' suggestibility; and (c) dividing younger adults' attention did not lead them to have the same pattern of suggestibility as that of older adults.

Conditionalized analyses regarding initial detection

Thus far, explicit detection instructions seem to be ineffective at reducing, or in any way affecting, suggestibility rates for either type of misinformation. This pattern diverges from Huff and Umanath (2018), in which the strong-detection instructions used here reduced younger adults' susceptibility to contradictory, but not additive, misinformation. Given the additional factor impacting attentional resources, the influence of the detection task here may be contingent on whether participants *successfully* detected a given error versus missed it rather than simply being asked to look for errors. Because the detection groups noted items that they believed contained errors during the misleading question phase, we can conditionalize subsequent suggestibility to misinformation on the final test on initial successful (vs. unsuccessful) error detection. A 2 (Error Detection: Success vs. Failure) \times 2 (Misinformation Type: Additive, Contradictory) \times 3 (Detection Group: OA FA-D, YA FA-D, YA

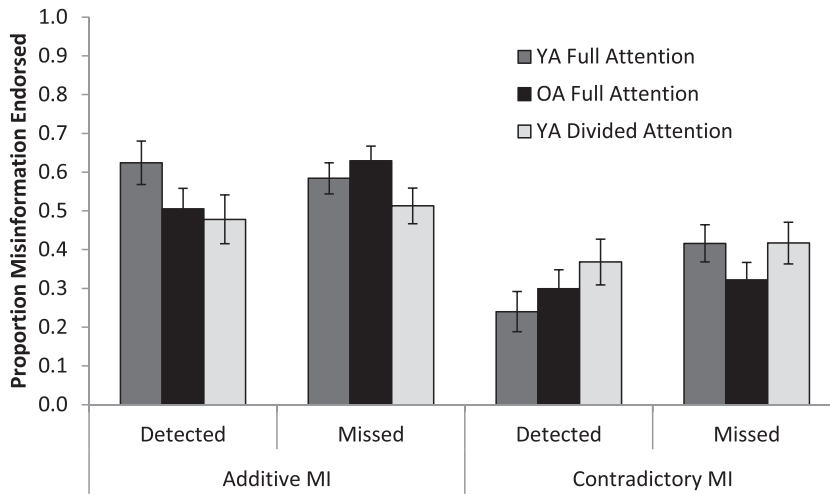


FIGURE 3 Effect of earlier correct detection on later suggestibility to additive and contradictory misinformation in older and younger adults. Proportions of errors detected during the final testing phase as a function of previous error detection (mean \pm SE). MI, misinformation; OA, older adult; YA, younger adult

DA-D) mixed ANOVA was conducted on misinformation selection. Error Detection, success or failure, is a within-subjects factor such that a given participant had both items for which they successfully detected an error during the misleading question phase (additive or contradictory) and items for which they failed to notice an error. These data are plotted in Figure 3. Note that we focus our discussion on effects involving the Error Detection factor because the other effects have already been discussed as part of other analyses above. Participants, across misinformation types and detection groups, selected less misinformation following successful detection during the misleading question phase ($M = 0.42$) than when they failed to do so, $M = 0.48$, $F(1, 90) = 6.32$, $MSE = 0.05$, $\eta_p^2 = 0.07$. This main effect was qualified by a significant three-way interaction, $F(2, 90) = 3.82$, $MSE = 0.06$, $\eta_p^2 = 0.08$.

To follow up on this three-way interaction, separate 2 (Error Detection \times 3 (Detection Group) mixed ANOVAs were conducted for additive and contradictory misinformation. For additive misinformation, all effects failed to reach conventional levels of significance, $p_s > 0.08$, $p_{BIC5} > 0.71$, indicating that misinformation selection remained the same regardless of age, attention, or successful detection. However, for contradictory misinformation, there was a main effect of Error Detection such that all participants showed reduced subsequent suggestibility when they successfully detected a contradictory error during the misleading question phase ($M = 0.31$) versus missed such an error, $M = 0.38$, $F(1, 93) = 4.50$, $MSE = 0.06$, $\eta_p^2 = 0.05$. That is, successful error detection of contradictory misinformation during the misleading question phase reduced suggestibility to those items on the final test. The effect of Detection Group and the interaction failed to reach significance, $p_s > 0.26$, $p_{BIC5} > 0.85$.

3.2.2 | Correct responses

Correct responses on the final 3-AFC test as a function of group and item type are reported in Table 3. Regarding correct answers, different responses to neutral, additive, and contradictory details constituted correct selections. For neutral and additive items, the correct response was selection of the "I don't know/Neither" option because no other option appeared in the original story. In contrast, for contradictory items, the correct response was to select the detail from the original story. A 3 (Item Type) \times 5 (Group) mixed ANOVA was used to examine correct responses. Participants showed lower correct selection for additive misleading details ($M = 0.26$) than either neutral, $M = 0.46$, $t(165) = 22.38$, $SEM = 0.02$, $d = 0.77$, or contradictory details, $M = 0.44$, $t(165) = 7.44$, $SEM = 0.03$, $d = 0.85$, with no difference between the latter two item types, $t < 1$, $F(2, 322) = 42.57$, $MSE = 0.05$, $\eta_p^2 = 0.21$. A significant main effect of Group, $F(4, 161) = 3.45$, $MSE = 0.10$, $\eta_p^2 = 0.08$, also emerged.

These main effects were qualified by a significant Item Type \times Group interaction, $F(8, 322) = 2.43$, $MSE = 0.05$, $\eta_p^2 = 0.06$. We deconstructed this interaction by comparing Groups within each item type. For neutral items, correct responses were lowest in the YA DA-D group, M_s range from 0.46 to 0.53, $t_s > 2.19$, $p_s < 0.03$; $F(4, 161) = 2.96$, $MSE = 0.09$, $\eta_p^2 = 0.07$. For additive details, there were no differences across condition for correct selection, $F < 1$, $p_{BIC} = 1.00$, indicating that neither detection instructions nor dividing attention affects participants' poor correct selection regarding additive items. For contradictory items, an interesting pattern emerged, $F(4, 161) = 4.86$, $MSE = 0.05$, $\eta_p^2 = 0.11$. For the YA Full Attention groups, the detection instructions improved correct responding, $M_s = 0.49$ vs.

TABLE 3 Mean (SD) proportions of correct responses during the cued-recall three-alternative-forced-choice (3-AFC) test

Final Test Item Type	OA full attention		YA full attention		YA divided attention	
	Detect	Control	Detect	Control	Detect	Control
Comprehension	0.89 (0.09)	0.92 (0.09)	0.92 (0.12)	0.89 (0.14)	0.90 (0.11)	0.90 (0.11)
Neutral	0.53 (0.33)	0.46 (0.30)	0.51 (0.34)	0.51 (0.27)	0.30 (0.28)	0.30 (0.28)
Additive	0.25 (0.22)	0.23 (0.18)	0.25 (0.21)	0.32 (0.21)	0.24 (0.27)	0.24 (0.27)
Contradictory	0.56 (0.26)	0.37 (0.23)	0.49 (0.20)	0.42 (0.24)	0.37 (0.21)	0.37 (0.21)

0.36, $t(63) = 2.41$, $SED = 0.05$, $d = 0.60$, whereas for YA Divided Attention groups, there was no difference ($t < 1$, $p_{BIC} = 0.89$). That is, FA-D improved correct selection, but when divided attention and detection instructions were combined ($M = 0.37$), performance was reduced to the level of the control conditions.

Interestingly, older adults showed the best correct performance of all groups ($M = 0.56$), significantly above both YA FA, $M = 0.36$, $t(71) = 3.45$, $SED = 0.06$, $d = 0.82$, and YA DA-D, $M = 0.37$, $t(69) = 3.34$, $SED = 0.06$, $d = 0.81$, but no different than YA FA-D, $M = 0.49$, $t(72) = 1.28$, $SED = 0.05$, $p = 0.21$, $p_{BIC} = 0.87$.

Within each group examining the pattern between item types, all full-attention groups showed the same pattern as well as YA DA group: Participants performed worse for additive items compared with neutral and contradictory items, for which they performed similarly. However, for YA DA-D, these differences in correct responding across the item types disappeared, $F(2, 58) = 2.49$, $MSE = 0.05$, $\eta_p^2 = 0.09$, $p = 0.09$, $p_{BIC} = 0.70$, with performance dropping to the level of additive items on neutral and contradictory items compared with other conditions as discussed above.

4 | DISCUSSION

The present findings replicated prior work (i.e., Huff & Umanath, 2018; Moore & Lampinen, 2016) but also extended our understanding of suggestibility to additive and contradictory misinformation in several ways. First, we discuss the findings that are specifically consistent with Huff and Umanath (2018). Error detection during the misleading question phase was equivalent for older and younger adults as well as for additive and contradictory misinformation. That is, there was no age difference in the ability to notice errors, and the two types of errors were detected at equivalent rates. With heavily emphasized detection instructions including direct examples of the misinformation types, younger adults were able to match older adults' low suggestibility to contradictory misinformation just as Huff and Umanath previously demonstrated. Note that both the older adult and younger adult with full-attention groups also showed reduced suggestibility to contradictory misinformation relative to younger adults in the control group, indicating that detection instructions reduced suggestibility for this type of misinformation. These three groups were therefore more susceptible to additive misinformation than to contradictory misinformation.

The added contributions of the present study involve furthering our understanding of the mechanisms underlying suggestibility to additive and contradictory types of misinformation at exposure (during the misleading question phase) and retrieval (during the final test). Specifically, we were able to examine encoding of misinformation through our manipulations of detection instructions and, more importantly, through allocation of attentional resources during the misleading question phase. The influence of these factors on subsequent retrieval (or lack thereof) was observed via misinformation selection on the final test of the original story.

Surprisingly, taxing attentional resources during the misleading question phase did not affect detection of additive errors (vs. younger adults under full attention or older adults), nor did it influence false alarms to neutral items. Younger adults in the divided attention with

detection condition were the most taxed in terms of cognitive resources, having been asked to look for erroneous details while answering questions and completing a digit-monitoring task. If the division of attention generally affected younger adults' criteria to report any given item as containing error, error reporting of all item types should have been affected.¹ Instead, only detection of contradictory errors was impacted, suggesting a qualitative difference in how these misleading details are processed.

The present data indicate that when attentional resources are scarce, retrieving the original story detail to compare it to the current detail is effortful and thereby beyond the cognitive load that participants are able to take on (Simons & Ambinder, 2005). It is also possible that the participants did encode both the original and changed details, but with reduced attention, failed to directly compare the two and discover the discrepancy (Simons, 2000). These possibilities are consistent with the vast literature on change blindness and change detection (see Simons, 2000, for a review). Because of its relations to attention and memory, we draw on this literature below to help interpret the present findings because little direct work in memory and misinformation has been conducted. Similarly, recollection is more effortful than familiarity-based processes (Yonelinas, 2002), and because recollection rejection is employed more for contradictory than for additive details (Moore & Lampinen, 2016), processing contradictory misinformation would then require more resources than additive misinformation.

Why then were additive details still detected similarly under full and divided attention? Perhaps, in contrast to our initial hypotheses, it is for *these* items that no effortful comparison is needed; one simply has to notice that there is something new. Thus, rather than noting a discrepancy, which may be difficult as it requires a comparison with a specific event from the past (i.e., change blindness, see Simons & Rensink, 2005, for a review), participants merely need to detect novelty. Novelty may therefore be a more fluent cue than exposure to contradictory information. Without any prior knowledge to rely on to bolster detection of a change or error, a different fictional detail may not be particularly salient (e.g., Zambari vs. Bumbaru) especially when attention is divided. Our results suggest that although detection of additive and contradictory details may be equivalent under some circumstances such as with full attention, the underlying processes leading to that equivalent error detection seem to be different—one involving discrepancy detection or recollection rejection (contradictory misinformation) requires sufficient attentional resources and another involving novelty detection (additive misinformation) that seems to be less affected by cognitive load.

Turning to the final recognition test, a different pattern was found. Despite divided attention reducing younger adults' detection of contradictory details and having no influence on the initial

¹Interestingly, when younger adults were tasked with detecting errors under full attention, this combination led to the greatest number of correct responses to misleading questions. Though all groups should encode the original story similarly because encoding was self-paced and evidenced by equivalent story comprehension, this pattern suggests that the detection task did not distract participants from thinking back to the original story and actually enhanced their ability to recall correct information. That is, the error-detection task did not act as another division of attentional resources.

detection of additive details, the opposite was true for the later endorsement of misinformation. Dividing attention during exposure to misinformation had little impact on later suggestibility to contradictory misinformation and reduced suggestibility to additive misinformation. This pattern held for participants who were and were not tasked with detecting errors during the misleading question phase.

As discussed above, during the misleading question phase, dividing attention did not affect detection of additive misinformation; younger adults' detection was equivalent to when they were fully attending to the task of answering questions about the original story. Why then would this pattern not carry over to the final recognition test? With full attention, as Huff and Umanath (2018) pointed out, for additive misinformation, the details become familiar by the final test and come to mind more fluently than the lack of an original detail but, importantly, do not have another detail available to make a comparison. For example, it has been shown that when misinformation that contradicted well-known facts was highlighted in red font to increase its distinctiveness, participants actually reproduced those errors more than if the misinformation had not been highlighted (Eslick, Fazio, & Marsh, 2011). The distinctiveness essentially backfired, making the errors more memorable at retrieval but without the tag of being misinformation, suggesting a source monitoring failure. In fact, information for source details has been shown to require more attentional resources to encode and retrieve than item information (Troyer, Winocur, Craik, & Moscovitch, 1999). Hence, participants show a high suggestibility rate. Such issues as well as retrieval interference and retrieval blocking may only be exacerbated by the recognition test used here compared with a recall-based assessment; despite a three-alternative-forced-choice format, the negative consequences of multiple-choice testing may be at play here (Roediger & Marsh, 2005). In contrast, when attention is divided at exposure to these details, the fleeting novelty signal that allows for maintenance of detection of additive details seems to do little for encoding the details, and actual storage of the errors is disrupted, leading to a reduction in endorsement of these details later.

Turning to contradictory misinformation, because dividing attention during the misleading question phase led to a reduction in error detection, one could imagine several potential outcomes. One possibility is that reduced error detection indicates impoverished encoding, which, in turn, reduces suggestibility. However, work in the change detection literature suggests that this is unlikely. Hollingworth and Henderson (2002) found that participants can recognize details in previously seen natural scenes despite failing to note a major change to the scenes (see also, Mitroff, Simons, & Levin, 2004; Simons & Ambinder, 2005). Another possibility is that reduced detection could indicate a lack of "tagging" of these details as errors that would then lead to increased suggestibility. Instead, our data revealed that contradictory misinformation rates were no different for those who were exposed under divided versus full attention. Exposure to the contradictory detail during the misleading question phase seems to have been enough to provide a secondary cue to recognize the original story detail on the final test. For instance, in a change detection paradigm, participants were able to recognize both an original stimulus and a changed stimulus at above chance levels

despite failing to detect the change itself (Mitroff et al., 2004). Finally, the lack of an effect of attentional resources might also have been due to the mere presence of the original story detail at test. That is, when the original story item is presented, participants can choose this option on the basis of remembering exclusively the original story, regardless of memory for anything presented (or not) during the misleading question phase.

The present data corroborated the previous finding that the error-detection task reduced later endorsement of contradictory errors (see also, Tousignant, Hall, & Loftus, 1986), but not additive ones, as the detection task marginally reduced suggestibility to contradictory but not additive misinformation. A stronger indication of the impact of explicit error detection was seen in examining of detection success versus failure. For additive items, suggestibility remained high regardless of whether or not participants successfully detected the error across all three detection groups. However, consistent with other findings on discrepancy detection and subsequent memory (Putnam et al., 2014; Umanath & Marsh, 2012), successful detection of contradictory items did reduce subsequent suggestibility to errors compared with when an error was not noticed. These findings further support the notion that detection of additive misinformation at encoding does not seem to affect suggestibility to this type of misinformation, whereas for contradictory misinformation, initial detection of the errors at exposure reduces subsequent susceptibility.

A secondary question examined in this work addressed whether dividing younger adults' attention would result in performance similar to that of older adults under full attention. Under a variety of circumstances involving item and associative memory (Castel & Craik, 2003) and recognition memory (Jennings & Jacoby, 1993), dividing younger adults' attention, thereby depleting their cognitive resources, can lead to performance reminiscent to that of older adults. Indeed, reduced attentional resources in conjunction with the error-detection task resulted in their correct responding during the misleading question phase dropping to the level of older adults. Older adults, replicating Huff and Umanath (2018), showed less correct responding than did younger adults in the full attention with detection condition but were no different than younger adults in the divided attention with detection condition.

However, the similarity between younger adults with taxed attentional resources and older adults ended there. Older adults were equivalent to younger adults in the full attention with detection condition in detecting errors, outperforming younger adults in the divided attention with detection condition. Coupled with equivalent performance on story comprehension questions on the final test, this pattern is unlikely to have been due to generally poorer encoding by older adults. Instead, under circumstances of few attentional resources, older adults may have simply allocated their cognitive resources differently. By "differently," we mean towards the error-detection task rather than answering the questions during the misleading question phase. Although older adults can show impairments in metamemory (Dodson, Bawa, & Krueger, 2007; Toth, Daniels, & Solinger, 2011), under some circumstances, older adults accurately judge their forgetting, adjusting their estimates of their performance accordingly (Halamish, McGillivray, & Castel, 2011), and they are capable of allocating additional study time to high-value information, matching

younger adults on memory for those items (Castel, Murayama, Friedman, McGillivray, & Link, 2013).

Regarding subsequent suggestibility, older adults showed similar patterns of suggestibility to younger adults under full attention with detection, replicating Huff and Umanath (2018), rather than those under divided attention. Older adults similarly showed reduced suggestibility to contradictory misinformation than did the younger adults under full attention who were not asked to detect errors during the misleading question phase. Again, this indicates that heavily taxing younger adults' attentional resources during encoding of the misinformation did not lead to a similar performance as older adults. In fact, older adults had the best correct performance on the final test of all groups, driven by their accuracy on contradictory items. Thus, a reduction in attentional resources does not explain older adults' reduced suggestibility to contradictory misinformation. Instead, as mentioned above, it could be due to a differential approach during exposure to misinformation, either intentional or automatic, or something as simple as proactive interference, to which they are more susceptible (for reviews, see Jacoby, Hessel, & Bopp, 2001; Winocur, 1982).

Overall, the present data indicate that additive and contradictory misinformation are processed differently both at initial exposure and at retrieval. Low attentional resources reduce only detection of contradictory errors and not additive ones at exposure. This finding provides support that the detection process itself is fundamentally different for these two types of misinformation. Noting contradictory errors involves a discrepancy detection process wherein one must remember the original story detail and then compare the two just as seen in the change blindness literature (Simons & Rensink, 2005). In contrast, noticing additive errors may only involve attending to a novelty signal, something that may be easier to process initially.

The differing patterns of suggestibility to additive and contradictory misinformation support the idea that there are basic differences between these types of misinformation at retrieval as well. Greater endorsement rates for additive misinformation suggest that detection or rejection of these items at test is less likely than contradictory misinformation, producing a greater cost to memory accuracy (see also, Moore & Lampinen, 2016). When attention is divided during misinformation exposure, additive misinformation is reduced, demonstrating that limiting exposure to such details restricts their accessibility at retrieval. Thus, certain groups such as children, though not older adults, may be less susceptible to this type of misinformation due to attentional limitations; further work is needed here. For contradictory misinformation, however, restricting exposure through divided attention is insufficient. Instead, participants need to have attentional resources available, specifically directed towards detecting errors by having knowledge of how errors manifest. Older adults benefit from directed resources towards error detection just as younger adults do, demonstrating an improvement in memory accuracy in both age groups. These differences provide further evidence for the dissociation between these types of misinformation in terms of attention, detection, and aging. Future work should aim towards greater understanding of the dissociations noted here between additive and contradictory misinformation in order to reduce suggestibility and increase memory accuracy overall.

ACKNOWLEDGEMENTS

We express our gratitude to Alexandra Carter, Lauren Clubb, and Grant Gilchrist for assistance with data collection and coding. Partial funding support was provided by the National Institute on Aging (T32 AG0000-0-39).

ORCID

Sharda Umanath  <https://orcid.org/0000-0002-6699-4357>

REFERENCES

- Ayers, M. S., & Reder, L. M. (1998). A theoretical review of the misinformation effect: Predictions from an activation-based memory model. *Psychonomic Bulletin & Review*, 5, 1–21. <https://doi.org/10.3758/BF03209454>
- Berger, S. A., Hall, L. K., & Bahrack, H. P. (1999). Stabilizing access to marginal and submarginal knowledge. *Journal of Experimental Psychology: Applied*, 5, 438–447.
- Castel, A. D., & Craik, F. I. (2003). The effects of aging and divided attention on memory for item and associative information. *Psychology and Aging*, 18, 873–885. <https://doi.org/10.1037/0882-7974.18.4.873>
- Castel, A. D., Murayama, K., Friedman, M. C., McGillivray, S., & Link, I. (2013). Selecting valuable information to remember: Age-related differences and similarities in self-regulated learning. *Psychology and Aging*, 28, 232–242. <https://doi.org/10.1037/a0030678>
- Craik, F. I. (1982). Selective changes in encoding as a function of reduced processing capacity. *Cognitive Research in Psychology*, 152–161.
- Craik, F. I., & Byrd, M. (1982). Aging and cognitive deficits. In *Aging and cognitive processes* (pp. 191–211). Boston, MA: Springer. https://doi.org/10.1007/978-1-4684-4178-9_11
- Craik, F. I., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General*, 125, 159–180. <https://doi.org/10.1037/0096-3445.125.2.159>
- Craik, F. I. M., & Anderson, N. D. (1999). Applying cognitive research to problems of aging. In D. Gopher, & A. Koriat (Eds.), *Attention and performance XVII: Cognitive regulation of performance: Interaction of theory and application* (pp. 583–615). Cambridge, MA: The MIT Press.
- Dodson, C. S., Bawa, S., & Krueger, L. E. (2007). Aging, metamemory, and high-confidence errors: A misrecollection account. *Psychology and Aging*, 22, 122–133. <https://doi.org/10.1037/0882-7974.22.1.122>
- Eakin, D. K., Schreiber, T. A., & Sergent-Marshall, S. (2003). Misinformation effects in eyewitness memory: The presence and absence of memory impairment as a function of warning and misinformation accessibility. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 29, 813–825.
- Ecker, U. K., Lewandowsky, S., & Tang, D. T. (2010). Explicit warnings reduce but do not eliminate the continued influence of misinformation. *Memory & Cognition*, 38, 1087–1100. <https://doi.org/10.3758/MC.38.8.1087>
- Eslick, A. N., Fazio, L. K., & Marsh, E. J. (2011). Ironic effects of drawing attention to story errors. *Memory*, 19, 184–191. <https://doi.org/10.1080/09658211.2010.543908>
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189–198. [https://doi.org/10.1016/0022-3956\(75\)90026-6](https://doi.org/10.1016/0022-3956(75)90026-6)
- Frost, P. (2000). The quality of false memory over time: Is memory for misinformation “remembered” or “known”? *Psychonomic Bulletin & Review*, 7, 531–536. <https://doi.org/10.3758/BF03214367>

- Frost, P., Ingraham, M., & Wilson, B. (2002). Why misinformation is more likely to be recognised over time: A source monitoring account. *Memory*, 10, 179–185. <https://doi.org/10.1080/09658210143000317>
- Halamish, V., McGillivray, S., & Castel, A. D. (2011). Monitoring one's own forgetting in younger and older adults. *Psychology and Aging*, 26, 631–635. <https://doi.org/10.1037/a0022852>
- Hollingworth, A., & Henderson, J. M. (2002). Accurate visual memory for previously attended objects in natural scenes. *Journal of Experimental Psychology: Human Perception and Performance*, 28, 113–136.
- Huff, M. J., & Umanath, S. (2018). Evaluating suggestibility to additive and contradictory misinformation following explicit error detection in younger and older adults. *Journal of Experimental Psychology: Applied*, 24, 180–195. <https://doi.org/10.1037/xap0000138>
- Jacoby, H. L., Hessels, S., & Bopp, K. (2001). Proactive and retroactive effects in memory performance: Dissociating recollection and accessibility bias. In H. L. Roediger, III, J. S. Nairne, I. Neath, & A. M. Surprenant (Eds.), *The nature of remembering: Essays in honor of Robert G. Crowder* (pp. 35–54). Washington, DC: American Psychological Association.
- Jennings, J. M., & Jacoby, L. L. (1993). Automatic versus intentional uses of memory: Aging, attention, and control. *Psychology and Aging*, 8, 283–293. <https://doi.org/10.1037/0882-7974.8.2.283>
- Loftus, E. F. (1975). Leading questions and the eyewitness report. *Cognitive Psychology*, 7, 560–572. [https://doi.org/10.1016/0010-0285\(75\)90023-7](https://doi.org/10.1016/0010-0285(75)90023-7)
- Loftus, E. F. (2005). Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. *Learning & Memory*, 12, 361–366. <https://doi.org/10.1101/lm.94705>
- Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory*, 4, 19–31.
- Luna, K., & Migueles, M. (2009). Acceptance and confidence of central and peripheral misinformation. *The Spanish Journal of Psychology*, 12, 405–413. <https://doi.org/10.1017/S1138741600001797>
- 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. <https://doi.org/10.1037/0882-7974.14.1.3>
- Marsh, E. J. (2004). Story stimuli for creating false beliefs about the world. *Behavior Research Methods, Instruments, & Computers*, 36, 650–655. <https://doi.org/10.3758/BF03206546>
- Masson, M. E. J. (2011). A tutorial on a practical Bayesian alternative to null-hypothesis significance testing. *Behavior Research Methods*, 43, 679–690. <https://doi.org/10.3758/s13428-010-0049-5>
- 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. <https://doi.org/10.1002/acp.857>
- Mitroff, S. R., Simons, D. J., & Levin, D. T. (2004). Nothing compares 2 views: Change blindness can occur despite preserved access to the changed information. *Perception & Psychophysics*, 66, 1268–1281. <https://doi.org/10.3758/BF03194997>
- Moore, K. N., & Lampinen, J. M. (2016). The use of recollection rejection in the misinformation paradigm. *Applied Cognitive Psychology*, 30, 992–1004. <https://doi.org/10.1002/acp.3291>
- Mueller-Johnson, K., & Ceci, S. J. (2004). Memory and suggestibility in older adults: Live event participation and repeated interview. *Applied Cognitive Psychology*, 18, 1109–1127. <https://doi.org/10.1002/acp.1078>
- Nemeth, R. J., & Belli, R. F. (2006). The influence of schematic knowledge on contradictory versus additive misinformation: False memory for typical and atypical items. *Applied Cognitive Psychology*, 20, 563–573. <https://doi.org/10.1002/acp.1207>
- Okado, Y., & Stark, C. E. (2005). Neural activity during encoding predicts false memories created by misinformation. *Learning & Memory*, 12, 3–11. <https://doi.org/10.1101/lm.87605>
- Putnam, A. L., Wahlheim, C. N., & Jacoby, L. L. (2014). Memory for flip-flopping: Detection and recollection of political contradictions. *Memory & Cognition*, 42, 1198–1210. <https://doi.org/10.3758/s13421-014-0419-9>
- Roediger, H. L. III, & Marsh, E. J. (2005). The positive and negative consequences of multiple-choice testing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31, 1155–1159.
- Roediger, H. L., Meade, M. L., & Bergman, E. T. (2001). Social contagion of memory. *Psychonomic Bulletin & Review*, 8, 365–371. <https://doi.org/10.3758/BF03196174>
- Saunders, J., & Jess, A. (2010). The effects of age on remembering and knowing misinformation. *Memory*, 18, 1–11. <https://doi.org/10.1080/09658210903376268>
- Schneider, W., Eschmann, A., & Zuccolotto, A. (2002). *E-Prime v1.1*. Pittsburgh, PA: Psychology Software Tools Inc.
- Schwartz, B. L. (2002). *Tip-of-the-tongue states: Phenomenology, mechanism, and lexical retrieval*. Mahwah, NJ: Erlbaum.
- Shibley, W. C. (1946). The Shibley-Hartford vocabulary test. Shibley Institute of Living Scale.
- Simons, D. J. (2000). Current approaches to change blindness. *Visual Cognition*, 7, 1–15. <https://doi.org/10.1080/135062800394658>
- Simons, D. J., & Ambinder, M. S. (2005). Change blindness: Theory and consequences. *Current Directions in Psychological Science*, 14, 44–48. <https://doi.org/10.1111/j.0963-7214.2005.00332.x>
- Simons, D. J., & Rensink, R. A. (2005). Change blindness: Past, present, and future. *Trends in Cognitive Sciences*, 9, 16–20. <https://doi.org/10.1016/j.tics.2004.11.006>
- Takarangi, M. K., Parker, S., & Garry, M. (2006). Modernising the misinformation effect: The development of a new stimulus set. *Applied Cognitive Psychology*, 20, 583–590. <https://doi.org/10.1002/acp.1209>
- Toth, J. P., Daniels, K. A., & Solinger, L. A. (2011). What you know can hurt you: Effects of age and prior knowledge on the accuracy of judgments of learning. *Psychology and Aging*, 26, 919–931. <https://doi.org/10.1037/a0023379>
- Tousignant, J. P., Hall, D., & Loftus, E. F. (1986). Discrepancy detection and vulnerability to misleading postevent information. *Memory & Cognition*, 14, 329–338. <https://doi.org/10.3758/BF03202511>
- Troyer, A. K., Winocur, G., Craik, F. I., & Moscovitch, M. (1999). Source memory and divided attention: Reciprocal costs to primary and secondary tasks. *Neuropsychology*, 13, 467–474. <https://doi.org/10.1037/0894-4105.13.4.467>
- Umanath, S., & Marsh, E. J. (2012). Aging and the memorial consequences of catching contradictions with prior knowledge. *Psychology and Aging*, 27, 1033–1038. <https://doi.org/10.1037/a0027242>
- Umanath, S., & Marsh, E. J. (2014). Understanding how prior knowledge influences memory in older adults. *Perspectives on Psychological Science*, 9, 408–426. <https://doi.org/10.1177/1745691614535933>
- Wagenmakers, E.-J. (2007). A practical solution to the pervasive problems of *p* values. *Psychonomic Bulletin & Review*, 14, 779–804. <https://doi.org/10.3758/BF03194105>
- Wilford, M. M., Chan, J. C., & Tuhn, S. J. (2014). Retrieval enhances eyewitness suggestibility to misinformation in free and cued recall. *Journal of Experimental Psychology: Applied*, 20, 81–93. <https://doi.org/10.1037/xap0000001>
- Winocur, G. (1982). The amnesic syndrome: a deficit in cue utilization. In L. S. Cermak (Ed.), *Human memory and amnesia* (pp. 139–166). Hillsdale, NJ: Erlbaum.

- Wright, D. B., & Stroud, J. N. (1998). Memory quality and misinformation for peripheral and central objects. *Legal and Criminological Psychology*, 3, 273–286. <https://doi.org/10.1111/j.2044-8333.1998.tb00366.x>
- Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, 46, 441–517. <https://doi.org/10.1006/jmla.2002.2864>
- Zhu, B., Chen, C., Loftus, E. F., Lin, C., He, Q., Chen, C., ... Dong, Q. (2010). Individual differences in false memory from misinformation: Cognitive factors. *Memory*, 18, 543–555. <https://doi.org/10.1080/09658211.2010.487051>

How to cite this article: Umanath S, Ries F, Huff MJ. Reducing suggestibility to additive versus contradictory misinformation in younger and older adults via divided attention and/or explicit error detection. *Appl Cognit Psychol*. 2019;33: 793–805. <https://doi.org/10.1002/acp.3522>