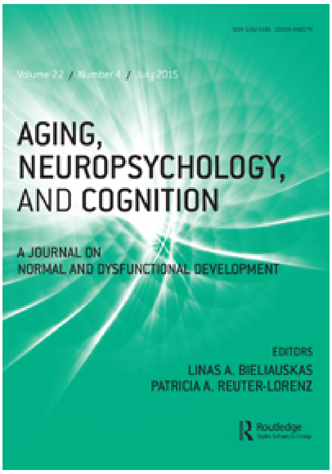

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The role of prior knowledge in error correction for younger and older adults

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Previous work has demonstrated that, when given feedback, younger adults are more likely to correct high-confidence errors compared with low-confidence errors, a finding termed the hypercorrection effect. Research examining the hypercorrection effect in both older and younger adults has demonstrated that the relationship between confidence and error correction was stronger for younger adults compared with older adults. Their results demonstrated that the relationship between confidence and error correction was stronger for younger adults compared with older adults. However, recent work suggests that error correction is largely related to prior knowledge, while confidence may primarily serve as a proxy for prior knowledge. Prior knowledge generally remains stable or increases with age; thus, the current experiment explored how both confidence and prior knowledge contributed to error correction in younger and older adults. Participants answered general knowledge questions, rated how confident they were that their response was correct, received correct answer feedback, and rated their prior knowledge of the correct response. Overall, confidence was related to error correction for younger adults, but this relationship was much smaller for older adults. However, prior knowledge was strongly related to error correction for both younger and older adults. Confidence alone played little unique role in error correction after controlling for the role of prior knowledge. These data demonstrate that prior knowledge largely predicts error correction and suggests that both older and younger adults can use their prior knowledge to effectively correct errors in memory.

Keywords: hypercorrection effect; feedback; memory; confidence; aging

Feedback is essential for correcting errors in memory, a finding that is evident and important across the life span (Eich, Stern, & Metcalfe, 2013; Kelley & McLaughlin, 2012; Tse, Balota, & Roediger, 2010). For example, consider an older adult who takes a moderate dose of medication (1 pill a day) for a heart condition and is then told by a physician to change the dosage and frequency (2 pills, twice a day). Will this individual be able to effectively incorporate feedback from her physician and update her knowledge? Previous research does not provide a consistent answer. Indeed, although some work suggests that older adults have difficulty updating their memory when information conflicts with prior knowledge (Okun & Rice, 1997; Rice & Okun, 1994; Umanath & Marsh, 2014), other findings indicate that older adults can effectively use feedback to update memory (Eich et al., 2013; Kelley & McLaughlin, 2012; Tse et al., 2010).

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Our particular concern in this study regards the role of feedback and the processes responsible for updating older adults' knowledge. A number of studies have indicated that, following feedback, individuals are more likely to maintain correct responses and more likely to correct errors compared to when feedback is withheld (Kulhavy, Yekovich, & Dyer, 1976; Pashler, Cepeda, Wixted, & Rohrer, 2005). Although feedback is often beneficial to memory, there are a number of factors that affect how feedback is processed and, accordingly, the likelihood of error correction. For example, a person's confidence in a response and prior knowledge may influence attention to feedback and subsequent error correction (Butterfield & Mangels, 2003; Butterfield & Metcalfe, 2001, 2006; Fazio & Marsh, 2009; Kulhavy et al., 1976). In the current study, we sought to clarify the processes responsible to error correction in older adults.

Feedback, error correction, and aging

The majority of research examining the role of confidence in error correction has tested college-aged students. Counterintuitively, young adults are more likely to correct high-confidence errors compared with low-confidence errors. This finding, termed the hyper-correction effect, has been well documented (Butterfield & Mangels, 2003; Butterfield & Metcalfe, 2001, 2006; Fazio & Marsh, 2009; Kulhavy et al., 1976). For example, Butterfield and Metcalfe (2001) had young adults answer general knowledge questions (e.g., "What poison did Socrates take at his execution?") and rate their confidence in the correctness of their response. Participants were then given feedback confirming whether an answer was correct or displaying the correct answer if a response was incorrect. After a short delay (5 min), participants were retested on the same questions. Overall, participants were more likely to correct high-confidence errors on the initial test compared with low-confidence errors.

Hypercorrection is typically measured by calculating a gamma correlation (a nonparametric measure of association; see Nelson, 1984) between the level of confidence in errors on an initial test and accuracy for those items on a final test. Positive correlations indicate that people are more likely to correct errors held with high levels of confidence compared with low-confidence errors. Butterfield and Metcalfe (2001) found that the mean correlation across participants was positive (G = .36), indicating that individuals were more likely to correct high-confidence errors compared with errors held with lower levels of confidence.

Recently, researchers have begun to investigate whether hypercorrection is exhibited by children (Metcalfe & Finn, 2012) and older adults (Cyr & Anderson, 2013; Eich et al., 2013). Most relevant to the current study, Eich et al. (2013) reported that older adults hypercorrect to a lesser extent than younger adults. Specifically, both younger (M age = 20.7) and older (M age = 65.7) adults answered a series of general knowledge questions and rated their confidence in the correctness of their response on a scale from "very unsure" (equal to a rating of 0) to "very sure" (equal to a rating of 100). Participants were given feedback after each answer, either indicating that their response was correct or providing the correct response if the wrong answer was provided, and answered questions until they had 15 incorrect responses. Overall, and consistent with prior work indicating stable or increased general knowledge with age (Verhaeghen, 2003), older adults answered significantly more questions than younger adults before accumulating 15 errors. Younger adults showed a hypercorrection effect (G = .51) and were more likely to correct high-confidence errors compared with low-confidence errors. However, the hypercorrection effect for older adults was much smaller and the mean correlation (G = .14) did not significantly differ from chance (zero). That is, older adults were equally likely to correct high-confidence and low-confidence errors. Indeed, younger adults corrected a greater proportion of high-confidence errors compared with low-confidence errors (high confidence = .85; low confidence = .76), whereas the proportion of errors corrected by older adults differed little as a function of initial confidence (high confidence = .84; low confidence = .81).

Cyr and Anderson (2013) had older and younger adults answer 150 general knowledge questions and rate their confidence for each answer; following this, the correct answer was displayed for 2 s. Older adults and younger adults correctly recalled the same proportion of responses on this initial test. However, on a second test, younger adults corrected a greater proportion of errors than older adults. In addition, younger adults were more likely than older adults to correct high-confidence errors (i.e., hypercorrection), evident in a stronger correlation between confidence in errors on test 1 and accuracy on test 2 for younger adults (G = .54) relative to older adults (G = .25). Thus, both groups exhibited hypercorrection but the magnitude of the effect was greater for younger adults.

In a second experiment, Cyr and Anderson eliminated age-related differences in hypercorrection by providing answers to general knowledge questions in a multiple-choice format. In lieu of confidence ratings, participants indicated how many responses they had considered before answering on the premise that fewer possibilities signaled greater confidence in a choice. Using this format, both older and younger adults exhibited a similar hypercorrection effect (G = .33 and G = .38, respectively). Thus, it appears that the relationship between confidence and error correction for older adults may be malleable. We suggest that a full account of hypercorrection, regardless of the experimental format, requires one to assess factors that may influence confidence judgments (e.g., prior knowledge).

What factors contribute to the age-related differences in hypercorrection reported by Eich et al. (2013) and Cyr and Anderson (2013; Experiment 1)? Such results are particularly unusual given that the ability to monitor and understand memory (i.e., metacognition) appears to be largely spared with age (e.g., Hertzog & Dunlosky, 2011; but see Dodson, Bawa, & Krueger, 2007; Rhodes & Kelley, 2005). As well, aging is characterized by stable or increasing levels of general knowledge (Verhaeghen, 2003) making it unlikely that age-related differences reflect a knowledge deficit. Instead, we suggest it may be important to consider accounts of the hypercorrection effect (e.g., the role of prior knowledge) to fully understand error correction in older adults.

Explanations of the hypercorrection effect

Explanations of the hypercorrection effect have generally posited that the degree to which a participant endorses the accuracy of their response can influence attention to feedback (Butterfield & Mangels, 2003; Butterfield & Metcalfe, 2006; Fazio & Marsh, 2009; Kulhavy et al., 1976). By this account, when there is a discrepancy between subjective perceptions of accuracy (e.g., high confidence) and objective performance (e.g., an incorrect answer), participants are surprised. This surprise, in turn, directs attentional resources toward processing feedback. Thus, the greater the discrepancy between subjective perceptions of accuracy (i.e., confidence) and performance, the greater the amount of attentional resources devoted to feedback processing and thus retention of that feedback.

Consistent with this account, Kulhavy et al. (1976) demonstrated that participants spent more time processing feedback after high-confidence errors compared with low-confidence errors. Butterfield and Metcalfe (2006; see also Butterfield & Mangels, 2003) showed that participants performed worse on a secondary tone-detection task while processing feedback for high-confidence errors compared with low-confidence errors. Likewise, Fazio and Marsh (2009) demonstrated that participants were better able to remember contextual information associated with feedback (e.g., the color of the font) following high-confidence compared with low-confidence errors. In all, these data suggest that the discrepancy between subjective perceptions of accuracy and objective performance leads to a differential allocation of attentional resources to feedback processing.

However, several studies have also indicated that prior knowledge may play a role in error correction (Butterfield & Mangels, 2003; Metcalfe & Finn, 2011; Sitzman, Rhodes, & Tauber, 2014). Specifically, participants are more likely to have high-confidence errors following questions within domains characterized by high levels of prior knowledge and can use this knowledge to correct errors. For example, suppose someone mistakenly produces the response "Glasgow" when asked to name the capital of Scotland, despite having high levels of knowledge of European geography. Confidence in the error may be elevated due to familiarity with the domain (European geography). However, given high levels of domain knowledge, the correct answer (Edinburgh) may have also been known and accessible. According to the knew-it-all-along account, such prior knowledge facilitates error correction (Metcalfe & Finn, 2011). Metcalfe and Finn observed that, after being told their high-confidence response was incorrect, participants were more likely to provide the correct response either by detecting the correct response in a multiple-choice question or by generating the correct answer when given a second opportunity to generate a response. Therefore, although an initial answer was incorrect, participants had prior knowledge of the correct response all along. For low-confidence errors, participants did not display prior knowledge of the correct response.

Research thus far suggests that both confidence and prior knowledge influence error correction. However, in a series of experiments, Sitzman et al. (2014) demonstrated that an individual's level of prior knowledge seems to largely account for error correction, while confidence judgments may be related primarily because they reflect the degree of prior knowledge. Young adults answered general knowledge questions, rated their confidence on a scale of 0 (not at all confident) to 100 (completely confident), and were given feedback in the form of the correct response. Similar to Metcalfe and Finn (2011), participants also indicated if they "knew the correct answer all along" and rated their prior knowledge on a scale of 1 (completely new to me) to 7 (I knew the correct answer). Participants then answered the same general knowledge questions again on a final test. Overall, participants were more likely to correct high-confidence errors and errors with high levels of prior knowledge. Importantly, logistic hierarchical regression analyses allowed Sitzman et al. to examine the influence of one judgment (e.g., knew-it-all-along judgments) on error correction while controlling for the influence of the other judgment (e.g., confidence judgments). Overall, these regression analyses indicated that knew-it-all-along judgments largely predicted error correction while subjective confidence played little unique role. Therefore, confidence may be related to error correction primarily because it serves a proxy for prior knowledge.

Thus, Sitzman et al. (2014) suggested that prior knowledge influences attention to feedback and is positively related to confidence. Accordingly, confidence judgments will be elevated for high-knowledge domains and lower in domains for which there is a dearth of knowledge. Participants will be most likely to attend to feedback when there is a discrepancy between a response and feedback (e.g., high-confidence responses that are incorrect) for high-knowledge domains. Not only are participants more likely to attend to feedback when there is a discrepancy between prior knowledge and the correct response, but high levels of prior knowledge are also likely to help the participant more efficiently encode new information. This suggests that a full account of error correction, and any age-related differences in hypercorrection, requires one to assess domain knowledge. Thus far, efforts have primarily been focused on examining the influence of prior knowledge on error correction for younger adults, but have yet to explore this relationship in older adults.

Prior knowledge and aging

Previous research suggests that older adults are likely to remember information consistent with their prior knowledge. Thus, prior knowledge will facilitate performance when it is consistent with to-be-remembered information but will hinder learning when it is inconsistent with to-be-remembered information (see Umanath & Marsh, 2014, for a review). Under these circumstances, older adults may have difficulty updating their knowledge to incorporate the new, correct information (Rice & Okun, 1994). Relatedly, other research has indicated that older adults are less efficient at updating their knowledge about the effectiveness of memory strategies than younger adults (Matvey, Dunlosky, Shaw, Parks, & Hertzog, 2002; Price, Hertzog, & Dunlosky, 2008).

Therefore, it is unclear whether older adults use the same mechanisms as younger adults to update their knowledge. If older adults are more likely to remember information consistent with their prior knowledge (regardless of accuracy), then they may be less likely to update memory errors in high-knowledge domains. However, if prior knowledge can facilitate error correction in older adults, then older adults should perform the same as, if not better than, younger adults when correcting errors in general knowledge. To fully understand the connection between error correction, confidence, and aging, one must also assess the level of prior knowledge.

The current study

As noted previously, Eich et al. (2013) and Cyr and Anderson (2013) observed that older adults exhibited a milder hypercorrection effect than younger adults. Notably, Eich et al. (2013) reported that older adults were equally likely to correct high-confidence and low-confidence errors. However, results reported by Sitzman and colleagues (2014) suggest that confidence is weakly related to error correction. Instead, the level of prior knowledge one has of a particular domain is (1) more robustly associated with error correction and (2) accounts for the majority of the variability in error correction, when controlling for confidence. Accordingly, understanding any potential age-related changes in hypercorrection requires that one also assess participants' level of knowledge.

In the current study, we examined how both prior knowledge and confidence contribute to error correction in older and younger adults. Using a method similar to Sitzman et al. (2014), participants answered general knowledge questions, rated their confidence in their response, and were provided immediate feedback in the form of the correct answer. They were then asked to rate their prior knowledge by making a knew-it-all-along judgment. Overall, we expected to replicate Eich et al. (2013) such that younger adults would demonstrate the hypercorrection effect. However, for older adults, we anticipated that the relationship between confidence in errors on the initial test and accuracy on the final test would be weaker compared to younger adults. For younger adults, we expected to replicate previous research by Sitzman et al. (2014). That is, prior knowledge should be a better predictor of error correction, while confidence was expected to play little unique role. If older adults similarly rely on prior knowledge to correct errors, then prior knowledge should be a better predictor of error correction than confidence. In all, the experiment reported should serve to clarify the basis for error correction following feedback in older and younger adults.

Methods

Participants

Participants consisted of 32 younger adults (*M* age = 21.16, range 17–29; 21 females) from Colorado State University who participated for their choice of course extra credit or pay and 32 healthy older adults (*M* age = 69.5, range 59–78; 22 females) who participated in exchange for a small honorarium. Older adults were recruited from the community and all participants reported to be of normal health and not experiencing any memory or cognitive deficits.

In an unrelated experiment with the same participants, both younger and older adults were asked to define common words (e.g., country, house; LogHAL = 11.57) and low-frequency words (e.g., cherub, parson; LogHAL = 5.20; Loaiza, Rhodes, & Anglin, 2013). Overall, there was no difference in proportion of common words accurately defined by older adults ($M = .95$, $SE = .03$) and younger adults ($M = .98$, $SE = .01$), $t < 1$. However, older adults ($M = .75$, $SE = .03$) correctly defined a greater proportion of low-frequency words than younger adults ($M = .17$, $SE = .03$), $t(55) = 13.99$, $p < .001$. Thus, the older adults tested exhibited superior crystallized knowledge of words relative to younger adults (Verhaeghen, 2003).

Materials

General knowledge questions were obtained from Nelson and Narens (1980) who developed normative data for the questions from a sample of college students. Questions were evenly divided among easy (probability of recall ≥ .660), medium (probability of recall between .659 and .360), and hard (probability of recall ≤ .359) levels of difficulty and were chosen if they were considered reasonable for current students to answer (e.g., What is the name of Dorothy's dog in "The Wizard of Oz?" Answer: Toto). We also compared the questions used in the current experiment with a more recent normative data collected on these questions (Tauber, Dunlosky, Rawson, Rhodes, & Sitzman, 2013). There was a strong, positive relationship between the probability of answering a question in 1980 (Nelson & Narens, 1980) and the probability of answering the same question in 2012 (Tauber et al., 2013) for the questions used in the current experiment, $r(60) = .85$, $p < .001$.

Procedure

On the initial test, participants were given 34 general knowledge questions in a random order. Four of the questions served as primacy and recency buffers and were not included in any of the analyses. Once a question was displayed on the screen, participants were given 13 s to say a response aloud to a research assistant who then typed the response into the computer. Participants were encouraged to answer the question to the best of their ability; however, they were told to say "I don't know," if they were unable to generate a response. Following this, participants were given 5 s to rate their confidence in their response on a scale of 0–100. A confidence rating of 0 indicated that they were not at all confident that their answer was correct and a rating of 100 indicated that they were absolutely confident that they provided the correct response. Participants were encouraged to use the entire range of the scale to indicate varying levels of confidence. Responses were reported aloud to a research assistant who then entered these responses into the computer. Following the confidence rating, participants were shown the correct response for 5 s and asked to indicate whether or not they had answered the question correctly. This ensured that participants were processing the feedback (Sitzman et al., 2014). Finally, similar to previous work by Metcalfe and Finn (2011) and Sitzman et al. (2014), participants were asked to make a knew-it-all-along rating on a scale of 1–7 to indicate whether or not they actually knew the correct response all along. A rating of 1 indicated that the participant had no prior knowledge of the correct response, while a rating of 7 indicated that they actually knew the correct response all along. Participants were encouraged to use the entire range of the scale to indicate varying levels of prior knowledge. They were given 7 s to provide their judgment aloud to the research assistant. This same process was completed for all 34 questions.

After a 25-min delay filled with unrelated tasks, participants were given a final test in which they were asked to answer the same set of general knowledge questions. As with the initial test, the question was displayed on the computer screen and participants were given 13 s to provide their response aloud to a research assistant who entered the response into the computer. Following their response, participants were again asked to rate their confidence in their response on a scale of 0–100 (no feedback was provided on this final test.) Participants completed this procedure for all questions.

Results

In the following analyses, we first examine performance on the initial and final tests for younger and older adults. We then report our focal analyses examining the relationship between confidence judgments and error correction (i.e., hypercorrection) and knew-it-all-along judgments and error correction. The alpha level was set at .05 for all analyses reported.

Proportion of questions answered correctly

On the initial test, older adults ($M = .60$, $SE = .03$) correctly answered a greater proportion of general knowledge questions than younger adults ($M = .43$, $SE = .03$), $t(62) = 3.94$, $p < .001$, $d = .99$. Older adults ($M = .91$, $SE = .02$) also correctly answered a greater proportion of questions than younger adults ($M = .81$, $SE = .02$) on the final test, $t(62) = 3.47$, $p = .001$, $d = .87$.

Relationship between test confidence and accuracy

Gamma correlations were computed to compare confidence judgments and accuracy on the initial test for both younger and older adults to ensure that monitoring of memory performance did not differ as a function of age. If participants were able to accurately monitor the accuracy of their responses, they should give high-confidence judgments to items that are correct and low-confidence judgments to items that are incorrect. This would result in a strong, positive correlation between confidence judgments on the initial test and initial test accuracy. One-sample *t*-tests were used to assess whether gamma correlations were reliably greater than zero. Overall, both younger adults (G = .94, SE = .01), $t(31) = 83.49$, $p < .001$, and older adults (G = .94, SE = .02), $t(31) = 60.91$, $p < .001$, were able to accurately assess their memory performance, and gamma correlations for the two groups did not differ, $t < 1$. These data replicate previous research suggesting that older adults are able to monitor their memory performance as effectively as younger adults.

Gamma correlations were also computed to compare confidence judgments and accuracy on the final test. Both younger adults (G = .997, SE = .002), $t(30) = 424.31$, $p < .001$, and older adults (G = .996, SE = .002), $t(20) = 416.66$, $p < .001$, were able to accurately assess their performance on the final test, with gamma correlations at ceiling. These gamma correlations did not differ between the two groups, $t < 1$.

Hypercorrection effect and knew-it-all-along judgments

Hypercorrection effect

Consistent with previous research (e.g., Butterfield & Metcalfe, 2001, 2006), the hypercorrection effect was operationalized as the gamma correlation between confidence judgments given to items answered incorrectly on the initial test and the accuracy of the responses to those questions on the final test. A hypercorrection effect is indicated by a positive correlation (i.e., errors with higher confidence are more likely to be corrected on the final test) that is reliably greater than zero. Several participants reported invariant confidence judgments or displayed invariant performance on the final test, and thus correlations could not be calculated. This is reflected by variations in degrees of freedom reported for statistical tests. For younger adults (G = .47, SE = .11), there was a positive correlation between confidence judgments on the initial test and accuracy on the final test, $t(28) = 4.24$, $p < .001$. However, for older adults (G = .10, SE = .15), this correlation did not differ from chance, $t < 1$ (see the left panel of Figure 1). The hypercorrection effect was reliably stronger for younger adults compared with older adults, $t(49) = 2.04$, $p = .05$,

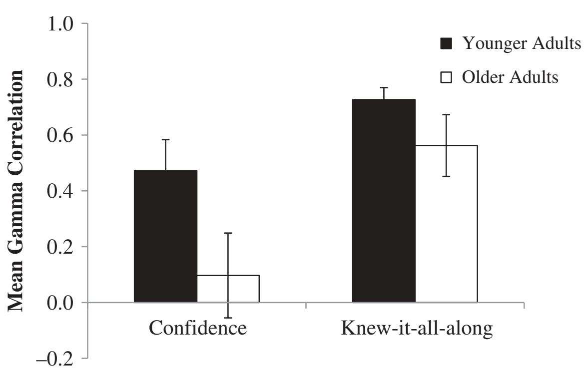

Figure 1. Mean gamma correlations between confidence in errors on test 1 and accuracy on test 2 (i.e., the hypercorrection effect) and between knew-it-all-along judgments for errors on test 1 and accuracy on test 2, as a function of age group. Error bars represent one standard error of the mean.

Table 1. Number of errors on test 1 and the proportion of those errors corrected on test 2 based on level of confidence on test 1.

	Number of errors on test 1		Proportion of errors corrected on test 2	
Confidence level	YA	OA	YA	OA
0–24	431	196	0.65 (.03)	0.83 (.04)
25–49	24	14	0.79 (.09)	0.91 (.06)
50–74	52	55	0.89 (.04)	0.87 (.06)
75–100	29	42	0.92 (.06)	0.82 (.06)

Note: Standard error of the mean is presented in parentheses.

d = .58. These data replicate Eich et al. (2013), who also reported a reliable hypercorrection effect for younger adults but not older adults.

We also examined the proportion of errors corrected on test 2 based on the initial level of confidence in that error on test 1 (see Table 1). The proportion of errors corrected was compared for items that were initially given a confidence judgment of 0–49 (low confidence) and items given confidence judgments of 50–100 (high confidence). Younger adults corrected a greater proportion of high-confidence errors (M = .89, SE = .04) compared with low-confidence errors (M = .66, SE = .03), $t(25)$ = 4.58, p < .01, d = 1.27. In contrast, older adults corrected an equal proportion of high-confidence (M = .80, SE = .06) and low-confidence (M = .82, SE = .04) errors, t < 1.

Knew-it-all-along

To examine the relationship between prior knowledge and error correction, we calculated gamma correlations between knew-it-all-along judgments given to errors on the initial test and the accuracy for the same question on the final test. For both younger adults (M = .73, SE = .04), $t(30)$ 16.84, p < .001, and older adults (M = .56, SE = .11), $t(20)$ = 5.09, p < .001, there was a strong, positive relationship between knew-it-all-along judgments and error correction (see the right panel of Figure 1). Both groups were more likely to correct errors for which they indicated high levels of prior knowledge compared with errors for which they indicated low levels of prior knowledge of the correct response. The magnitude of these correlations did not reliably differ between younger adults and older adults, $t(50)$ = 1.57, p = .12.

Next, we compared whether confidence judgments or knew-it-all-along judgments were more closely related to error correction. For both younger adults, $t(28)$ = 2.01, p = .05, d = .51, and older adults, $t(19)$ = 2.38, p = .03, d = .66, knew-it-all-along judgments were more closely related to error correction than confidence judgments.

Logistic hierarchical linear modeling analyses

Following from previous research (Sitzman et al., 2014), we examined confidence judgments and prior knowledge as the bases for error correction via logistic hierarchical linear model (HLM) analyses (cf. Hines, Touron, & Hertzog, 2009; Sitzman et al., 2014; Tauber & Rhodes, 2012). Accordingly, analyses were conducted to evaluate the degree to which younger and older adults' confidence judgments and knew-it-all-along judgments from an initial test trial contributed to response accuracy on a second test for only those items that were incorrect on test 1. Our choice of HLM analyses reflects several key benefits. Such analyses are powerful because they allow for simultaneous evaluation of multiple judgments (i.e., confidence judgments and knew-it-all-along judgments) on error correction. Further, HLM analyses account for the contribution of within-person variance. That is, by using HLM, we were able to evaluate whether individual variance and age group variance contributed to error correction. In contrast, other approaches such as conducting within-participant regressions and averaging the resulting coefficients across participants ignore within-person error variance and are subject to aggregation bias. We avoided these limitations by adopting an HLM approach. Most important, by using HLM, we were able to evaluate the degree to which each judgment type contributed to error correction while controlling for the other judgment type.

We anticipated that younger and older participants' prior knowledge would make a more substantial contribution to error correction than would confidence. That is, knew-it-all-along judgments should more robustly predict error correction than confidence judgments. The HLM model included the intercept and two main effect predictors: knew-it-all-along judgments and confidence judgments, which were both centered on each participant's average for that variable. We also included an age group main effect variable and the interaction between age group and the two main effect predictors. STATA statistical software (StataCorp, 2009) was used to conduct this analysis.

As is evident in Table 2, test 1 knew-it-all-along judgments reliably predicted test 2 response accuracy for young and older adults. Specifically, for young adults, a 1 unit (1–7 scale) increase in knew-it-all-along judgments on test 1 was associated with a 30% increase in the likelihood of correctly answering that question on test 2. A significant interaction indicated that knew-it-all-along judgments had an even larger influence on test 2 response accuracy for older adults. Specifically, for older adults, a 1-unit increase in knew-it-all along judgments on test 1 was associated with an 80% increase in the likelihood of correctly answering that question on test 2. Replicating prior research

Table 2. Logistic hierarchical linear models for test 2 accuracy.

	Effect	Estimate	$e^{\text{Estimate}-1}$	*t*	95% Confidence interval Lower	95% Confidence interval Upper
Older adults	Intercept	1.06 (.19)	1.89	5.70***	.69	1.42
	Trial 1 knew-it-all-along judgments	.59 (.08)	.80	7.82***	.44	.74
	Trial 1 confidence judgments	.02 (.01)	.02	2.61**	.004	.02
Interactions	Trial 1 knew-it-all-along judgments × age group	.33 (.12)	.39	2.66**	.09	.57
	Trial 1 confidence judgments × age group	.02 (.01)	.02	2.06*	.001	.03
Young adults	Trial 1 knew-it-all-along judgments	.26 (.10)	.30	2.71**	.07	.46
	Trial 1 confidence judgments	−.001 (.01)	−.001	.27	−.01	.01

Notes: The model included an intercept, two main effect predictors, and two interaction terms. These variables are represented in the first five rows, and the reference group for this analysis is older adults. For comparison purposes, we also provide the estimates for the main effect predictors for the young adult group. *SE*s are provided in parentheses. ***$p < .001$, **$p < .01$, *$p < .05$.

(Sitzman et al., 2014) and extending to a group of older adults, these data suggest that participants' prior knowledge had a large influence on test 2 accuracy.

Also evident from Table 2, young adults' test 1 confidence judgments did not reliably predict test 2 response accuracy. However, a significant interaction indicated that confidence judgments did reliably predict test 2 response accuracy for older adults. Specifically, for older adults, a 1-unit increase in confidence judgments (0–100% scale) was associated with a 2% increase in the likelihood of correctly answering that question on test 2. Taken together, these data indicate that young and older adults' prior knowledge had a substantial influence on test 2 accuracy (i.e., 30% and 80% increase, respectively), whereas participants' confidence had a much smaller influence on test 2 accuracy (i.e., 2% increase for older adults).

It should be noted that the two judgments were measured on different scales. That is, knew-it-all-along judgments were measured on a 1–7 scale, whereas confidence judgments were measured on a 0–100% scale. Following Sitzman et al. (2014), we transposed judgments onto a common scale to facilitate interpretation. A 1-unit increase in the knew-it-all-along judgments would be the equivalent to a 14.29-unit increase for the confidence judgments (i.e., 1 out of 7 is equivalent to 14.29 out of 100). As stated previously, for every 1-unit increase in knew-it-all-along judgments, there is a 30% increase (young adults) and 80% increase (older adults) in the likelihood that participants will answer the question correctly on a second test. A 14.29-unit increase in confidence judgments led to a 4.29% increase (young adults) and 11.43% increase (older adults) in the likelihood that participants would answer the question correctly on a second test.

Question difficulty

We also examined error correction as a function of question difficulty (see Table 3). If prior knowledge drives hypercorrection, then participants should be more likely to correct errors on easy questions, followed by medium questions, and, finally, hard questions. For both younger adults, $F(2,52) = 66.54$, $p < .001$, $\eta^2_p = .72$, and older adults, $F(2,42) = 23.13$, $p < .001$, $\eta^2_p = .52$, error correction varied as a function of question difficulty. For both groups, participants corrected a reliably greater proportion of errors on easy questions than medium questions. In addition, a reliably greater proportion of errors were corrected for easy and medium questions compared with hard questions (all ps < .04).

Table 3. Proportion of initial errors corrected, knew-it-all-along judgments for errors, and confidence judgments for errors, as a function of question difficulty.

	Proportion of errors corrected		Knew-it-all-along judgments for errors		Confidence judgments for errors	
Question difficulty	Younger adults	Older adults	Younger adults	Older adults	Younger adults	Older adults
Easy	.94 (.03)	.99 (.02)	3.46 (.28)	4.00 (.41)	18.35 (4.57)	33.82 (5.79)
Medium	.76 (.04)	.79 (.05)	3.24 (.19)	3.25 (.27)	14.41 (2.28)	32.21 (4.37)
Hard	.53 (.04)	.72 (.04)	2.13 (.13)	2.79 (.25)	13.30 (2.14)	21.70 (3.20)

Notes: Standard error of the mean is presented in parentheses. Knew-it-all-along judgments were made on a scale of 1–7, with lower values denoting lower levels of prior knowledge.

General discussion

In the current experiment, we explored the role of subjective confidence and prior knowledge in error correction for both younger and older adults. Previous research has found that younger adults are more likely to correct high-confidence errors compared with low-confidence errors (Butterfield & Mangels, 2003; Butterfield & Metcalfe, 2001, 2006; Fazio & Marsh, 2009; Kulhavy et al., 1976). However, this relationship between confidence and error correction was reduced for older adults (Cyr & Anderson, 2013, Experiment 1; Eich et al., 2013). Recent work by Sitzman et al. (2014) suggests that error correction is primarily related to the level of prior knowledge, while confidence is likely a proxy for prior knowledge. Because semantic memory generally does not decline and often increases with age in healthy older adults (e.g., McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010; Verhaeghen, 2003), we explored whether prior knowledge predicted error correction for older adults in the same way that it does for younger adults.

Overall, younger adults were more likely to correct high-confidence errors compared with low-confidence errors. In contrast, the correlation between confidence and error correction for older adults did not differ from chance (see also Eich et al., 2013). Importantly, we also demonstrated that, for both younger and older adults, error correction was strongly related to prior knowledge. That is, participants were more likely to correct errors when they indicated high levels of prior knowledge compared with lower levels of knowledge. Further, HLM analyses indicated that error correction was largely predicted by prior knowledge, while confidence played little to no unique role (Sitzman et al., 2014). For younger and older adults, prior knowledge ratings better predicted the likelihood of correcting an error (30% and 80%, respectively) than confidence ratings (4.29% and 11.43%, respectively).

Prior knowledge, feedback, and aging

Previous research has suggested that prior knowledge can either facilitate or hinder memory for older adults (Umanath & Marsh, 2014). Due to declines in episodic memory, older adults may rely more on their prior knowledge and thus be more likely to remember information consistent with their prior knowledge. Therefore, they may have difficulty overriding prior knowledge when that knowledge is incorrect. For example, Rice and Okun (1994) reported that older adults recalled information about osteoarthritis less accurately if it contradicted their prior knowledge; however, they were able to accurately recall information that was consistent with their prior knowledge. In another experiment, Okun and Rice (1997) attempted to enhance older adults' ability to identify information at odds with prior knowledge by signaling such contradictory information. Although this resulted in benefits on an immediate test (i.e., participants were better able to recall inconsistent information), these benefits were not apparent on tests administered 2 weeks later. Such data also suggest that future research should explore the longevity of the benefits of feedback in older adults (see Butler, Fazio, & Marsh, 2011, for work with younger adults).

Older adults may also require different types of feedback when their prior knowledge is incorrect. Kelley and McLaughlin (2012) demonstrated that older adults benefited from different types of feedback when completing a task requiring fluid abilities compared with a task requiring more crystallized knowledge. When tasks could be completed using prior knowledge (i.e., crystallized knowledge), older adults benefited from minimal feedback. However, when tasks required fluid abilities, older adults benefited from more extensive feedback. Thus, when trying to encode new information into memory to correct an error in prior knowledge, older adults may benefit from elaborative feedback. While the current experiment demonstrated that older adults can efficiently use the correct answer to update errors in knowledge on an immediate test, more elaborative feedback may not only increase the likelihood of error correction immediately, but also increase the longevity of the benefits gained through feedback.

Subjective confidence and prior knowledge

Although prior knowledge was a better predictor of error correction than subjective confidence, the role of confidence may vary based on experimental design (Cyr & Anderson, 2013; Eich et al., 2013; Sitzman et al., 2014). Our experiment and research by Eich et al. (2013) demonstrated that younger adults corrected a greater proportion of high-confidence errors compared with low-confidence errors, yet older adults corrected the same proportion of high-confidence and low-confidence errors. In contrast, Cyr and Anderson (2013, Experiment 2) eliminated age-related differences in hypercorrection by employing a recognition test and using a greater number of general knowledge questions. Whether this reflects the test used, the method of soliciting confidence judgments, variability in the number of errors generated by participants, or some other variable remains unclear. This sets an agenda for future research to confirm these findings across a variety of paradigms employing different experimental methods and using paradigms that increase or decrease the number of high-confidence errors.

Importantly, the current experiment is the first to examine the relationship between confidence and prior knowledge in older and younger adults' error correction. Our results suggested that prior knowledge was the strongest predictor of error correction for older and younger adults, although subjective confidence did play a unique, albeit small, role. Indeed, confidence judgments reflect a variety of cues such as level of prior knowledge, speed of which a response comes to mind, and the consistency of a single response coming to mind (Koriat, 2008). Therefore, confidence judgments themselves are unlikely to play a causal role in error correction but are driven by factors strongly associated with error correction, such as prior knowledge. For both older and younger adults, discrepancies between prior knowledge and corrective feedback are likely to increase attention to that feedback. Prior knowledge will also be related to the efficiency with which new information can be incorporated into memory. However, we note that prior knowledge is just one cue that contributes to confidence judgments. Future research may profit by examining other variables, aside from prior knowledge, that may contribute to confidence and error correction for older adults and younger adults.

Summary and conclusions

In sum, the current experiment explored the role of prior knowledge and subjective confidence in error correction for both younger and older adults. Previous work suggests that prior knowledge plays a large role in error correction in younger adults, while confidence judgments play little unique role (Sitzman et al., 2014). Similar to findings by Sitzman et al. (2014) both younger and older adults in the current experiment showed a strong relationship between prior knowledge and error correction. Participants were much more likely to correct an error if they had indicated increased levels of prior knowledge compared with errors in which they indicated low levels of prior knowledge. After controlling for the influence of prior knowledge, subjective confidence in a response played little to no unique role in error correction. These findings expand upon a growing body of literature demonstrating the importance of prior knowledge in error correction for both younger and older adults and establish that prior knowledge is related to error correction in older adults.

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