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Do young adults show conceptual knowledge of previous distractors?

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ABSTRACT
Using implicit tests, older adults have been found to retain conceptual knowledge of previously seen task-irrelevant information. While younger adults typically do not show the same effect, evidence from one study [Gopie, N., Craik, F. I. M., & Hasher, L. (2011). A double dissociation of implicit and explicit memory in younger and older adults. Psychological Science, 22, 634–640. doi:10.1177/0956797611403321] suggests otherwise. In that study, young adults showed greater explicit than implicit memory for previous distractors on a word fragment completion task. This was interpreted as evidence for maintaining access to previous conceptual knowledge of the distractors. Here, we report two failures to replicate that original finding, followed by a third study designed to test directly whether young adults use conceptual-level information that was previously irrelevant. Our findings agree with others that young adults show weak to no evidence of conceptual knowledge of previously irrelevant information.

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Much of the memory literature focuses on information that people attend to as a focal task. There is now a smaller literature on memory for non-relevant information presented in the context of a target task. From this work, two surprising findings have emerged: (1) with rare exception, young adults appear to know little about the distracting information they have seen and (2) by contrast, older adults know both perceptual- and conceptual-level information about that distracting information (e.g., Amer & Hasher, 2014; Gazzaley, Cooney, Rissman, & D'Esposito, 2005; Kim, Hasher, & Zacks, 2007; May, 1999; Rowe, Valderrama, Hasher, & Lenartowicz, 2006; Schmitz, Cheng, & De Rosa, 2010), and that knowledge transfers tacitly to new tasks (e.g., Campbell, Hasher, & Thomas, 2010; see also Amer, Campbell, & Hasher, 2016).

The literature on young adults, for the most part, has consistently shown minimal evidence of knowledge of previous distraction (or subsequent usage of that information), and this is particularly so on conceptual tests.[1] For example, a study by Kim et al. (2007) showed that distracting words exposed in the context of a reading task did not influence subsequent problem-solving performance, even when some of the distracting words were actually solutions to the problems. In another study, previously seen distraction did not influence young adults' performance on general knowledge questions, despite substantial benefits shown in older adults (Amer & Hasher, 2014). Those findings are consistent with the inhibitory deficit theory (Hasher & Zacks, 1988; Lustig, Hasher, & Zacks, 2007), which posits that, relative to older adults, young adults suppress both concurrent and previous irrelevant information (see also Plebanek & Sloutsky, 2017 for similar differences in attention between young adults and children).

To our knowledge, there is one exception to this pattern of findings for young adults (Gopie et al., 2011). In that study, Gopie et al. tested young adults' knowledge of previous distractors, presented in the context of a Stroop colour-naming task, using implicit and explicit word fragment completion tasks. The implicit test required participants to complete fragments with the first word that came to mind, and the explicit task required participants to complete the fragments with previously seen distracting words. Young adults in that study showed greater explicit than implicit memory for distractors (in both a within-subjects and a between-subjects design). Because explicit memory performance is believed to be conceptually driven (Jacoby, 1983), the authors concluded that young adults encoded the meaning of the distracting information and maintained access to conceptual knowledge of that information. That is, based on the principles of the transfer-appropriate processing theory (Blaxton, 1989), young adults conceptually processed the irrelevant information and consequently showed greater memory (or transfer) for that information on an explicit fragment completion task, which requires more conceptual processing than the implicit task (see Mulligan, 1998 for criticisms of this view). These findings contrast sharply with, for example, the Amer and Hasher (2014) findings of limited distractor conceptual priming by young adults and generally contradict the inhibitory deficit theory (Hasher & Zacks, 1988; Lustig et al., 2007). Furthermore, these findings could be

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criticized considering that a word fragment completion task was used as a measure of conceptual memory, although it is typically thought to be perceptually driven (e.g., Richardson-Klavehn & Bjork, 1988; Schacter, 1987 – but see Weldon, Roediger, Beitel, & Johnston, 1995). Given these concerns, and in light of the recent emphasis placed on the reproducibility and reliability of findings in psychology (e.g., Open Science Collaboration, 2015; Pashler & Wagenmakers, 2012), we report two direct replications of the original Gopie et al. study, both of which used fragment completion as tests. We also report a third study that asked participants to recall previous distractors, on the assumption that free recall requires more conceptual knowledge than does fragment completion (e.g., Blaxton, 1989; Roediger & Challis, 1992). To preview our results, we failed to replicate the original Gopie et al. findings. Young adults showed no evidence of greater explicit than implicit knowledge of distractors on word fragment tests and recalled almost none of the distractors on the free recall task. Our findings are not consistent with the Gopie et al. notion that young adults show conceptual knowledge of previous irrelevant information and use that knowledge when it becomes relevant on subsequent tasks.

Experiment 1

The first experiment was a direct replication of the Gopie et al. (2011) study. Participants first completed a neutral-word Stroop task, which required them to report the font colour of a non-colour word while ignoring the word itself, followed by an implicit and then an explicit word fragment completion task. In each instance, solutions for some of the fragments had previously occurred as distractor words on the Stroop task. A replication was anticipated with greater priming on the explicit than the implicit fragment task.

Method

Participants

Thirty-two undergraduates (17–23 years, $M = 18.97$ years, $SD = 1.60$; 10 male) from the University of Toronto participated for course credit or monetary compensation. Based on the magnitude of the difference between implicit and explicit memory for distractors reported in Gopie et al. (Experiment 2; $d = 0.84$), we calculated that only 14 participants were required to have 80% power to detect a difference of that magnitude. Hence, our sample size was more than sufficient to detect the effect. All participants were native English speakers or had learned English before age 5, had a minimum score of 26 (out of 40) on the Shipley (1946) vocabulary test ($M = 31.02$, $SD = 3.77$), and were not of East Asian descent (for cultural differences in distractor processing, see Amer, Ngo, & Hasher, 2016). The same criteria were used for the next two studies as well. Data from one participant were replaced due to awareness of the connection between the incidental encoding task and the implicit word fragment completion task (see Procedure for more details).

Stimuli

Stimuli were taken from Experiment 2 of Gopie et al. (2011). Two 40-word study lists (mostly consisting of common nouns; log frequency: 6.36–12.55, $M = 9.72$, $SD = 1.54$) were created and counterbalanced across participants for the incidental encoding Stroop task. Out of the 40 critical words on the task, 20 were used on the word fragment completion tasks (half on the implicit task and the other half on the explicit task; the remaining 20 words were fillers). An additional 12 words were added to each list to serve as primacy and recency buffers, for a total of 52 words. The stimuli were presented in uppercase, 18-point bold Arial font, in one of four different colours (red, blue, green, and yellow) against a black background.

Each of the implicit and explicit word fragment completion tasks consisted of 30 fragments: 10 could be solved with the previously encountered distracting words (target fragments), 10 could be solved with counterbalancing words that were never seen before and belonged to the other study list (providing a baseline measure), and 10 could be easily solved with common words. The fragments had multiple completion possibilities (but only one in the context of the experiment) and were presented at the centre of the screen in a black, 18-point bold Arial font against a white background. The fragments from the implicit and explicit tests were rotated across participants, so that the same fragments appeared equally on both kinds of memory tests.

Procedure

The procedure was identical to the one implemented in Experiment 2 of Gopie et al. (2011), with the exception that participants used a microphone instead of a response box to identify the colour of the distractor words on the initial encoding task. During the Stroop task, each word was presented individually at the centre of the screen until a response was made, for a maximum of 2000 ms. Participants were instructed to report as quickly as possible the font colour of the word, while ignoring the word itself as processing it would slow down performance. A response initiated an interstimulus interval (ISI) of 2000 ms. Six words were presented first as a primacy buffer. They were followed by 40 words (20 targets and 20 fillers) in random order. Finally, six words were presented as a recency buffer. The task was preceded by 20 practice trials. After completing the Stroop task, participants performed a 10-minute nonverbal task (a computerised version of the Corsi Block-tapping Test; Corsi, 1972) to obscure the connection between the initial task and the subsequent memory test.

During the test phase, participants solved 30 fragments on the implicit word fragment completion test and then 30 fragments on the explicit test. On the implicit test, each fragment appeared for a fixed rate of 4 s, and participants were instructed to solve the fragments with the first word that came to mind. One participant, who reported being aware of the connection between the initial task and the implicit test and intentionally using words from the initial task to solve fragments, was replaced. The explicit test, however, was self-paced, with each fragment appearing for a maximum of 15 s. Participants were instructed to complete the fragments with the words they encountered on the Stroop task.

Following the test phase, participants were asked whether they noticed a connection between the initial Stroop task and the implicit fragment completion task. They were also asked if they noticed the connection before the explicit task was administered, and whether they intentionally used words from the initial task to complete fragments on the implicit task. Finally, participants completed a background questionnaire and the Shipley (1946) vocabulary test.

Results and discussion

Stroop performance was at ceiling ($M = 0.99$, $SD = 0.01$). Table 1 presents means and standard deviations for the proportions of target and baseline fragment completions, as well as overall memory performance for each test. Target fragment completions were calculated as the proportion of fragments completed by distractor words seen in the Stroop task. Baseline fragment completions were calculated as the proportion of fragments completed by words that served as targets on the study list other participants were exposed to. Note that baseline completion rates were higher in the explicit condition due to the task's self-paced nature. Overall memory performance for both tasks was calculated by subtracting average baseline word fragment completion rates from individual target completion rates, as is typical in the priming literature.

We tested the hypothesis that priming by distractors would be greater on the explicit than the implicit test, as reported by Gopie et al. (2011). As illustrated in Table 1, explicit and implicit memory scores were almost identical.[2] Providing participants with explicit, rather than implicit, task instructions and informing them about the relevance of the previous distractors did not improve memory for the distractors.

Table 1. Mean proportions of target and baseline fragment completions and overall memory performance in Experiments 1 and 2.

	Memory task	Target completions	Baseline completions	Overall memory performance
Experiment 1	Implicit	0.29 (0.15)	0.18 (0.13)	0.11 (0.15)
	Explicit	0.35 (0.15)	0.24 (0.15)	0.11 (0.15)
Experiment 2	Implicit	0.13 (0.09)	0.09 (0.07)	0.05 (0.09)
	Explicit	0.09 (0.11)	0.07 (0.09)	0.03 (0.11)

Note: Standard deviations appear in parentheses.

We used a Bayesian analysis to calculate the probability of the hypothesis that the implicit and explicit memory scores are the same, given the data (i.e., that explicit memory scores are not higher than implicit scores). The hypothesis was tested by calculating the Savage–Dickey ratio (Dickey & Lientz, 1970), as implemented in Wagenmakers, Lodewyckx, Kuriyal, and Grasman (2010). To evaluate convergence of the sampling procedure, three MCMC chains (a Monte Carlo sampling technique to build stochastic Markov Chains) were run. The model was updated 50,000 times, with the first 1000 samples discarded as "burn in" samples. The Gelman–Rubin convergence criteria suggested that the chains stabilized on a reliable solution for accuracy, $R = 1$, 95% CI [,1], and the chains showed low evidence of autocorrelation, $Lag_1 = -.0002$, $Lag_5 = -.004$, $Lag_{10} = -.0009$, $Lag_{50} = -.0007$. The remaining estimates were thus used to interpolate the probability density distributions of the prior and posterior distributions.

Distributions for the explicit memory scores were created with an expected uniform distribution between the range of all possible memory scores (−1 and 1). The Savage–Dickey Density Ratio of the distributions was then calculated and tested against the known population value for implicit memory (.106). The analysis showed that explicit memory performance was reliably above baseline, $M = 0.109$, 95% highest posterior density (HPD) [.05, .16]. As illustrated by the Savage–Dickey points on the posterior and prior distributions in Figure 1(a), however, the probability that explicit memory was the same as implicit was .97, with the weight of evidence coming from the data being 3.37 (i.e., log Bayes factor).

Although young adults showed some knowledge of previous distractors, as indicated by the above baseline memory scores, there was no evidence of greater performance on explicit than on implicit tests. Indeed, a Bayesian analysis provided strong evidence that scores on the implicit and explicit tests were the same. In a conceptual replication, we presented distractors in the context of a different encoding task, and again tested for both implicit and explicit conceptual knowledge of distracting words.

Experiment 2

Here, participants were exposed to distracting words in the context of a 1-back task on pictures with superimposed irrelevant words (an incidental encoding task used in multiple previous studies; e.g., see Amer & Hasher, 2014; Rowe et al., 2006). Following the task and a filled interval, participants either performed an implicit or an explicit word fragment completion task, with the solutions for some of the fragments previously presented as distractors on the 1-back task. We used a between-subjects design here on the chance that we previously failed to find greater explicit than implicit distractor memory because of test order effects in a within-subjects design in Experiment 1. As before, we were interested in differences in memory performance between the implicit and explicit tasks.

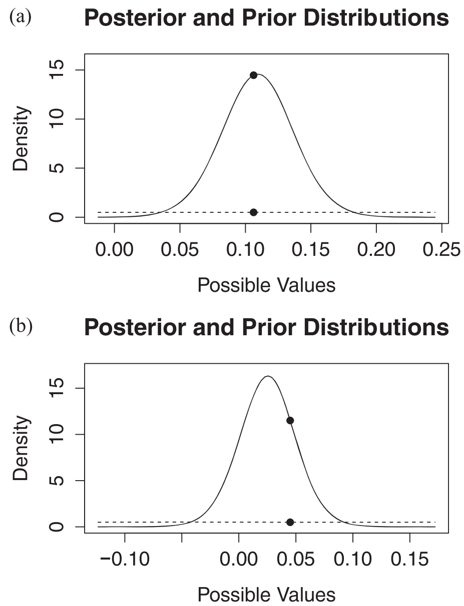

Figure 1. Posterior and prior distributions of explicit memory scores in (a) Experiment 1 and (b) Experiment 2. The Savage–Dickey points on the distributions show the mean implicit memory scores relative to the explicit memory distributions in each experiment.

Method

Participants

Participants were 40 undergraduates (17–26 years, $M = 20.12$ years, $SD = 2.73$; 11 male) at the University of Toronto who participated for course credit. Half of the participants were assigned to the implicit memory condition, and the other half were assigned to the explicit condition. Based on the effect size reported for the difference in distractor memory between young adults in the implicit and explicit conditions in Gopie et al. (Experiment 1; $d = 1.17$), we calculated that only 13 participants were required per group to have 80% power to detect a difference of a similar magnitude. Thus, our sample size was sufficient. All participants were native English speakers or had learned English before age 6, had a minimum score of 23 on the Shipley (1946) vocabulary test ($M = 31.14$, $SD = 4.19$), and were not of East Asian descent. Data from four participants who intentionally used distractor words from the initial 1-back task on the implicit fragment completion task were replaced.

Stimuli

For the 1-back task (adapted from Rowe et al., 2006), two 20-word lists (log frequency: 6.36–11.27, $M = 8.55$, $SD = 1.49$) were counterbalanced across participants. The words were individually superimposed on line drawings selected from Snodgrass and Vanderwart (1980). Seven of the 20 words served as solutions on the word fragment completion task, and the remaining 13 words served as fillers. Fourteen nonwords were also used as distractors, and an additional 16 nonwords were used as primacy and recency buffers. The words and nonwords were presented in uppercase, 18-point bold Arial font in black. They were individually superimposed on the line drawings, which were coloured red to make them easily distinguishable.

The fragment completion task consisted of 24 fragments: 7 could be solved with previously encountered distractors, 7 could be solved with distractors that belonged to the other study list (i.e., baseline measure), and 10 that could be easily solved with common words. The fragments had multiple solutions (but only one from the encoding phase) and were presented at the centre of the screen in a black, 18-point bold Arial font against a white background.

Procedure

During the 1-back task, participants were presented with a stream of pictures and instructed to press a key whenever two consecutive pictures were identical, while ignoring superimposed words or nonwords. Each picture was presented for 1000 ms with a 500 ms ISI. A total of 10 pictures were repetitions of the preceding picture, and no critical words were presented on repetition trials. Following a practice session with 7 pictures presented alone with no distractors, a total of 55 trials were presented in the following order: 5 pictures presented alone with no distractors, 8 pictures with superimposed nonwords (primacy buffer), 34 pictures with superimposed words or nonwords, and finally 8 pictures with superimposed nonwords (recency buffer). Following the 1-back task, participants performed the Corsi Block-tapping Test, as in Experiment 1.

Participants were randomly assigned to the implicit or explicit version of the word fragment completion task. The two versions were identical in this experiment, with the exception that participants were informed about the connection between the 1-back task and the fragment completion task in the explicit version. Each fragment was presented for a fixed rate of 4 s. The procedure for administering the questionnaires and the Shipley (1946) test was identical to that in Experiment 1 (without administering an awareness questionnaire to participants in the explicit condition).

Results and discussion

Accuracy on the 1-back task (calculated as proportion of hits − proportion false alarms) was at ceiling ($M = 0.99$, $SD = 0.05$). The means and standard deviations for the proportion of target and baseline fragment completions, as well as overall memory performance for each condition are shown in Table 1. Target and baseline completion rates and overall memory performance were calculated as in Experiment 1.

As demonstrated in Table 1, average implicit and explicit memory scores were low but similar to one another,[3] with no evidence that explicit memory instructions result in greater memory for distractors. We again conducted a Bayesian analysis to calculate the probability that explicit and implicit memory is the same, given the data. The analysis was conducted as Experiment 1, which included running three MCMC chains to evaluate convergence of the sampling procedure. The Gelman–Rubin convergence criteria suggested that the chains stabilised on a reliable solution for accuracy, $R = 1$, 95% CI [,1], and the chains showed low evidence of autocorrelation, $Lag_1 = .002$, $Lag_5 = -.005$, $Lag_{10} = -.006$, $Lag_{50} = .002$.

As in Experiment 1, distributions for the explicit memory scores were created with an expected uniform distribution (−1 and 1), and the Savage–Dickey Density Ratio of the distributions was calculated and tested against the known population value for implicit memory (.045). Explicit memory performance was not reliably above baseline, $M = .025$, 95% HPD [−.02, .07]. The probability that explicit memory was the same as implicit, however, was .96, with the weight of evidence coming from the data being 3.14 (see Figure 1(b)).

Consistent with the results of Experiment 1, explicit memory instructions given prior to a word fragment completion task did not improve young adults' memory for previous distractors (if anything, explicit scores were not even above baseline in this experiment). The impact of instruction was the same across two experiments: in no instance was performance better on the explicit test task than on the implicit one.

We note differences in the extent of priming in the two studies, with substantial priming in Experiment 1 and virtually none in Experiment 2. There were two major differences in the procedure that might have contributed to this observation: (a) items were presented at a slower pace on the incidental encoding task in Experiment 1 than in Experiment 2, and (b) explicit fragments were presented for a maximum longer duration in Experiment 1 than in Experiment 2. The differences in priming are, however, consistent with previous research demonstrating that repetition priming for words is minimally reduced by within-object attention manipulations at encoding (as in Experiment 1), but substantially reduced by between-object attention manipulations (as in Experiment 2) (e.g., Mulligan & Peterson, 2008). Nevertheless, there was no evidence of differential performance between the two memory tasks in each experiment, and thus no evidence of the use of conceptual-level information of distraction. Moreover, the encoding 1-back task in Experiment 2 has been used in multiple previous studies showing memory for distractors in older adults (e.g., Amer & Hasher, 2014; Biss, Ngo, Hasher, Campbell, & Rowe, 2013; Campbell et al., 2010; Rowe et al., 2006), as well as in young adults with induced low cognitive control (e.g., Biss & Hasher, 2011; Rowe et al., 2006), demonstrating its efficacy. Nonetheless, our finding joins with others, which have also failed to show evidence of conceptual knowledge using other implicit test tasks (e.g., category association and general knowledge questions; Amer & Hasher, 2014; Butler & Klein, 2009). As noted earlier, however, given that a fragment completion task was used as a test of conceptual knowledge of distraction, our two experiments could be criticized because they relied on a memory task that is typically thought to be perceptual in nature (e.g., Richardson-Klavehn & Bjork, 1988; Schacter, 1987). As well, some have argued against comparing implicit and explicit versions of the same task (Mulligan, 1998). We thus conducted a third experiment in which we used a memory task widely believed to be based directly on conceptual knowledge: free recall (e.g., Blaxton, 1989; Roediger & Challis, 1992).

Experiment 3

The third experiment tested young adults' explicit memory for previous distractors using a free recall test. Participants performed the same encoding task as in Experiment 2, followed by the same nonverbal filler task. They were then asked to recall the distractor words and then the target pictures on the 1-back task. We expected to see some recall of words if young adults encoded and maintained conceptual-level information of previous distractors.

Method

Participants

Thirty undergraduates (17–28 years, $M = 18.53$ years, SD = 2.30; 7 male) from the University of Toronto participated for course credit. Participants were native English speakers, had a minimum score of 23 on the Shipley (1946) vocabulary test ($M = 29.70$, SD = 4.96), and were not of East Asian descent.

Stimuli and procedure

The stimuli and procedure were identical to those used in Experiment 2, with the exception that participants performed a surprise free recall task after the filler task. Participants first recalled any of the distractor words presented on the 1-back task then recalled target pictures on the task, with no time limits.

Results and discussion

Accuracy on the 1-back task was at ceiling ($M = 0.97$, SD = 0.06). Recalled distractor words and target pictures were calculated as the proportion of words or pictures correctly recalled from the initial 1-back task, with the exclusion of the first word presented, words presented on repetition trials that required a response (see Mulligan, Spataro, & Picklesimer, 2014 for the "attentional boost effect"), or pictures presented twice. Pictures presented at the beginning of the task (i.e., the five pictures alone with no distractors), as well as those presented during the primacy and recency buffer trials (16 in total) were also excluded from the analysis.

As an initial step we determined whether the memory scores were above a baseline of zero. Because the scores were not normally distributed, nonparametric Wilcoxon Signed Rank tests were used. As demonstrated in Figure 2, young adults recalled a small, but reliable,

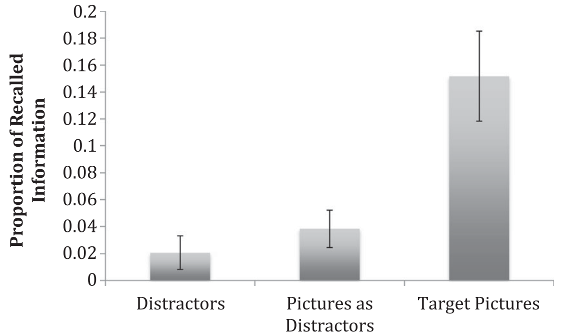

Figure 2. Proportion of information recalled from the 1-back task in Experiment 3. "Pictures as Distractors" shows the proportion of target pictures recalled when participants were asked to recall distractor words (i.e., intrusions from the target pictures). Error bars are 95% confidence intervals of the means.

$z = 2.71$, $p < .01$, proportion of previous distractor words. This effect was driven by only 8 out of 30 participants who each recalled 1 out of a possible 13 words, or 8% - the remaining 22 participants recalled no words. In contrast, the participants recalled a significantly higher proportion of target pictures than words, $z = 4.65$, $p < .0001$ (with the exception of 1 participant who recalled none of the pictures, all participants recalled at least 1 out of a possible 20 pictures – range: 5% to 40%). This indicates that more conceptual knowledge of the incidentally encoded target pictures was retained relative to the distractors, and is also consistent with a large literature showing superior memory for pictures than words (e.g., Postman, 1978). Interestingly, when asked to recall any of the previous distractor words, young adults were more likely to recall target pictures than words (i.e., to show intrusions from the target pictures), $z = 1.99$, $p < .05$, providing more evidence that they maintained conceptual knowledge of target stimuli and were more likely to recall that information when asked to recall any information from the 1-back task (see Figure 2).

In sum, young adults showed limited to no explicit memory for previous distractors. Comparing performance with the previous study, we note that participants recalled 2% of distractors here but 5% in the implicit fragment task (a significant difference, $U = 164$, $z = 2.85$, $p < .005$),[4] suggesting that young adults show more perceptually based knowledge of previous irrelevant information on word fragment completion tasks than conceptually based knowledge on typical explicit memory tasks.

General discussion

Although a number of studies found no evidence of conceptual knowledge of distraction by young adults (e.g., Amer & Hasher, 2014; Butler & Klein, 2009; Kim et al., 2007), at least one study provided counter-evidence to that notion based on greater explicit than implicit memory for distractors on a word fragment completion task (Gopie et al., 2011). We were unable to replicate that finding in two studies, using the same materials and methods as in Gopie et al., or using a different encoding task. In a third study, using a free recall test, we found weak evidence of conceptual knowledge of previous distractors in less than 30% of our young adult sample.

Young adults showed reliable memory for distractors on most of the word fragment completion tasks (whether implicit or explicit) in the first two experiments. Given that fragment completion tasks are typically considered to be perceptually driven (e.g., Richardson-Klavehn & Bjork, 1988; Schacter, 1987), and participants showed greater distractor memory on the implicit fragment task in Experiment 2 than recall task in Experiment 3, our findings suggest that young adults are more likely to remember perceptual, rather than conceptual, features of previous irrelevant information. This is consistent with studies demonstrating that although young adults show some priming for previous distractors on perceptually based identification tasks, they do not show the same effect on conceptually based category association or general knowledge tasks (Amer & Hasher, 2014; Butler & Klein, 2009).

Alternatively, it is possible that irrelevant information leaves a weak memory trace that can generally be more easily detected by more sensitive, or implicit, rather than explicit, memory measures. For example, Hoffman, Bein, and Maril (2011) showed that when young adults were given a surprise recognition test for previously encountered distractor words with a 4-point confidence interval scale (1 = high-confidence "yes"; 2 = low-confidence "yes"; 3 = low-confidence "no"; 4 = high-confidence "no"), they showed evidence of distractor knowledge only in the "no" responses (i.e., more low-confident "no" responses for distractor than new words), indicating that they encoded the distractors without explicit knowledge of previously encountering them. However, given that perceptual-level information can influence recognition memory performance (e.g., Mulligan & Osborn, 2009) and distractor knowledge in young adults is more likely to be detected in perceptual, rather than conceptual, implicit memory measures (e.g., Amer & Hasher, 2014; Butler & Klein, 2009), it seems plausible that young adults only maintain perceptual knowledge of previous distractors. This is supported by neuroimaging studies demonstrating that removing attention from words generally eliminates neural measures associated with conceptual processing (e.g., McCarthy & Nobre, 1993; Ruz, Wolmetz, Tudela, & McCandliss, 2005; Ruz, Worden, Tudela, & McCandliss, 2005).

In contrast to studies with young adults, older adults show both perceptual and conceptual priming from distraction including transfer of knowledge from distraction to new tasks, such as general knowledge tests and new learning of associations (e.g., Amer & Hasher, 2014; Weeks, Biss, Murphy, & Hasher, 2016). Their perceptual knowledge of distraction also seems to exceed that of younger adults (e.g., Amer, Anderson, Campbell, Hasher,

& Grady, 2016; Rowe et al., 2006). Together, these results suggest the greater ability of young adults, compared to older adults, to constrain encoding to targets, even in the face of distraction. Similarly, young adults have been shown to better constrain retrieval of encoded information, so that only relevant information comes to mind (Jacoby, Shimizu, Velanova, & Rhodes, 2005). It is worth noting, however, that there are likely some circumstances under which young adults fail to constrain encoding or retrieval. These are usually seen when they are operating at off peak times of day, when they are in a positive mood, when the distractor is repeated multiple times, or when they lack a specific goal (e.g., Berntsen, Rubin, & Salgado, 2015; Biss & Hasher, 2011; Dewald, Sinnett, & Doumas, 2013; Rowe et al., 2006; Walker, Ciraolo, Dewald, Sinnett, & Wennekers, 2017).

Finally, it is important to note that although our findings provide weak to no evidence of transfer of distractor conceptual knowledge in young adults, they do not sufficiently address the question of whether young adults show any conceptual processing of distractors at encoding. While the weak evidence of conceptual knowledge suggests minimal conceptual processing at encoding from a transfer-appropriate processing perspective (e.g., Blaxton, 1989), other findings, such as those on picture-word interference effects (e.g., Damian & Bowers, 2003; Glaser & Düngelhoff, 1984), suggest that some distracting information might be encoded at a conceptual level. Specifically, those findings show that young adults are slower to name a picture when a superimposed distractor word is conceptually related, rather than unrelated, to the picture. By contrast, other findings show that young adults neither benefit nor suffer from the presence of meaningful distraction in the context of a remote associates task (May, 1999) and show no neural evidence of conceptually encoding distractors (e.g., McCarthy & Nobre, 1993; Ruz, Wolmetz, et al., 2005; Ruz, Worden, et al., 2005). Thus, further work is needed to determine whether the apparent lack of transfer of conceptual distractor knowledge in young adults is mediated by minimal conceptual processing at encoding or reactivation of distractors on subsequent tasks.

In conclusion, our findings suggest that young adults show weak to no evidence of transfer of conceptual knowledge of previous irrelevant information, although they might show transfer of perceptual features of that information. This provides counter-evidence to the Gopie et al. notion that young adults show robust conceptual knowledge of previous distractors when given the appropriate retrieval cues or memory tasks (Gopie et al., 2011). Instead, the current findings point to a general lack of tendency in most young adults to maintain conceptual knowledge of seemingly irrelevant information once a task changes, or a reduced tendency to allow cues to automatically reactivate recent memories – both of which may be the result of heightened inhibitory control (e.g., Hasher & Zacks, 1988; Lustig et al., 2007).

Notes

1. A few studies have provided evidence of distractor knowledge in young adults (e.g., Dewald et al., 2013; Dywan & Murphy, 1996; Thomas & Hasher, 2012; Walker et al., 2017). In those studies, however, the same distractors were repeated multiple times or presented on trials that specifically required responding to a target (i.e., a target that required a response was presented on only a subset of the trials). Multiple repetitions are known to promote conceptual processing, and as a result, better memory (e.g., Challis & Sidhu, 1993; see also Dewald, Sinnett, & Doumas, 2011), and responses to targets can result in an "attentional boost effect" (e.g., Mulligan et al., 2014). The current study examines knowledge of distractors presented once in the context of a task that did not provide an attentional boost (see Method for more details).
2. Memory on both tests was significantly different from 0 using a nonparametric one-sample Wilcoxon Signed Rank test, as scores were not normally distributed (implicit: $z = 4.03$, $p < .0001$; explicit: $z = 3.50$, $p < .0005$). A paired-sample Wilcoxon Signed Rank test revealed no difference between the tests, $z < 1$, $p > .8$.
3. One-sample Wilcoxon Signed Rank tests showed that implicit, $z = 2.93$, $p < .005$, but not explicit, $z < 1$, $p > .8$, memory scores were significantly different from 0. A Mann–Whitney test showed no difference between the two conditions, $U = 196$, $z < 1$, $p > .9$.
4. Using the same Bayesian analysis as in Experiments 1 and 2, the probability that explicit memory from Experiment 3 is the same as implicit memory from Experiment 2 was .13.

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