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Retrieval Expectations Affect False Recollection: Insights from a Criterial Recollection Task

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Abstract

People use retrieval expectations to guide the accuracy of recollection attempts. This retrieval monitoring process minimizes illusory or false recollection, especially when the to-be-remembered events are distinctive. Our work with a criterial recollection task reveals that this monitoring process primarily depends on qualitative features of recollected information, an aspect of memory that can be dissociated from traditional measures of recollection frequency and familiarity. Neuroimaging and brain damage studies further indicate that this monitoring process relies on prefrontal regions that coordinate memory retrieval. This research helps explain why older adults are sometimes more susceptible to false recollection. More generally, this research highlights the importance of different kinds of recollected events and corresponding retrieval expectations in determining memory accuracy.

Keywords

diagnostic monitoring; distinctiveness heuristic; false memory; retrieval monitoring; source monitoring

The ability to consciously recollect details about past experiences – or episodic memory – is critical for an accurate sense of reality. Yet recollection is constructive, and many years of research indicate that false memories occur in a variety of situations (e.g., Loftus, 2005; Roediger & McDermott, 2000). This research highlights the fallibility of recollection, but it also raises a deeper question: If recollection can be distorted, how is it usually so effective? This article summarizes our recent work on this question, investigating the retrieval monitoring processes that people use to regulate their own memory accuracy.

Although different kinds of retrieval monitoring have been proposed, this review focuses on the use of retrieval expectations during recollection attempts (a process called “diagnostic monitoring” by Gallo, 2010). This conceptualization draws heavily from the source-monitoring framework, which assumes that people often use their intuitions about how memory works in order to evaluate retrieved information and infer what might have happened in the past (for review, see Johnson, 2006). For example, most people would probably reject the suggestion that they dressed as the Loch Ness Monster on a past Halloween, even if they could not recollect their actual costume. But how would they know? Based on their expectations, they might reason that this is a very memorable costume, so that the failure to recollect it would suggest it did not happen. By contrast, they might be more likely to mistakenly accept the suggestion that they dressed as a ghost or a vampire, because these costumes are more common and therefore less memorable.

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The idea that retrieval expectations influence memory errors has a long history in memory research, but recently gained prominence in a surge of research on false recognition. In a traditional recognition task, participants study a list of items and on a later memory test they must differentiate between studied items (targets) and nonstudied items (lures). Because memory is not perfect, people sometimes falsely recognize lures as having been presented in the study list. In an influential series of studies, Schacter and colleagues found that false recognition was less likely when the studied materials were presented in a format that elicited more distinctive recollections (e.g., pictures compared to words, for review see Schacter & Wiseman, 2006). They argued that distinctiveness affected retrieval expectations, helping people avoid false recognition because lures were unlikely to trigger distinctive recollections (a “distinctiveness heuristic”). This idea resonated with earlier source memory research (i.e., remembering the context of studied items; Johnson, 2006), which argued that memory expectations could bias people’s source memory errors.

Distinctiveness effects on false recognition and source memory errors are theoretically significant, suggesting that different kinds of events may be more or less susceptible to false memories more generally. However, as Gallo, Weiss, and Schacter (2004) argued, exactly how different aspects of retrieval contributed to these earlier effects can be questioned. According to dual-process theories, performance on any episodic memory test can be affected by a decontextualized feeling of familiarity or “oldness” towards the test items, as well as the recollection of associated details from the study context (for review, see Yonelinas, 2002). Because distinctiveness manipulations also can affect familiarity, people might expect the targets to be more familiar when tested for more distinctive items or sources. This expectation could cause a more conservative familiarity criterion, reducing familiarity-based memory errors independent from recollection-based processes. To more directly investigate the effects of recollection expectations on false recollection, and control for familiarity effects, Gallo et al. (2004) devised a criterial recollection task.

CRITERIAL RECOLLECTION TASK

A criterial recollection task evaluates people’s ability to selectively recollect specific features associated with prior events. An experiment by Gallo, McDonough and Scimeca (2010) provides an illustrative example. Participants studied a list of words associated with different presentation formats (a red font, a colored picture, or both, see Figure 1A). Items from the two presentation formats were repeated at study in order to match their familiarity on subsequent memory tests, but critically, we assumed the unique perceptual features of pictures would elicit more subjectively distinctive recollections than red font. These assumptions about familiarity and recollection were confirmed in a separate experiment using recognition tests and subjective judgments instead of criterial recollection tests.²

The criterial recollection tests used words in a neutral font as retrieval cues, with different instructions across test blocks. On the font test participants were instructed to accept test words that had been associated with red font at study, whereas on the picture test they were instructed to accept test words that had been associated with a picture (Figure 1B). A key aspect of this task is that, unlike a typical source memory task, the two presentation formats were not mutually exclusive at study (cf. Marsh & Hicks, 1998). As a result, recollecting the noncriterial format was relatively uninformative for the criterial recollection decision (i.e.,

²To measure familiarity, a separate group of participants studied the same list and then took a speeded recognition test that provided little time for recollection. Speeded recognition accuracy did not differ for test items that had been associated with pictures or red font, and neither did subjective judgments of familiarity on a self-paced recognition test. In contrast, subjective ratings of “uniquely recollected details” on the self-paced test were greater for test items associated with pictures than red font, confirming a difference in recollection quality or distinctiveness. This procedure provides a measure of distinctiveness that is independent from performance on the criterial recollection task (avoiding theoretical circularity).

test words that had been associated with both study formats had to be accepted, but those associated only with the noncriterial format had to be rejected). This design encouraged participants to base their decisions only on whether or not they could recollect the criterial format on each test (e.g. red font on the font test, pictures on the picture test), and they were explicitly instructed to do so.

We assumed recollection would not be perfect, and retrieval monitoring errors would cause participants to mistakenly accept some test lures due to false recollection. We further assumed false recollection would be greater for lures that were studied in the noncriterial format compared to nonstudied lures, because the studied lures were more familiar at test and hence more susceptible to false recollection (see Gallo & Roediger, 2003). Our main interest was in the pattern of false recollection errors across the two tests. We predicted that participants would expect qualitatively richer or more distinctive recollections for pictures than for font color. If these expectations increased retrieval monitoring accuracy, then false recollection errors (for either kind of lure) would be lower on the picture test than on the font test. This is exactly what we found (Figure 1C). Changing the dimension along which test items were evaluated from the recollection of font information to picture information greatly reduced false recollection, leading to large accuracy differences even though these tests required discriminating between exactly the same kinds of items.

Additional work with this task suggests that the use of retrieval expectations is a fundamental aspect of retrieval monitoring, applying to many kinds of recollected information. Specifically, we have generalized these retrieval-monitoring effects to several other manipulations of event distinctiveness (e.g., presentation modality, Pierce & Gallo, 2011; levels of processing, Gallo et al., 2008; and autobiographical elaboration, McDonough & Gallo, 2008). Each of these studies found that false recollection was less likely when participants were tested for more distinctive information, while controlling for familiarity. However, not all aspects of "memory strength" contribute equally. Scimeca, McDonough and Gallo (2011) found that repeating studied words increased their familiarity, and also increased the likelihood that participants would later claim to recollect these words on a recognition test (a traditional measure of recollection frequency, cf. Tulving, 1985). Nevertheless, the recollections associated with repeated words were rated as less detailed or distinctive than those associated with pictures (a measure of recollection quality), and unlike pictures, word repetitions were not associated with reduced false recollection on the criterial recollection task. These findings suggest that retrieval monitoring is primarily driven by expectations about recollection quality, as opposed to expectations about familiarity or recollection frequency.³

If distinctiveness effects on false recollection are mediated by people's retrieval expectations, or their metacognitive beliefs (cf. Dodson & Schacter, 2002), then artificially manipulating people's retrieval expectations also should affect false recollection. To test this prediction, McDonough and Gallo (2012) capitalized on the size illusion reported by Rhodes and Castel (2008). In this illusion, participants mistakenly believe that words presented in a large font at study will be more memorable than smaller words, even though large words are not remembered better on later tests. Our study replicated this illusion using traditional memory measures. More critically, using the criterial recollection task we found that false recollection was lower when participants monitored memory for large study words compared to small study words (using an intermediate-sized font at test). Falsely believing

³Of course, by definition, recollection frequency does affect the correct acceptance of targets at test. A greater sensitivity of targets than lures to recollection frequency can explain why target responses often are less sensitive to manipulations of recollection quality or distinctiveness than lure responses (Gallo et al., 2004; Schacter et al., 1999; for related work see Hunt, 2003). More generally, these ideas assume that traditional measures of accuracy that collapse across target and lure responses also collapse across potentially important differences between familiarity, recollection frequency, and recollection distinctiveness (see Scimeca et al., 2011).

that large words would be more memorable was sufficient to reduce false recollection, highlighting the unique contribution of retrieval expectations to monitoring accuracy.

BRAIN AND AGING

Retrieval monitoring involves at least two general processes: (1) consciously activating information from memory (retrieval success) and (2) evaluating this information based on one's retrieval expectations or criteria (monitoring). At the neurobiological level, these processes are supported by specialized but interconnected brain regions. For example, regions of sensory cortex process many of the qualitative features of memories, the hippocampus processes associations between these features, and prefrontal regions selectively activate this information and evaluate what was retrieved (for reviews, see Badre & Wagner, 2007; Mitchell & Johnson, 2009).

To identify brain regions specifically associated with the monitoring aspect of retrieval monitoring, Gallo, Kensinger and Schacter (2006) used fMRI of the criterial recollection task. Replicating earlier behavioral results, we found greater false recollection and slower response times when testing for font than for pictures, implicating more effortful monitoring for less distinctive recollections (i.e., more search and decision cycles, cf. Budson, Droller et al., 2005). To isolate this monitoring effect in the brain, we conducted whole-brain analyses identifying regions that were more active during responses to studied items on the font test compared to these same kinds of items on the picture test (while controlling for retrieval success confounds).⁴ These comparisons primarily revealed activity in prefrontal regions, including activity in dorsolateral prefrontal cortex (DLPFC) that we have replicated twice (Gallo et al., 2010; McDonough et al., 2012). DLPFC has extensive connectivity with other regions involved in recollection (see Simons & Spiers, 2003), and DLPFC has been linked to more complicated or difficult retrieval conditions with other tasks (e.g., Dobbins & Han, 2006; Ranganath et al., 2000). The novel feature of our task was the identification of brain activity specifically associated with differences in recollection expectations across the tests, and corresponding differences in retrieval monitoring effort implied by the behavioral data.

If DLPFC plays a causal role in retrieval monitoring, then damaging it should impair retrieval monitoring (cf. Budson, Dodson et al., 2005). To test this prediction, Hwang et al. (2007) compared participants with selective DLPFC damage to neurologically intact control participants on the criterial recollection task. Although this study found no overall effect of brain damage on recollection accuracy, a reanalysis here shows the side of the damage was critical. The 6 participants with left DLPFC damage showed performance comparable to control participants, with greater recollection accuracy on the picture test (.52) than the font test (.33).⁵ In contrast, the 5 participants with right DLPFC damage showed good accuracy on the picture test (.47) but were near chance on the font test (.07). This pattern suggests right DLPFC is critical for retrieval monitoring, and damage to this region disproportionately impairs tests requiring more effortful monitoring. Some neuroimaging studies also have found stronger associations between this kind of retrieval monitoring and right rather than left DLPFC (Gallo et al., 2010; cf. Cruse & Wilding, 2009, Rugg 2004), although left DLPFC often is active too.

⁴To control for possible differences in retrieval success, one of our analyses identified brain regions that were more active when correctly rejecting picture lures (on the font test) compared to correctly accepting picture targets (on the picture test). The latter items should elicit brain activity corresponding to successful picture recollection (e.g., activity in visual cortex corresponding to the perceptual representation). As a result, greater brain activity on the font test could be attributed to additional retrieval monitoring effort as opposed to retrieval success.

⁵For the between-group comparisons described in this paper, recollection accuracy was calculated as the difference between correct acceptance of targets (hits) and incorrect responses to lures (false alarms), comparing only items that were similar in familiarity (i.e. items that had been associated only with a red font or a picture at study).

Research on normal cognitive aging also implicates DLPFC in retrieval monitoring. Behavioral measures of prefrontal decline have been linked to increased false recollection in older adults (e.g., McCabe et al., 2009), and neuroimaging has linked age-related structural and functional changes in prefrontal cortex (including right DLPFC) to memory decline (e.g., Rajah et al., 2011). These findings are consistent with the hypothesis that prefrontal decline impairs retrieval monitoring in late adulthood, but note that aging also can reduce the ability to attend to specific features and bind them into a coherent representation at encoding (see Naveh-Benjamin, 2000). These encoding difficulties could increase false recollection even if retrieval-monitoring abilities were otherwise intact, making aging effects on retrieval monitoring difficult to pinpoint. For example, age differences in prefrontal activity during memory tests might be caused by differences in retrieval success or monitoring (e.g., Dulas & Duarte, 2012; Mitchell et al., 2006), or even compensatory strategies (e.g., Cabeza et al., 2002).

To more directly investigate age differences in the monitoring aspect of retrieval monitoring, McDonough et al. (2012) used fMRI and the criterial recollection task. Behavioral results replicated earlier work (Gallo, Cotel et al., 2007), as both younger and older adults had good recollection accuracy on the picture test (.44 and .31, respectively), but older adults were impaired considerably on the font test (.30 and .05). Similar to participants with right DLPFC damage, older adults were most impaired on the test requiring more effortful monitoring. Analysis of whole-brain activity in younger adults also replicated prior work, with greater activity in several regions when tested for font than pictures, including right DLPFC (Figure 2A). This right DLPFC effect again persisted after controlling for retrieval success, and across younger adults we found a positive correlation between right DLPFC activity and recollection accuracy on the font test, suggesting this region drives retrieval-monitoring effort. In sharp contrast, no prefrontal regions in older adults had greater activity when tested for font compared to pictures, even though the behavioral data confirmed older adults attempted to recollect on each test. There also was no brain-behavior correlation in DLPFC on the font test. Unlike younger adults, older adults did not boost prefrontal activity under the more demanding test conditions (Figure 2B), suggesting they had reached the limits of their retrieval monitoring resources.

CONCLUSION

The research reviewed here shows that expectations about recollection quality drive a retrieval monitoring process that affects false recollection. These effects can be disentangled from the effects of familiarity and recollection frequency, and they generalize across different kinds of recollected information. This research further indicates that DLPFC is critical for this kind of retrieval monitoring, and suboptimal recruitment of this region potentially increases false recollection in older adults. The upside of these findings is that older adults are more accurate when monitoring retrieval for distinctive recollections that place fewer demands on prefrontal resources. These findings have broad theoretical implications, because differences in recollection quality and corresponding retrieval expectations are likely to play an even larger role when monitoring the complex memories of daily life.

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Figure 1.

Criterial recollection task in Gallo et al. (2010). (A) Participants studied black words associated with red font, a picture, or both (randomly mixed). (B) Black words were presented as retrieval cues at test, with different instructions for the font test and the picture test (correct responses on the picture test are shown). Participants needed to accept the targets (i.e., studied items associated only with the criterial format, as well as those associated with both formats), and to reject the lures (i.e., studied items associated only with the noncriterial format, as well as nonstudied items). (C) On each test, participants used recollection to endorse targets more often than lures, and critically, false recollection errors

were less likely for lures on the picture test than the font test. Standard errors of each mean are depicted.

Figure 2.

FMRI results of McDonough et al. (2012). (A) Brain regions that were more active when correctly responding to studied items on the font test compared to the picture test in younger adults. This analysis revealed several regions often associated with retrieval, including the right DLPFC region (circled) that is specifically linked to monitoring effort. (B) Activity in the right DLPFC region when rejecting test lures. In younger adults activity tracked test difficulty (font test > picture test) and item difficulty on the more effortful test (studied lures > nonstudied lures). Older adults did not show these effects, suggesting an inability to recruit retrieval monitoring resources in more difficult conditions. Older adults also had

more overall activity than younger adults, but because age-related physiological differences might affect the overall level of fMRI signal, our focus was on the age $\times$ task interactions.