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Tag, you're it: Tagging as an alternative to yes/no recognition in item method directed forgetting

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ABSTRACT

The current study contrasted a standard yes/no recognition task with a tagging recognition task in the context of an item-method directed forgetting paradigm. During the study phase, a series of words was presented one at a time, each followed by an instruction to remember (R) or forget (F). The retention of R and F study words was tested using either a typical yes/no recognition task or a tagging recognition task in which participants labeled each word as "R", "F" or "New". The directed forgetting effect observed in each task was equivalent in magnitude. However, the tagging recognition task afforded an additional analysis of the errors of misattribution that was not possible with the more typical yes/no recognition task. Interestingly, when falsely recognizing a Foil word, participants were more likely to assign an "F" tag than an "R" tag. These errors of misattribution are consistent with existing accounts of directed forgetting that suggest R words are better encoded than F words. We argue for the utility of the tagging procedure, given it does not alter the directed forgetting effect normally seen with yes/no recognition but provides additional information about errors of misattribution.

The importance of forgetting is frequently underestimated: Without the ability to intentionally forget irrelevant information, our ability to function in everyday life would be greatly impeded. In the laboratory, intentional forgetting has been investigated using a variety of paradigms (for a review see Basden & Basden, 1998 or MacLeod, 1998); however, the present study is concerned exclusively with the item method. In an item-method directed forgetting paradigm, participants are presented with a list of words one at a time, each followed by an instruction to remember (R) or forget (F) the preceding word. Critically, participants are subsequently tested for recall or recognition of all study words, regardless of the preceding memory instruction. Typical findings show reduced recall and recognition of F words compared to R words; this R–F difference is referred to as a directed forgetting effect (for a review, see Basden & Basden, 1998 or MacLeod, 1998). Although there has been some argument that the directed forgetting effect may reflect inhibition of the F items (e.g., Zacks, Radvansky, & Hasher, 1996), there is no behavioral evidence to demonstrate that this is the case (see Marks & Dulaney, 2001; Thompson, Christie, & Taylor, submitted for publication). Instead, converging evidence suggests that the directed forgetting effect reflects selective rehearsal of R over F items (Basden & Basden, 1998; MacLeod, 1998).

There are two theoretical accounts of how differential encoding of R and F words is achieved. One view attributes forgetting to the passive decay of an unrehearsed memory trace (Basden, Basden, & Gargano, 1993). The notion is that upon presentation of the study word, participants perform maintenance/rote rehearsal until a memory instruction is provided. When an R instruction appears, participants engage in elaborative rehearsal to commit that item to memory; when an F instruction appears, participants let the word passively decay from memory, without providing any further rehearsal. The alternative views argue that forgetting is not the result of passive decay but, instead, is due to an active mechanism. One view attributes intentional forgetting to the engagement of executive control mechanisms (Hourihan & Taylor, 2006; Wylie, Foxe, & Taylor, 2008) that actively remove limited capacity processing resources from the F item (Fawcett & Taylor, 2008, 2010; Taylor, 2005). This withdrawal of attentional resources from F words limits their commitment to long-term memory and frees limited-capacity resources for the elaborative rehearsal of R words.

Importantly, whether forgetting is viewed as resulting from passive decay or the operation of an active cognitive process, the directed forgetting effect is at least partially due to the differential encoding of R and F words: Because R words are elaboratively rehearsed they are remembered at a higher rate than F words (which receive minimal rehearsal). Such differences in rehearsal at study are thought to lead to the successful encoding of more R words than F words. It follows that any F words that are accidentally encoded should on average be

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characterized by a weaker memory trace than successfully encoded R words. This is because F words are unlikely to receive direct rehearsal but may receive some degree of incidental processing. That R words are characterized by a stronger memory trace than F words is supported by the fact that recognition reaction times (RTs) for 'yes' responses are typically longer for correctly recognized F words than for correctly recognized R words (e.g., MacLeod, 1999; Wylie et al., 2008; Zacks et al., 1996). Likewise, a directed forgetting effect occurs for 'remember' but not 'know' responses, suggesting that participants are more likely to have an episodic recollection of R words than F words (Gardiner, Gawlik, & Richardson-Klavehn, 1994; Lee, Lee, & Tsai, 2007). Finally, even when an F item is successfully retrieved, the quality of its episodic representation is impoverished relative to intentionally remembered information (Fawcett, Taylor, & Nadel, 2010; Fawcett, Taylor & Nadel, submitted for publication). Together, these findings suggest that information intended for long-term storage has a richer mental representation than information intended to be forgotten.

Yes/no recognition is the most common test of recognition memory used to assess directed forgetting in an item-method paradigm. In a typical yes/no recognition task, participants are presented with all of the R and F study words, one at a time, randomly interspersed with an equal number of unstudied Foil words. For each word, participants are required to make a yes/no response to indicate whether the word was presented in the study phase of the experiment, irrespective of its associated memory instruction. Yes/no recognition tasks treat R words and F words as though they represent a single category (i.e., studied items). Yet, as discussed above, these two types of words are likely represented differently in memory. Moreover, when a participant erroneously classifies an unstudied Foil as having been presented at study, it is unclear whether the participant conceives of the item as having been a (weakly encoded) F word or a (strongly encoded) R word: The single false alarm rate does not provide any indication of the source of the false alarm. One would expect that if F words were characterized by a weaker memory trace than R words, they should be confused with Foil words more frequently. A yes/no recognition task is incapable of providing this information.

One way to get more information about memory for R and F words from a recognition test is to instruct participants to 'tag' each word based on whether they believe it was an R word, an F word, or a new word (i.e., an unstudied Foil). While a similar procedure has been used previously in the literature, it has typically been implemented after an initial recall or yes/no recognition test (e.g., Davis & Okada, 1971; Horton & Petruk, 1980; MacLeod, 1975; Woodward & Bjork, 1971). When used with yes/no recognition, the typical approach is to re-present only those items that participants classified as having been studied in the yes/no task, and to then ask them to identify each item as having received an R or F instruction (or "don't know"). This method of tagging is post hoc in nature: Participants have already decided whether or not the item was studied or unstudied before providing the memory instruction they thought accompanied the item at study.

The present study explored the utility of a tagging task implemented at initial recognition (for an example at initial recall, see Goernert, Widner, & Otani, 2006, 2007). At study, participants were presented with a list of words, one at a time, each followed with equal probability by an R or F instruction. At recognition, the R and F items were presented, one at a time, randomly intermixed with an equal number of unstudied Foils. Half of the participants performed a standard yes/no recognition test: For each item, participants had to indicate that 'yes', it had been presented at study (regardless of R or F memory instruction), or 'no', it had not been presented at study. The other half of the participants performed a tagging task: For each item, they had to classify the word as having received an 'R' instruction at study, as having received an 'F' instruction at study, or as being a 'New' unstudied item. Since no direct comparison of the directed forgetting effect in a yes/no versus a tagging recognition task has been done (probably because most previous tagging manipulations occurred after a yes/no task), our goal was to assess the equivalence of the tagging task and standard yes/no task by comparing the magnitude of the directed forgetting effect observed in each task. We also wished to examine the nature of the source attributions made in the tagging procedure. While previous tagging studies surely collected data on misattributions of false alarms, the importance of this data has never been given much attention. Assessing these misattributions can confirm our suspicions about how R and F words are represented in memory. Given that accidentally encoded F words appear to have weaker memory traces than intentionally encoded R words, we predicted that F words would receive more misattributions as 'New' words than as 'R' words and, conversely, that false alarms to Foils would more often reflect their misattribution as 'F' than as 'R' words.

1. Method

1.1. Participants

Fifty-nine undergraduate students (30 in the tagging recognition task, and 29 in the yes/no recognition task) enrolled at Dalhousie University participated in this experiment in exchange for course credit. Participants were tested individually in a session that lasted no more than 1 h.

1.2. Stimuli and apparatus

The stimuli were presented using PsyScope 5.1.2 (Cohen, MacWhinney, Flatt, & Provost, 1993) on either a Macintosh G4-400 computer running OS9 with a 17 in. 1024×768 resolution Macintosh Studio Display color monitor, or a Macintosh G3-300 computer running OS9 with a 17 in. 1024×768 resolution ViewSonic PT775 color monitor. Participants were seated approximately 57 cm away from the monitor. Responses were recorded on a standard Macintosh Universal Serial Bus keyboard.

The stimuli consisted of 252 words sampled from the Kucera and Francis (1967) word norms using the Paivio, Yuille and Madigan Word List Generator (http://www.math.yorku.ca/SCS/Online/paivio/). Prior to running each participant, custom software was used to randomly divide this master wordlist into four lists of words: 60 R words, 60 F words, 120 Foil words, and 12 buffer words; this ensured a unique list composition for each participant. All words were presented in black 24 point Arial font, on a uniform white background.

Memory instructions consisted of either a high (1170 Hz) or low (260 Hz) auditory tone presented to the participant through both channels of Sony MDR-XD100 headphones. Assignment of tone to memory instruction (remember or forget) was counterbalanced across participants within each recognition task condition.

1.3. Procedure

1.3.1. Study phase

Upon arrival, the general procedure (detailed below) was explained to each participant, and these instructions were reiterated on-screen prior to starting the experiment. Participants were informed that there would be a memory test after the study phase, but were not told what this test would entail; there was no mention of the fact that participants would be tested for both R and F words.

Each trial of the study phase consisted of the following events, all of which appeared in sequential order at the center of the computer screen: (a) A fixation stimulus (+) for 1000 ms, (b) a blank screen for 500 ms, (c) a word drawn randomly from either the R or F word list for 800 ms, (d) another blank screen for 500 ms, (e) a high- or low-frequency tone (R or F memory instruction) for 400 ms, and finally, (f) a blank screen for 800 ms. There were 120 study trials in total. The 12 buffer trials (i.e., six at the beginning and six at the end of the study phase) were identical to experimental trials except that they were invariably followed by an R instruction and not subsequently tested. The buffer trials were included to minimize the impact of recency and primacy effects on subsequent recognition performance.

1.3.2. Recognition phase

The study phase was followed by either a yes/no or tagging recognition task, administered between-subjects. Instructions for the appropriate task were presented at the top of the computer monitor throughout this phase. Participants were presented with all R and F study words as well as an equal number of Foil words, one at a time, and in random order. Each word was centered on screen directly below the instructions. Participants' responses were visible in a box outlined in black centered below the word. Responses could be modified until the participant submitted the response by depressing the space bar. The current trial ended as soon as the participant submitted a response, and the next trial started immediately. Responses were self-paced and no feedback was given.

In the recognition phase, participants were instructed to indicate whether or not they remembered seeing each word during the study phase, regardless of the memory instruction associated with the word. In the yes/no recognition task, participants were to input a 'y' if they remembered the word (for 'yes, I remember the word'), or an 'n' if they thought the word was not presented (for 'no, the word was not presented at study'). In the tagging recognition task, participants were to input an 'r' ('R' tag — 'the word was a Remember word'), an 'f' ('F' tag — 'the word was a Forget word'), or an 'n' ('New' tag — 'no, the word was not presented at study').

After completion of the study phase and the recognition phase, participants were debriefed and given an opportunity to ask questions.

2. Results

2.1. Yes/no recognition task

The proportion of 'yes' responses was analyzed as a function of word type (R, F, Foil) using a one-way repeated measures analysis of variance (ANOVA); these data are presented in Fig. 1. This analysis revealed a significant effect of word type [$F(2, 56) = 174.29$, $MSe = 0.01$, $p < .01$, $\eta_p^2 = .86$]. Planned contrasts confirmed a significant directed forgetting effect ($R - F = 0.28$), with greater recognition of R than F words [$t(28) = 8.94$, $p < .01$]. Compared to unstudied Foils, recognition was greater for both R [$t(28) = 18.75$, $p < .01$] and F words [$t(28) = 9.73$, $p < .01$].

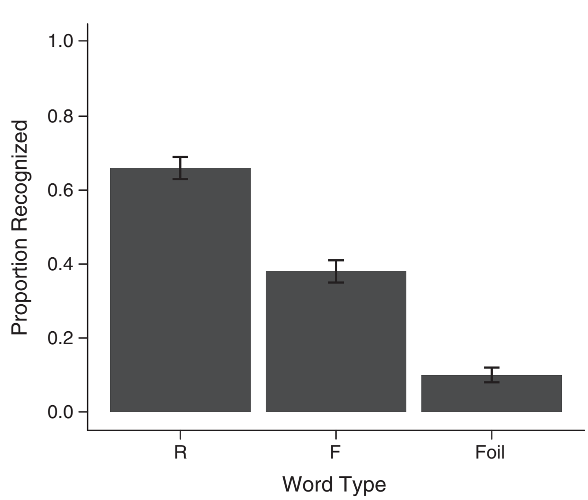

Fig. 1. Proportion recognized as a function of word type (R, F, Foil); error bars represent one standard error of the mean.

2.2. Tagging recognition task

2.2.1. Combined 'yes' data

For the tagging task, 'R' and 'F' responses – regardless of whether they were made to R, F, or Foil words – were initially re-coded to 'yes' responses to facilitate comparison with the yes–no recognition task. The rationale was that both 'R' and 'F' responses implied that the participant recognized the word as having been presented at study. This is represented in Fig. 2 as stacked bars, such that the proportion of 'R' and 'F' tags adds to represent the proportion of 'yes' recognition responses. Using this recoding, the proportion of 'yes' responses was then analyzed as a function of word type (R, F, Foil) using a one-way repeated measures ANOVA. The analysis was significant [$F(2, 58) = 137.93$, $MSe = 0.02$, $p < .01$, $\eta_p^2 = .83$]. Planned contrasts revealed a significant directed forgetting effect ($R - F = 0.24$), with greater recognition of R than F words [$t(29) = 8.98$, $p < .01$]. Compared to unstudied Foils, recognition was higher for both R words [$t(29) = 13.61$, $p < .01$] and F words [$t(29) = 10.06$, $p < .01$].

To compare performance in the yes/no and tagging recognition tasks, the recoded tagging data were entered into an omnibus ANOVA with the results from the yes/no recognition task. The proportion of 'yes' responses were analyzed with word type (R, F, Foil) as a within-subjects variable and recognition task (yes/no, tagging) as a between-subjects variable. This analysis revealed a significant main effect of word type [$F(2, 114) = 308.50$, $MSe = .01$, $p < .01$, $\eta_p^2 = .84$]. The main effect of recognition task was also significant [$F(1, 57) = 13.55$, $MSe = .05$, $p < .01$, $\eta_p^2 = .19$], such that more words received 'yes' responses in the tagging recognition task than in the yes/no recognition task. An analysis of B″D (a nonparametric measure of response bias, Donaldson, 1992) suggests that this difference in overall responding was likely due to a more liberal response criterion in the tagging task (for R words: $M = .12$, $SE = .11$; for F words: $M = .45$, $SE = .10$) than in the yes/no task (for R words: $M = .59$, $SE = .07$; for F words: $M = .84$, $SE = .04$) for both R words [$t(57) = 7.21$, $p < .01$] and F words [$t(57) = 20.80$, $p < .01$]. Importantly, however, the word type × recognition task interaction in the omnibus ANOVA was not significant [$F(2, 114) = .331$, $MSe = .01$, $p = .72$, $\eta_p^2 = .01$], indicating that the effect of word type on recognition accuracy did not differ by recognition task. Indeed, the magnitude of the directed forgetting effect was not statistically different across the two recognition tasks [$t(57) = .82$, $p = .42$].

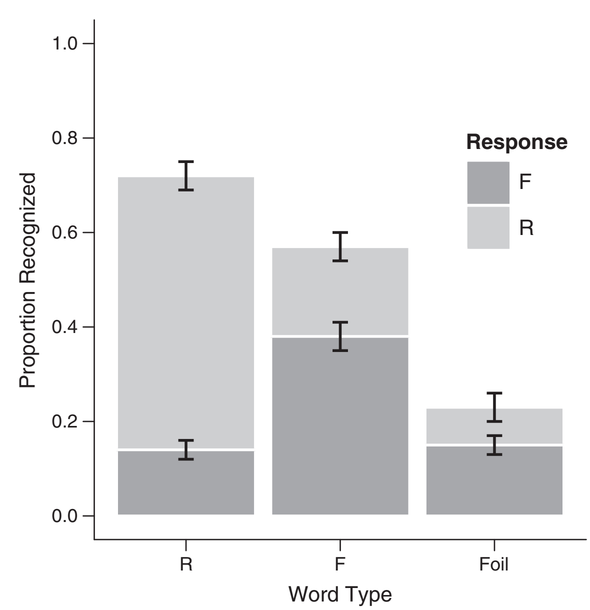

Fig. 2. Proportion recognized as a function of Word Type (R, F, Foil) and Response ("R", "F"); error bars represent one standard error of the mean.

2.2.2. Errors of misattribution

While these results demonstrate that the tagging and yes/no procedures yield statistically similar magnitudes of the directed forgetting effect, the tagging procedure enables a fine grain analysis of source attributions. To begin, we selected those trials on which a participant endorsed the word as having been presented at study (i.e., 'R' + 'F' trials; the stacked bars in Fig. 2). We determined the proportion of these responses that were classified as 'R' rather than 'F' (i.e., 'R'/('R' + 'F')) separately for each word type (R, F, Foil). This analysis revealed a significant effect of word type [$F(2, 56) = 77.33$, $MSe = .03$, $p < .01$, $\eta_p^2 = .73$][1], such that participants assigned an 'R' tag to more R words than to either F words [$t(29) = 11.22$, $p < .01$], or Foil words [$t(28) = 9.77$, $p < .01$]; there was no difference between the proportion of F words and Foil words assigned an 'R' tag [$t(28) = 1.04$, $p = .30$]. Of those R words that participants endorsed as having been presented at study, they correctly attributed an 'R' instruction on .75 ($SE = .03$) of trials and misattributed an 'F' instruction on .25 ($SE = .02$) of trials [$t(29) = 10.00$, $p < .01$]. Of those F words that participants endorsed as having been presented at study, they misattributed an 'R' instruction on .25 ($SE = .03$) of trials and correctly attributed an 'F' instruction on .75 ($SE = .03$) of trials [$t(29) = 7.15$, $p < .01$]. In other words, when participants correctly recognized that a word had been presented at study, they identified its source correctly approximately 75% of the time. Participants were more likely to mistake F words for Foil words ($M = .48$, $SE = .03$) than for R words ($M = .14$, $SE = .03$) [$t(29) = 5.96$, $p < .01$]. Finally, for unstudied Foil words to which participants made false alarms, they misattributed .29 ($SE = .05$) of them as having been presented as 'R' words and they misattributed .71 ($SE = .05$) as having been presented as 'F' words. In other words, when participants made a false alarm by incorrectly endorsing a Foil word as having been presented at study, they were more likely to misattribute the source of the false memory to an 'F' instruction than to an 'R' instruction [$t(28) = 4.50$, $p < .01$].

3. Discussion

The current experiment implemented a tagging procedure as a test of recognition memory. Instead of tagging words as 'R' or 'F' post hoc (i.e., after making a previous yes/no decision about each word) as in previous tagging manipulations (e.g., Davis & Okada, 1971; Horton & Petruk, 1980; MacLeod, 1975; Woodward & Bjork, 1971), participants made this distinction upon initial presentation of the word during the recognition phase. A significant directed forgetting effect was found in both yes/no and tagging recognition tasks. Interestingly, more words were categorized as having been presented at study (regardless of word type) in the tagging than in the yes/no recognition task. This suggests that allowing participants to label a studied word as 'R' or 'F' encouraged them to respond more liberally to studied items, which was supported by the analysis of response bias. Even so, when 'R' and 'F' words were combined in the analysis of the tagging recognition task, a comparison with the standard yes/no recognition task revealed no significant difference in the magnitude of the directed forgetting effect. This suggests that the use of the tagging procedure did not impair the ability to measure directed forgetting.

Findings from our tagging recognition task are generally consistent with previous research that has used a post hoc tagging method. Davis and Okada (1971) analyzed the proportion of 'yes' responses for each type of word (R, F, and Foil) that was subsequently assigned an 'F' tag in their post hoc tagging procedure. They found that participants were more likely to respond 'F' to F and Foil words than to R words. In fact, F and Foil words were tagged as 'F' equally often — a pattern mirrored in the current data. Woodward and Bjork (1971) observed a similar pattern using free recall. In their study, participants identified a third of their intrusions as 'F' words, and accurately classified about half (45%) of their correctly recalled F words. In comparison, their participants misclassified only 6% of the recalled R words as 'F'. Thus, our results are consistent with previous incarnations of the tagging procedure, despite the differences in methodology (i.e., tagging as the primary recognition response versus as a post-recognition categorization). Given the similarities between these outcomes, and our finding that the magnitude of the directed forgetting effect is the same in yes/no and tagging tasks, it is advisable for future investigations to adopt the current approach, as it enables an examination of source attributions without compromising the overall directed forgetting effect.

Further analysis of the source attributions within the tagging recognition task in this experiment revealed that, of all recognized words (words given either an 'R' or 'F' tag), R words were more likely to be tagged as 'R' than as 'F'. In addition, F words were more likely to be tagged as 'F' than as 'R'. In other words, participants are generally accurate at attributing the correct source to recognized R and F words. Indeed, when participants correctly recognized that a word had been presented at study, they tagged it correctly 75% of the time whether it was an R word or an F word. Clearly, whatever basis participants use to correctly identify a word as having been presented at study (e.g., explicit source memory, signal strength), their attribution of source tends to be quite good.

Perhaps unsurprisingly, participants were not perfect in their attributions of recognized R and F words. That is, some R words were tagged as 'F', and some F words were tagged as 'R'. On one hand, given the demanding nature of the task (a total of 120 words presented at study), it is likely that some R words were not well encoded, resulting in a relatively weak memory trace more similar to an F word. On the other hand, some words that were given an F instruction might generate fairly strong memory traces by chance. The same goes for Foil words, which may sometimes be highly familiar to the participant, causing the participant to judge them as studied. A strong familiarity signal for F and Foil words could be due to unequal levels of activation prior to the experiment, random noise, or to idiosyncratic individual differences. Even so, the fact that F recognition hits are significantly higher than Foil false alarms argues that at least some of the recognition of F words is due to their (unintentional) encoding.

Even when F items are encoded into memory (contrary to instruction) the resulting signal strength distinguishes them from intentionally encoded R items. Consider that when false alarms were made to unstudied Foil words, they were more likely to be tagged as 'F' than 'R'. If there was no difference in the strength of memory traces for encoded R and F words, unstudied Foil words would be expected to be misclassified as 'R' and 'F' words equally often. The fact that participants more often mistook unstudied Foil words for F words rather than R words is consistent with the suggestion that F words are characterized by a weaker memory trace than R words (and are therefore more easily confused with unstudied Foils). The higher false alarm rate observed using 'F' relative to 'R' tags might suggest that participants were prone to use this response in the face of uncertainty, artificially inflating the hit rate for F words (to which most 'F' tags were assigned). Unfortunately, measures of criterion and discriminability derived from a signal detection analysis of the current data are not dissociable for R and F items within the same sample because they rely upon a common false alarm rate (see Zacks et al., 1996, footnote 2). Trying to resolve this problem by using the proportion of Foil words tagged as 'F' and 'R' violates the assumptions of the typical signal detection model by requiring participants to discriminate between three concurrent distributions (Noise, Forget, and Remember) as opposed to two (for further discussion, see Donaldson, 1996). Thus, this hypothesis cannot be tested using the current data.

Even if participants were using a more liberal criterion for F words, we still observed greater recognition of R words than F words. This suggests that the cognitive mechanisms engaged top–down to

[1] Discrepancies in reported degrees of freedom are due to the elimination of participants whose data included empty cells for the relevant analysis (e.g., if no Foil words were tagged as "R").

intentionally forget and remember are sufficiently powerful that their effects cannot be overridden by a simple shift in the participant's response criterion. If such a shift occurs, it may reflect an effort to compensate for the weak memory traces representing the F words. When viewed in this light it suggests that participants are themselves aware that F words are not well represented in memory, resulting in the expectation that words eliciting only a weak recognition response are likely to be F words (even though Foils are also capable of eliciting such responses).

In our tagging recognition task, the ability of participants to accurately categorize studied words as either 'R' or 'F' and the tendency to categorize false alarms as 'F' seem to be based on the participants' judgment of the strength of the memory trace. Indeed, whereas a similar level of familiarity characterizes both R and F items, R items are more likely to be associated with a recollective experience than F items (Gardiner et al., 1994). This suggests that participants in the current study may have reserved the 'R' tag for words associated with such a recollective experience. This would explain why unstudied Foils were only rarely misclassified as 'R'. Conversely, the recognition of F words may have relied more upon a feeling of familiarity in the absence of a recollective experience. Presuming that most unstudied Foil words were falsely recognized on the basis of familiarity, this would explain why participants were most likely to misclassify these words as 'F'. This is all in accordance with the widely held view that the directed forgetting effect in an item–method task is attributable to differential rehearsal of R and F items (regardless of whether this is achieved through passive decay of F items or active removal of processing resources from their representations).

In summary, we have found that the tagging task is equally sensitive to the directed forgetting effect as the yes/no recognition task, and can be implemented on its own (without following yes/no recognition). It is clear that the misattribution errors are consistent with the premise that R words are associated with richer encoding than F words. Thus, even when R and F words are correctly identified as having been presented at study, there is something qualitatively (e.g., recollective experience versus feeling of familiarity) and/or quantitatively (e.g., signal strength) different about their memory traces.

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