Running head: ATTENTION AND FALSE RECOGNITION

The Role of Attention at Retrieval on the False Recognition of Negative Emotional DRM Lists

Datin Shah & Lauren M. Knott
City, University of London

Address correspondence to: Dr Lauren Knott
Department of Psychology
City University London
London, EC1V 0HB
Phone: +44 (0)20 7040 3354
E-mail: Lauren.Knott.1@city.ac.uk

Abstract

This study examined the role of attention at retrieval on the false recognition of emotional items using the Deese-Roediger-McDermott (DRM) paradigm. Previous research has shown that divided attention at test increases false *remember* judgements for neutral critical lures. However, no research has yet directly assessed emotional false memories when attention is manipulated at retrieval. To examine this, participants studied negative (low in valence and high in arousal) and neutral DRM lists and completed recognition tests under conditions of full and divided attention. Results revealed that divided attention at retrieval increased false *remember* judgements for all critical lures compared to retrieval under full attention, but in both retrieval conditions, false memories were greater for negative compared to neutral stimuli. We believe that this is due to reliance on a more easily accessible (meaning of the word) but less diagnostic form of source monitoring, amplified under conditions of divided attention.

Keywords: DRM Paradigm; Divided Attention; False Memory; Emotion; Retrieval

The Role of Attention at Retrieval on the False Recognition of Negative Emotional DRM lists

Due to the reconstructive nature of our memory, one can falsely recall details of an experienced event. A popular paradigm to examine false memories in a laboratory setting is the Deese/Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). Here, participants study semantically associated word lists (e.g. *bed*, *rest*, and *awake*) that all converge on a non-presented *critical lure* (e.g. *sleep*). In subsequent tests, it is found that critical lures are frequently falsely recalled and recognised. Additionally, when participants are required to make either *remember* (a conscious and vivid recollection of a presented word) or *know* (word familiarity without vivid remembrance) judgements alongside their recognition decisions, *remember* responses to false critical lures are made at a similar rate to correct list items (e.g. Roediger & McDermott, 1995, Expt. 2).

One theoretical account to explain false memories in this paradigm is the *activation-monitoring framework* (Roediger & McDermott, 1995). Words presented at encoding (e.g. *table*) are activated, which then spreads to corresponding semantically-related concepts/associates (e.g. *wood*, *legs*). Critical lures within one's semantic network are thought to receive repeated activation (*chair*) through list item presentation, thus increasing the likelihood of its false recognition/recall. During a memory test, failure to successfully monitor the source (internally generated or externally presented) of the non-presented items (i.e. critical lures) leads to the production of false memory (Johnson, Hashtroudi & Lindsay, 1993).

To improve the ecological validity of the DRM paradigm, recent research has been increasingly interested in the role of emotion on memory performance. Similar to the effects on veridical memory (e.g., Cahill & McGaugh, 1995; Maddox, Naveh-Benjamin, Old, and

Kilb, 2012; Talmi, Luk, McGarry, & Moscovitch, 2007), we typically see an enhanced false memory effect for emotional stimuli with higher false alarms for negative compared to neutral valance associative critical lures (e.g. Brainerd, Stein, Silveira, Rohenkohl, & Reyna, 2008; Howe, Candel, Otgaar, Malone, & Wimmer, 2010).

The heightened emotional false memory effect has been attributed to the well-integrated and dense networks of interrelated concepts for negative valence information. Fewer theme nodes means more likely activation of the critical lure (Otgaar, Howe, Brackmann, & Smeets, 2016). Otgaar et al. (2016) argued that in such a well-integrated and dense network, negative information is more likely to spread in a fast and automatic manner. A recent study by Knott, Howe, Toffalini, Shah, & Humphreys (2017, under review) found evidence to support this claim with higher false recognition rates to critical lures associated with negative high arousing compared to positive and neutral DRM lists after divided attention at study. Knott et al (2017). argued that the encoding of negative items benefits from automatic processing and less demanding attentional resources. It occurs relatively automatically, and without the individual's explicit direction. Thus the secondary task at encoding has a less damaging effect on the relatively automatic activation of concepts/nodes in the negative emotional memory network.

Although research has examined the role of automatic and controlled encoding processes on enhanced emotional (both veridical and false) memory performance, less thought has been given to the importance of attention, and controlled and automatic processing during the retrieval phase. If retrieval of emotional items is relatively automatic, then the enhanced emotional memory effect should still be observed even under divided attention at retrieval. Alternatively, if retrieval of emotional stimuli is an effortful process then divided attention during retrieval may eliminate or reduce the enhanced emotional memory effect. To test such an assumption, Maddox et al. (2012) asked participants to study lists of positive, neutral, and negative words pairs under full attention at encoding, divided attention at encoding, or divided attention at retrieval. They reported that when studied in a full attention condition at encoding but tested under a divided attention at retrieval, no emotion enhanced memory effect emerged for single item recognition and word pair associations. The disappearance of this effect appears to be a result of an increase in false alarms, reducing the overall accuracy scores for negative item recognition with divided attention at retrieval. They concluded that retrieval of emotional stimuli relies in part on controlled attention. That is, controlled processing is required to inhibit the processing fluency of lure items, a conclusion that has some theoretical support given that past evidence has suggested that negative stimuli benefit more from semantic categorisation than do positive or neutral stimuli (Talmi & McGarry, 2012). The impact of controlled attention at retrieval on false memory production has also been examined using the DRM paradigm. Knott and Dewhurst (2007a), found that false *remember* responses to critical lures increased whilst correct *remember* responses were unaffected when attention was divided (using a random number generation [RNG] secondary task) during the recognition test. They concluded that the increase in false *remember* responses was due to the interference with more controlled source monitoring processes at retrieval, forcing participants to make more automatic but less diagnostic source monitoring decisions that increase errors in identifying the source of the critical lure (internally generated versus externally presented). This study however, use neutral valence DRM lists. Research has yet to examine the effect of attention at retrieval and the role of automatic and controlled processing on the production of negative emotional false memories.

This would be an important investigation as it would provide further understanding related to any differences in retrieval processes and retrieval monitoring for emotionally valenced stimuli and associated false memories. The effects of reduced attentional resources at retrieval are unclear. Research has shown that the semantic cohesiveness of negative stimuli leads to greater activation of the critical lure and greater source confusion at retrieval. Under conditions of normal retrieval, we should expect to see higher instances of false memory production for negative emotional compared to neutral DRM lists. However, what would we expect when attention is limited at retrieval? Maddox et al. (2012) found that the enhanced emotional memory effect disappeared for correct recognition because controlled processing was needed to inhibit the processing fluency of lure items and thus reduce false alarms. But this logic would imply an increase in negative false recognition responses in the DRM paradigm. We have seen from previous research, that false *remember* responses increase for neutral DRM critical lures due to possible disruptions in the effortful source-monitoring needed to strategically evaluate the presence of the item on the list. The question is, will the enhanced false memory effect for negative stimuli remain, even with disruption to attentional resources at retrieval? The aim of the present study is to investigate this question.

Method

Participants

Thirty-six participants (15 males and 21 females) aged 18-52 (M = 20.06, SD = 5.75) participated for either course credits or £6. A sample size of 36 was required to detect significance as indicated by an a priori power analysis, with a medium effect size and a high Power (α = 0.05, 1-β err prob) of 0.95.

Design and stimuli

The experiment followed a 2 (Attention at Retrieval: Full vs. Divided) x 2 (List Type: Neutral vs. Negative) repeated measures design. A total of 20 DRM lists (10 negative and 10 neutral) were used (see Appendix). Neutral lists were either taken from Stadler, Roediger, and McDermott (1999; although reduced to 12 items per list), or developed using The

University of South Florida Free Association Norms database choosing 12 associates to each list (Nelson, McEvoy, & Schreiber, 1998). All negative lists were developed using the Nelson et al. (1998) norms. Affective Norms for English Words (ANEW; Bradley & Lang, 1999) were used to obtain available arousal and valence values for the individual list items and critical lures. Independent samples t-test showed that negative list items and critical lures were significantly higher in arousal, $t(18) = 4.17$, $p < .001$, $r = .70$, and $t(15) = 2.65$, $p < .05$, $r = .56$ respectively, and significantly lower in valence, $t(18) = -13.53$, $p < .001$, $r = .03$, and $t(15) = -8.81$, $p < .001$, $r = .92$ respectively, compared to neutral list items and critical lures. Mean values and 95% confidence intervals for all the list characteristics can be found in Table 1.

List type was blocked and counterbalanced so that half of the participants began with negative lists followed by neutral lists after the first test. List presentation within the emotion block type was randomised. The negative and neutral lists were matched for backward associative strength (BAS). An independent samples t-test showed that BAS between the negative and neutral conditions did not differ significantly, $t(18) = -.44$, $p = .66$, $r = .10$ (see Table 1).

Procedure

Participants took part in two study-test phases, one with negative lists and one with neutral lists. Each phase followed the same procedure. Before the presentation of each new list, participants were shown an on-screen instruction (i.e. List 1, List 2, etc.) that lasted for 1 second. Thereafter, 12 words from the lists appeared individually for 2 seconds, with an inter-stimulus interval of 1 second. After the study phase, participants engaged in a 5-minute non-verbal distractor task. A self-paced recognition test was then administered. The attention conditions at test was counterbalanced, such that half of the participants engaged in DA for the first half of the test followed by FA in the second half. In the DA condition, participants performed an RNG secondary task that involved randomly generating numbers aloud between 1 and 20 in time with a metronome every 750ms. Such a task has been shown to successfully disrupt retrieval processes (e.g. Knott & Dewhurst, 2007a, 2007b). They were instructed to maintain the correct speed and a correct level of randomness, and to avoid incremental counting or following familiar sequences. Consent to record their number generation during the task was also obtained in order to calculate measures of randomness for each participant. RgCalc (Towse & Neil, 1998) was used to analyse number sequences. RgCalc provides a numerical value between 0 and 1 for each participants' sequence, with high degree of randomness represented by a low RNG score.

Each recognition test was constructed in the same fashion. The test contained 60 words: 10 critical lures, 30 presented words (3 items from each list from positions 1, 6, and 12), and 20 non-studied words (10 weakly-related and 10 unrelated fillers). The weakly-related fillers were selected from the (near) bottom of the Nelson et al. (1998) normed lists. The words were individually presented on the computer screen and participants made *old*/*new* responses for each word by pressing keys marked with the corresponding response. If participants responded *old*, they were then asked to make a *remember*/*know*/*guess* judgement. Instructions for remember, know, and guess responses were taken from Dewhurst and Anderson (1999). In line with these instructions participants were asked to make a *remember* response if they recollected some aspect of the item's explicit study presentation; a *know* response if the word felt familiar but they were unable to recollect any specific details; or a *guess* response if they were unsure whether or not the word had appeared at study. List presentation and data collection was completed using E-prime.

Results

Random number generation task

Secondary task performance was measured in each of the list type conditions for each participant. An RNG score was obtained to measure participant's randomness in generated number sequences. Paired samples t-test revealed that RNG did not differ significantly between negative (M = .24, *95% CI* [.22, .27]) and neutral (M = .24, *95% CI* [.22, .27]) conditions, $t(35) = .19$, $p = .85$, $r = .03$. The number of responses generated within each sequence was also noted. However, since the time taken to complete the recognition test varied between participants and between list type conditions, the total was converted into an average that represented the number of responses generated every 10 seconds, *Na*. Paired samples t-test revealed that *Na* did not differ significantly between negative (M = 7.65, *95% CI* [6.63, 8.67]) and neutral (M = 7.44, *95% CI* [6.54, 8.35]) conditions, $t(35) = .76$, $p = .45$, $r = .13$. Overall, neutral and negative conditions did not differ in attentional resources allocated to the completion of the secondary task.

Recognition test responses

Proportions of the recognition test responses (*old*, *remember*, *know*, and *guess* judgements) to critical lures, studied items, weakly related and unrelated filler items were subjected to a 2 (Attention at Test: FA vs. DA) x 2 (List Type: negative vs. neutral) repeated measures ANOVA. Any significant interactions were further analysed using paired-samples t-test with Bonferroni corrections (alpha set at .025). Table 2 reports all the mean proportions and their 95% confidence intervals for the recognition responses in each type of test item.

Correct recognition. For *old* responses, there was a significant main effect of attention, $F(1, 35) = 7.84$, $p = .008$, $\eta_p^2 = .18$, whereby correct recognition was higher in the FA (M = .72, *95% CI* [.66, .77]) compared to the DA (M = .63, *95% CI* [.57, .70]) condition.

There were no significant main effects of list type, $F(1, 35) = .08$, $p = .78$, $\eta_p^2 = .002$, indicating an absence of an emotion enhanced memory effect (although this is not unexpected when using the DRM paradigm), and no significant Attention x List Type interaction, $F(1, 35) = .20$, $p = .66$, $\eta_p^2 = .01$. For correct *remember* judgements, there were no significant main effects or interaction (all *Fs* < 2.50). For correct *know* judgements, there was a significant main effect of attention, $F(1, 35) = 4.77$, $p < .05$, $\eta_p^2 = .12$, with higher correct recognition found again in the FA ($M = .14$, *95% CI* [.11, .17]) compared to the DA ($M = .12$, *95% CI* [.08, .15]) condition, but no main effect of List Type was observed, $F(1, 35) = .17$, $p = .68$, $\eta_p^2 = .01$. However, there was a significant Attention x List Type interaction, $F(1, 35) = 6.83$, $p = .01$, $\eta_p^2 = .16$. The Simple Main Effects (SME) of list type revealed no difference in correct *know* responses between attention conditions for the neutral list type, $t(35) = .48$, $p = .63$, $r = .08$. However, correct *know* responses were significantly higher when tested under FA ($M = .16$, *95% CI* [.12, .20]) than under DA ($M = .10$, *95% CI* [.06, .14]) for the negative list type, $t(35) = -3.84$, $p < .001$, $r = .54$. For *guess judgements*, the main effects nor interaction reached significance (all *Fs* < 1.20).

False Recognition of Critical lures. For false *old* responses, there were no main effects or Attention x List Type interaction (all *Fs* < 1.70) For false *remember* judgements, there was a significant main effect of attention, $F(1, 35) = 9.23$, $p = .004$, $\eta_p^2 = .21$, with higher false recognition found in the DA ($M = .33$, *95% CI* [.26, .39]) compared to the FA ($M = .23$, *95% CI* [.17, .29]) condition. There was also a significant main effect of list type, $F(1, 35) = 4.63$, $p < .05$, $\eta_p^2 = .12$, where negative false *remembering* ($M = .33$, *95% CI* [.25, .40]) was significantly greater compared to neutral false *remembering* ($M = .23$, *95% CI* [.17, .30]), revealing an enhanced false memory effect for emotional lists. There was no Attention x List Type interaction, $F(1, 35) = .28$, $p = .60$, $\eta_p^2 = .01$. For the analysis of false *know* judgements, there was a significant main effect of attention, $F(1, 35) = 5.09$, $p < .05$, $\eta_p^2 = .13$, where false recognition was higher in the FA compared to the DA condition, a reversed pattern to false *remember* responses. There was no significant main effect of list type, $F(1, 35) = 2.01$, $p = .17$, $\eta_p^2 = .05$, nor interaction, $F(1, 35) = .01$, $p = .92$, $\eta_p^2 = .00$. Similarly for *guess* judgements, a significant main effect of attention was found, $F(1, 35) = 6.06$, $p < .05$, $\eta_p^2 = .15$, with the same pattern as *know* judgements, but no significant main effect of list type or Attention x List Type interaction was found (all *Fs* < 2.00).

False Recognition of Weakly Related Items. For false *old* responses, there was no main effect of attention, $F(1, 35) = 3.63$, $p = .07$, $\eta_p^2 = .09$, However, there was a significant main effect of list type, $F(1, 35) = 11.25$, $p = .002$, $\eta_p^2 = .24$, with higher false responses produced in the negative ($M = .31$, *95% CI* [.24, .38]) compared to the neutral ($M = .22$, *95% CI* [.16, .28]) condition. A significant Attention x List Type interaction was also found, $F(1, 35) = 4.19$, $p < .05$, $\eta_p^2 = .11$. The analysis of SME revealed false responses was significantly greater within the negative ($M = .38$, *95% CI* [.28, .47]) compared to the neutral ($M = .23$, *95% CI* [.15, .30]) condition when test was taken under DA, $t(35) = 3.74$, $p = .001$, $r = .53$. No difference was found when test occurred under FA ($p = .31$). For false *remember* judgements, there were main effects of attention, $F(1, 35) = 13.35$, $p < .001$, $\eta_p^2 = .28$, and list type, $F(1, 35) = 7.07$, $p < .05$, $\eta_p^2 = .17$, with higher false remembering occurring in the DA condition and in the negative compared to the neutral condition (see Table 2). The main effects were qualified by an Attention x List Type interaction, $F(1, 35) = 6.24$, $p < .05$, $\eta_p^2 = .15$. Analysis of SME revealed that when retrieval was under DA, false *remembering* was significantly greater within the negative ($M = .16$, *95% CI* [.10, .22]) compared to the neutral ($M = .06$, *95% CI* [.03, .10]) condition, $t(35) = 3.00$, $p = .005$, $r = .45$. No difference was found when test occurred under FA ($p = .29$). For false *know* and *guess* judgements, there were no significant main effects or Attention x List Type interactions (all *Fs* < 2.50).

False Recognition of Unrelated Items. For false *old* responses, there were main effects of attention, $F(1, 35) = 5.98$, $p < .05$, $\eta_p^2 = .15$, and list type, $F(1, 35) = 6.59$, $p < .05$, $\eta_p^2 = .16$, with higher false recognition of unrelated items in the DA condition and higher false recognition rates for negative compared to neutral stimuli. There was no significant Attention x List Type interaction, $F(1, 35) = .08$, $p = .78$, $\eta_p^2 = .002$. For false *remember* judgements, there was a significant main effect of attention, $F(1, 35) = 4.94$, $p < .05$, $\eta_p^2 = .12$, but no main effect of attention or significant interaction (both $F < 1$), and for false *know* judgements, there was a significant main effect of list type, $F(1, 35) = 10.42$, $p = .003$, $\eta_p^2 = .23$, but no main effect of attention or significant interaction (both $F < 1$). For false *guess* judgements, there were no significant main effects or interaction (all *Fs* < 1.60). See table 2 for the means and 95% confidence intervals for the aforementioned significant effects.

False recognition of negative weak-related and unrelated filler items was higher than that of neutral filler items. Researchers (e.g., Knott & Thorley 2014; Howe et al 2010) have argued that the semantic connectivity of negative items leads to a wider spread of activation and possibly a more liberal response bias. We found a similar effect in our own research. The persistence of the finding demonstrates the fact that negative filler items are naturally more inter-related compared to neutral filler items.

Discussion

The aim of the present study was to investigate the effect of DA at test on true and false memory production for neutral and negative items using the DRM paradigm. The findings from this study demonstrate that negative, in addition to neutral, critical lures were more falsely *remembered* under DA compared to FA conditions at retrieval. In addition, although typical for DRM studies, we did not find an emotionally enhanced memory effect for correct items, we did demonstrate this enhanced effect for false critical lures.

The high false *remembering* of critical lures, but decrease in *knowing,* associated with retrieval under DA compared to FA for both negative and neutral words replicates and extends the findings of Knott and Dewhurst (2007a). The source-monitoring component of the *activation-monitoring framework* (Roediger, Watson, McDermott, & Gallo, 2001) can explain this finding. As outlined in the introduction, the monitoring component suggests that false recognition of critical lures occurs due to the inability to discriminate between internally and externally generated items (Roediger & McDermott, 1995). According to Mather, Henkel, and Johnson (1997), poor source monitoring can occur when one's memory contains insufficient information to accurately discriminate between items, or when easily accessible but less diagnostic information is preferred over potentially accurate source information. Knott and Dewhurst (2007a) referred to the distinction between controlled and automatic source monitoring decisions to explain the pattern of findings in their study. According to Johnson, Hastroudi, and Lindsay (1993) automatic source monitoring processes are made rapidly and without awareness. When we rely on automatic processing, it is the perceptual details that take precedence when making such decisions. In contrast, controlled source monitoring requires a more strategic process with the need for additional information and reasoning. The latter process would be greatly disrupted when attentional resources are limited, but the former would remain largely unaffected. Similar to Knott and Dewhurst (2007a), the increase in false *remember* responses to both negative and neutral critical lures during conditions of reduced attention are likely a result of the reduced availability of more controlled source-monitoring processes and the over reliance on more automatic source monitoring decisions. Without disruption controlled and automatic source-monitoring decisions work together to reduce recognition errors, but with disruption, controlled source monitoring processes cannot monitor memories that would otherwise be readily accepted by less stringent automatic decisions that rely on mere perceptual attributes or matches to schemas or templates (Johnson, 1991). In this instance such an effect led to the increase in false memory production because the DA task increased the difficulty of using source information to strategically evaluate whether the item was one presented on the list, or internally activated when associated items were presented during study. This caused a specific increase in *remember* responses because, as evidenced by Knott & Dewhurst (2007a; 2007b; but see also Dewhurst, Holmes, Brandt & Dean, 2006), *remember* responses rely on relatively automatic, fast retrieval processes. If an item triggers perceptual or contextual features, a *remember* response can be made immediately. Decisions under DA were based on more automatic source-monitoring that rely on perceptual details thus increasing false *remember* responses.

Briefly, we also note that the correct recognition responses associated with *remember* and *know* judgements also replicate findings from Knott and Dewhurst (2007a, 2007b). That is, correct *know* responses were reduced under DA conditions, but correct *remember* responses remained unaffected. These findings too can be explained by controlled and automatic processes. According to Knott and Dewhurst (2007a), correct *remember* responses are based on automatic processes that can be made immediately by relying only on perceptual details. Hence, these responses are unaffected by limited attentional resources during retrieval. However, correct *know* responses are based on controlled processes that require effortful post-retrieval decisions, which are disrupted by the DA task. Deciding whether a level of familiarity is sufficient to identify the item as old requires a more effortful decision and attentional resource.

Regardless of attention condition, we found higher rates of false remembering for negative compared to neutral critical lures. This finding supports previous research that demonstrates an enhanced emotional false memory effect (Brainerd et al., 2008; Howe et al., 2010). A plausible explanation comes from the *activation-monitoring framework* described earlier. In order for a false memory to occur the associate links between nodes/concepts need to be activated. Negative items are highly interconnected and more easily activated (Thijssen, Otgaar, Howe, & de Ruiter, 2013). Therefore, participants are more likely to believe that the critical lure was part of the presented list, consequently increasing the likelihood of false *remembering* to occur. Interestingly, Dehon, Laroi, and Van der Linden (2010, Experiment 2) asked participants at the end of the memory test to specify words they had thought of during the presentation of each list but did not write them down because they believed them not to be experimenter-generated. They found that the probability of activating critical lures from neutral and emotional lists was similar, but accurate monitoring of emotional lures was a difficulty compared to non-emotional lures. The more easily accessible but less diagnostic information (the meaning of the item) is used in absence of additional information and reasoning of the source of the item. Much the same way that our reduced attention condition prevents the use of more controlled effortful source monitoring procedures.

We did not find an enhanced emotional memory effect for veridical recognition, however characteristics of emotional stimuli that has been known to elicit the enhanced effect will likely explain the absence of the effect in the FA condition. Emotional stimuli tend to be high in *semantic density* (the semantic relatedness between stimuli) compared to neutral stimuli, and quite *distinctive* if intermixed with neutral stimuli (Talmi et al., 2007). Both factors improve memory for emotional stimuli resulting in a subsequent enhanced retrieval. The associative nature of neutral and negative lists and the presentation style have likely led to similar levels of correct recognition between neutral and negative words. This supports Talmi et al. (2007), who found that when both factors were controlled, the emotion enhanced effect was eliminated.

At the beginning of this study we asked the question, would the enhanced (increased) false memory effect for negative emotional stimuli occur even with disruption to attentional resources at retrieval? The answer is yes. Both neutral and negative false memories do increase with divided attention, but the enhanced effect for negative over neutral false memories remains even when attentional resources are limited at retrieval. To end, if we were to apply the findings of the present study to a more ecologically valid environment then we could imply that if witnesses do not hold full attention when retrieving information about a witnessed event, the chances of producing false memories of event details (be it neutral or negative) is high. Of course witnesses would not be asked to randomly generate numbers while being presented with a photographic line-up, however, there are other ways to disrupt retrieval, and we should be mindful of the effects this has on our source-monitoring processes and accurate recognition. This study has begun an important investigation, but applying this procedure to other false memory paradigms will help develop a consensus for the effects of disrupted attention on retrieval of emotionally valanced information

References

Baddeley, A., Lewis, V., Eldridge, M., & Thomson, N. (1984). Attention and retrieval from long-term memory. *Journal of Experimental Psychology: General*, *113*(4), 518-540.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW): Instruction manual and affective ratings* (Tech. Report No. C-1). Gainesville, FL: The Centre for Research in Psychophysiology, University of Florida.

Brainerd, C. J., Stein, L. M., Silveira, R. A., Rohenkohl, G., & Reyna, V. F. (2008). How does negative emotion cause false memories? *Psychological Science, 19*(9), 919-925.

Clark-Foos, A., & Marsh, R. L. (2008). Recognition memory for valenced and arousing materials under conditions of divided attention. *Memory*, *16*(5), 530-537.

Craik, F. I., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General*, *125*(2), 159-180.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, *58*(1), 17-22.

Dehon, H., Larøi, F., & Van der Linden, M. (2010). Affective valence influences participant's susceptibility to false memories and illusory recollection. *Emotion*, *10*(5), 627-639.

Dewhurst, S. A., & Anderson, S. J. (1999). Effects of exact and category repetition in true and false recognition memory. *Memory & Cognition*, *27*(4), 665-673.

Dewhurst, S. A., Holmes, S. J., Brandt, K. R., & Dean, G. M. (2006). Measuring the speed of the conscious components of recognition memory: Remembering is faster than knowing. *Consciousness and Cognition*, *15*(1), 147-162.

Fernandes, M. A., & Moscovitch, M. (2000). Divided attention and memory: evidence of substantial interference effects at retrieval and encoding. *Journal of Experimental Psychology: General*, *129*(2), 155-176.

Howe, M. L., Candel, I., Otgaar, H., Malone, C., & Wimmer, M. C. (2010). Valence and the development of immediate and long-term false memory illusions. *Memory*, *18*(1), 58-75.

Johnson, M. K. (1991). Reality monitoring: Evidence from confabulation in organic brain disease patients. In G. P. Prigatano & D. L. Schacter (Eds.), *Awareness of deficit after brain injury: Clinical and theoretical issues* (pp. 176-197). New York: Oxford University Press.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, *114*(1), 3-28

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(9), 3310-3315.

Knott, L. M., & Dewhurst, S. A. (2007a). The effects of divided attention at study and test on false recognition: A comparison of DRM and categorized lists. *Memory & Cognition*, *35*(8), 1954-1965.

Knott, L. M., & Dewhurst, S. A. (2007b). Divided attention at retrieval disrupts knowing but not remembering. *Memory*, *15*(6), 664-674.

Knott, L. M., & Thorley, C. (2014). Mood-congruent false memories persist over time. *Cognition & Emotion*, *28*(5), 903-912.

Knott, L. M., Dewhurst, S. A., & Howe, M. L. (2012). What factors underlie associative and categorical memory illusions? The roles of backward associative strength and interitem connectivity. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*(1), 229.

Knott., K. L., Howe, M. L., Toffalini, E., Shah, D., & Humphreys, L. (2016). *The role of attention in immediate emotional false memory enhancement*. Manuscript submitted for publication.

Maddox, G. B., Naveh-Benjamin, M., Old, S., & Kilb, A. (2012). The role of attention in the associative binding of emotionally arousing words. *Psychonomic Bulletin & Review*, *19*(6), 1128-1134.

Mather, M., Henkel, L. A., & Johnson, M. K. (1997). Evaluating characteristics of false memories: Remember/know judgments and memory characteristics questionnaire compared. *Memory & Cognition*, *25*(6), 826-837.

McEvoy, C. L., Nelson, D. L., & Komatsu, T. (1999). What is the connection between true and false memories? The differential roles of interitem associations in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*(5), 1177–1194.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). The University of South Florida word association, rhyme, and word fragment norms. (Available at: http://www.usf.edu/FreeAssociation/)

Otgaar, H., Howe, M. L., Brackmann, N., & Smeets, T. (2016). The malleability of developmental trends in neutral and negative memory illusions. *Journal of Experimental Psychology: General*, *145*(1), 31.

Pezdek, K., & Lam, S. (2007). What research paradigms have cognitive psychologists used to study "false memory," and what are the implications of these choices?. *Consciousness and Cognition*, *16*(1), 2-17.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(4), 803-814.

Roediger, H. L., Watson, J. M., McDermott, K. B., & Gallo, D. A. (2001). Factors that determine false recall: A multiple regression analysis. *Psychonomic Bulletin & Review*, *8*(3), 385-407.

Smith, S. M., Gerkens, D. R., Pierce, B. H., & Choi, H. (2002). The roles of associative responses at study and semantically guided recollection at test in false memory: The Kirkpatrick and Deese hypotheses. *Journal of Memory and Language*, *47*(3), 436-447.

Stadler, M. A., Roediger, H. L., & McDermott, K. B. (1999). Norms for word lists that create false memories. *Memory & Cognition*, *27*(3), 494-500.

Talmi, D., Luk, B. T., McGarry, L. M., & Moscovitch, M. (2007). The contribution of relatedness and distinctiveness to emotionally-enhanced memory. *Journal of Memory and Language*, *56*(4), 555-574.

Towse, J. N., & Neil, D. (1998). Analyzing human random generation behavior: A review of methods used and a computer program for describing performance. *Behaviour Research Methods, Instruments, & Computers*, *30*(4), 583-591.

Appendix

Neutral Lists				
Car (.26)	***Chair*** (.22)	***Fruit*** (.23)	***Square*** (.21)	***Window*** (.24)
Vehicle	Table	Kiwi	Rectangle	Pane
Drive	Recliner	Citrus	Circle	Sill
Van	Stool	Pear	Triangle	Shutter
Truck	Couch	Vegetable	Round	Blinds
Bus	Sit	Banana	Cube	Curtain
Jeep	Furniture	Strawberry	Pyramid	Door
Caravan	Sofa	Orange	Oval	Glass
Fuel	Bench	Apple	Shape	Drapes
Ride	Sitting	Grape	Sphere	Shade
Taxi	Cushion	Basket	Object	Screen
Train	Throne	Orchard	Cone	Open
Race	Legs	Bowl	Prism	Frame
Mouth (.11)	***Smell*** (.37)	***Pen*** (.20)	***Mountain*** (.20)	***Pants*** (.29)
Tongue	Odour	Ink	Climber	Trousers
Jaw	Aroma	Quill	Hill	Slacks
Lip	Scent	Pencil	Climb	Zipper
Teeth	Stench	Marker	Peak	Jeans
Throat	Incense	Write	Hike	Belt
Gums	Sniff	Fountain	Valley	Shorts
Moustache	Perfume	Point	Summit	Shirt
Whistle	Fragrance	Felt	Slope	Dress
Braces	Sense	Scribble	Rocks	Pocket
Cheek	Rose	Blot	Steep	Skirt
Eyes	Nostril	Crayon	Canyon	Suit
Chin	Hear	Cap	Cave	Vest

Negative Lists				
Bomb (.14)	***Fight*** (.35)	***Thief*** (.15)	***Lie*** (.27)	***Sick*** (.34,)
Atomic	Brawl	Crook	Fib	Ill
Explode	Quarrel	Robber	Deception	Nauseous
Nuclear	Feud	Burglar	Deceive	Flu
Boom	Argument	Stolen	Untrue	Virus
Blast	Struggle	Bandit	Bluff	Hospital
Shelter	Fist	Robbery	Dishonest	Fever
Missile	Conflict	Steal	Rumour	Disease
Destruction	Riot	Theft	Deny	Medicine
Cannon	Defend	Outlaw	Excuse	Vomit
Destroy	Violent	Crime	Cheat	Germ
Dynamite	Assault	Suspect	False	Malaria
Fuse	Hit	Jail	Betray	Cancer
Dead (.19)	***Alone*** (.17)	***Poor*** (.19)	***Cry*** (.28)	***Rude*** (.11)
Corpse	Isolated	Rich	Weep	Interrupt
Coffin	Solo	Poverty	Sob	Crude
Bury	Secluded	Welfare	Tears	Obnoxious
Cemetery	Lonely	Needy	Laugh	Polite
Tombstone	Single	Jobless	Emotional	Pushy
Grave	Independent	Broke	Upset	Insult
Funeral	Private	Beg	Sorrow	Manners
Decompose	Individual	Slum	Sensitive	Arrogant
Tomb	Withdrawn	Charity	Grief	Ignore
Burial	Leave	Evict	Sad	Selfish
Die	Bored	Hobo	Worry	Harsh
Suicide	Empty	Starve	Misery	Mean

All neutral and negative lists used in the experiment, with critical lures shown in bold italics and the mean Backward Associative Strength (BAS)

Table 1. *Mean values and 95% Confidence Intervals for list items, critical lures, and BAS, as a function of List Type*

	Negative Lists			*Neutral Lists*		
		95% CI			*95% CI*	
	M	*LB*	*UB*	*M*	*LB*	*UB*
Valence list items	3.09	2.79	3.39	5.44	5.19	5.69
Valence critical lures	2.42	1.98	2.87	5.96	5.09	6.82
Arousal list items	5.35	4.86	5.83	4.26	3.92	4.60
Arousal critical lures	5.95	5.15	6.74	4.58	3.67	5.50
BAS	0.22	0.16	0.28	0.23	0.18	0.28

Note: M, LB, and UB refers to mean, lower bound, and upper bound respectively. The Mean is taken based on those items where valence and arousal ratings are available.

Table 2. *Mean proportions and 95% Confidence Intervals for recognition test responses to critical lures, correct items, weakly related filler items, and unrelated filler items as a function of List Type and Attention*

	Divided Attention						Full Attention					
	Negative Lists			Neutral Lists			Negative Lists			Neutral Lists		
		95% CI			95% CI			95% CI			95% CI	
	M	*LB*	*UB*	*M*	*LB*	*UB*	*M*	*LB*	*UB*	*M*	*LB*	*UB*
Item type												
Critical lures												
Old responses	.61	.51	.71	.56	.48	.64	.62	.52	.72	.64	.54	.73
Remember	.38	.30	.47	.27	.19	.35	.27	.17	.36	.19	.12	.27
Know	.12	.07	.18	.17	.10	.23	.18	.10	.25	.22	.14	.29
Guess	.11	.05	.16	.12	.07	.17	.18	.10	.25	.23	.16	.30
Correct items												
Old responses	.63	.54	.71	.64	.58	.71	.72	.66	.78	.71	.66	.77
Remember	.44	.35	.52	.41	.35	.48	.45	.39	.51	.49	.41	.56
Know	.10	.06	.14	.13	.09	.17	.16	.12	.20	.12	.08	.16
Guess	.09	.05	.12	.10	.07	.13	.11	.08	.14	.11	.07	.14
Weak-related fillers												
Old responses	.38	.28	.47	.23	.15	.30	.25	.17	.33	.21	.14	.28
Remember	.16	.10	.22	.06	.03	.10	.05	.02	.08	.03	-.00	.06
Know	.08	.03	.12	.05	.02	.08	.05	.02	.08	.08	.03	.13
Guess	.14	.07	.21	.12	.06	.18	.15	.10	.20	.11	.05	.16
Unrelated fillers												
Old responses	.27	.19	.36	.19	.13	.25	.21	.14	.29	.11	.06	.16
Remember	.08	.04	.11	.07	.02	.12	.06	.03	.10	.01	-.00	.03
Know	.08	.04	.12	.02	.00	.04	.07	.02	.11	.03	-.00	.06
Guess	.12	.05	.18	.09	.04	.14	.08	.04	.12	.07	.04	.11

Note: M, LB, and UB refer to mean, lower bound, and upper bound respectively.