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Citation: Murphy, J., Ichijo, E., Bird, G. & Cooper, L. (2025). False Memory Formation in Autism: The Role of Relational Processing at Study. Journal of Autism and Developmental Disorders, doi: 10.1007/s10803-025-06803-1

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Link to published version: <https://doi.org/10.1007/s10803-025-06803-1>

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False Memory Formation in Autism: The Role of Relational Processing at Study

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the research, authorship, and/or publication of this manuscript. The study was conducted independently, and no external parties influenced the design, data collection, analysis, or interpretation of the findings. Furthermore, the authors have no financial or personal relationships that could inappropriately influence or bias the content of this work.

This research received no external funding.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Jennifer Murphy and Eri Ichijo. The first draft of the manuscript was written by Lauren Cooper and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Abstract

Purpose

Several studies have investigated false memory production in autistic adults, yet it remains unclear whether susceptibility to false memories differs from non-autistic adults and what mechanisms might contribute to any differences. This study examines the mechanisms behind false memory formation in autistic adults using the Deese-Roediger-McDermott (DRM) paradigm.

Methods

Participants studied DRM word lists designed to activate a critical word (the ‘critical lure’). To examine false memory formation and associative processing, participants completed three tasks: a standard recognition test to measure false memory rates, a word stem completion task to assess implicit priming of the critical lure, and a free association task to evaluate explicit associative processing.

Results

Autistic individuals showed comparable rates of false memories as non-autistic adults (i.e., falsely reporting having studied the critical lure), were as likely to mention the critical lure on the free association task but showed no tendency to complete word stems with the critical lure when implicitly primed to do so.

Conclusion

These findings suggest that autistic adults may experience less spontaneous spreading of semantic activation during encoding but are capable of engaging in explicit associative processing when directed. The results provide valuable insights into the mechanisms underlying the typical rates of false memory formation in autism.

Introduction

False memories occur when we remember events or details that did not happen. A common type, spontaneous associative memory errors, involves recalling semantically related details that were not part of the original information. The Deese-Roediger-McDermott (DRM) paradigm is widely used to study these errors. In a typical DRM experiment (e.g., Deese, 1959; Roediger & McDermott, 1995), participants study lists of semantically related words (e.g., "bed, rest, pillow") and often mistakenly recall or recognize an unrepresented "critical lure" (e.g., "sleep") as part of the list. Several theories have been developed to explain why this might occur. For example, spreading activation models such as the activation monitoring theory (AMT; Roediger & McDermott, 1995; Roediger, et al., 2001) posit that when a word is encoded, it can activate related but non-presented words in a semantic network through spreading activation (Underwood, 1965). The strength of activation then increases the difficulty of making diagnostic source monitoring decisions about the presence or absence of the word in the list. The resulting outcome is often the mistaken belief that the 'critical lure' was presented in the list.

Free recall and recognition tests in the DRM paradigm are explicit, requiring individuals to deliberately retrieve studied words. They often incorporate metamemory assessments such as confidence ratings, remember/know judgments, or source assessments. However, according to Underwood (1965), DRM lists activate semantic networks via spontaneous and implicit spreading activation. To examine these processes during encoding, researchers have also used implicit measures, which bypass conscious retrieval (Graf & Schacter, 1985). One such measure is the stem completion task, where participants complete word fragments (e.g., "win" for "window") with the first word that comes to mind. Priming is reflected by a higher likelihood of completing stems with critical lures from studied lists (implicitly primed) than with lures from unseen lists (unprimed). McDermott (1997) demonstrated this effect, showing that implicit spreading activation during study contributes to false memories. This finding was replicated by Smith et al. (2002). Notably, Smith et al. (2002) included a free association task to assess deliberate spreading activation, finding that participants often generated critical lures explicitly. Their results highlight the roles of both unconscious and conscious spreading activation in false memory formation, separate from retrieval-based effects (e.g., source-monitoring errors or test induced priming).

Recently, research has examined these processes in neurodiverse populations, including autistic¹ individuals, where competing theories predict differing susceptibility to false memories using the DRM paradigm. Previous research suggests that autistic individuals process conceptual relationships differently, often benefiting less from contextual cues than non-autistic individuals (Bowler et al., 2009; Gaigg et al., 2008; 2015). This aligns with the "weak central coherence" theory (Happé, 1997), which posits that autistic cognition emphasizes detail over gist. This theory would

¹ We use the term 'autistic' and identity-first language as this is endorsed by the majority of the autistic community (see Kenny et al., 2016; Keating et al., 2023).

1 predict reduced false memory formation in autistic adults due to reduced spreading activation at study
2 (McClelland, 2000). Conversely, deficits in source-monitoring (Lind & Bowler, 2009) predict
3 increased false memories due to difficulty distinguishing self-generated from externally presented
4 information. That is, autistic individuals are less likely to distinguish between self- versus other-
5 generated event details (Lind & Bowler, 2009) and real versus imagined events (Cooper et al., 2016).
6 Cooper et al. (2016) observed difficulties in autistic individuals when attempting to differentiate and
7 monitor internal and external details related to memories.

8 Interestingly, studies examining false memory production in autistic adults using the DRM
9 paradigm have yielded mixed results. Beversdorf et al. (2000) found that autistic adults exhibited
10 fewer false memories than non-autistic adults, a finding replicated by Parra et al. (2015) and Hillier et
11 al. (2007) but only for visual, not verbally presented DRM lists. In contrast, Bowler et al. (2000)
12 reported no differences in false memory performance, while Gaigg and Bowler (2009) observed
13 comparable false recognition rates for neutral words but higher false recognition rates for emotionally
14 charged words (which was later also replicated for emotionally valenced photographs; Soloman et al.,
15 2019). Although these studies differ methodologically—such as in task modality (visual versus
16 verbal) and emotional content of stimuli—the variability in outcomes may also indicate differences in
17 how semantic activation spreads and how source-monitoring processes function among autistic
18 individuals. Wojcik et al. (2018) aimed to examine these differences by attempting to distinguish
19 between errors caused by spreading activation during encoding and errors due to source-monitoring
20 failures (identify-to-reject or error-editing). They used an externalised free-recall task (Unsworth et
21 al., 2010) to examine these processes. At test, participants freely recalled words from the list plus any
22 other related words that came to mind. They then marked the words they were sure were from the list
23 versus those they generated themselves. If spreading activation is typical, participants should output
24 the critical lures, but if source monitoring is successful, participants should then identify the critical
25 lure as self-generated. Wojcik et al. (2018) found that, compared to non-autistic participants, autistic
26 participants output fewer critical lures, indicative of reduced semantic activation. However, when
27 autistic participants did produce the critical lure, they were more likely to mark these as having been
28 present on the studied list. They argued that this was indicative of source-monitoring difficulties.
29 Interestingly, when asked about strategies, identifying the critical lure as internally generated was the
30 most reported approach in both groups. However, autistic individuals, despite being aware of effective
31 memory strategies, were less successful applying them.

32 Although Wojcik et al. (2018) aimed to distinguish between the roles of spreading activation
33 during study and source monitoring at test, we argue that the externalised free recall task does not
34 measure spreading activation as it occurs at study, free of test retrieval contamination. Participants are
35 deliberately told to generate associates at recall and then make retrospective decisions as to whether
36 the generated words were present on the studied list. An affirmative response that the generated
37 critical lure was presented is taken as evidence that the word must have been generated with the
38 studied words. To address whether autistic individuals show differences in spreading activation during

study, one would need to demonstrate implicit spreading activation during the encoding phase, independent of the memory task. Based on the logic of previous research, implicit tasks that reflect spontaneous rather than deliberate processes can be used to examine the role of implicit activation of semantic associates at encoding (Graf & Schacter, 1985). Being able to differentiate between implicit activation of semantic associates and deliberate generation of semantic associates may provide evidence for further discrepancies in DRM task performance between autistic and non-autistic adults. Indeed, previous research examining performance on non-DRM implicit and explicit memory tasks in autistic adults support the utility of examining implicit and explicit tasks for characterising underlying processes; for example, Lebreton et al. (2021) found that autistic adults showed reduced accuracy on an implicit memory task that promoted global processing, but could make use of global processing on explicit memory tasks if the design and instructions encouraged this (see also Van der Hallen et al., 2015).

Considering the aforementioned evidence, the aim of this study was to differentiate between explicit and implicit DRM performance in autistic adults. Employing the DRM paradigm, we first aimed to test false recognition performance using a standard recognition task (DRM task 1). We then assessed implicit priming for critical lures via a stem completion task (McDermott, 1997; Smith et al. 2002 - DRM task 2). In this task, if autistic individuals show reduced spontaneous spreading activation during encoding, then they should be less likely than non-autistic adults to complete the word stems with critical lures. Finally, we contrasted this with performance on an explicit free association task (DRM task 3) to test our prediction that autistic adults would perform similarly to non-autistic adults when explicitly asked to generate associates (and thus the critical lure) to DRM word lists.

Method

Participants

Participants were recruited from pre-existing databases managed by the research team of individuals who had expressed an interest in taking part in psychological research. All participants on these databases were invited and eligible to participate so long as they had previously visited the laboratory to complete measures of intelligence². Intelligence was assessed using the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1997) or the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). For autistic individuals, the Autism Diagnostic Observation Schedule, Second Edition (ADOS; Lord et al., 1999) alongside IQ measures was used. Since ADOS data was only available for 65% of the autistic sample, clinical diagnosis was confirmed by clinician letters from all autistic participants. The final sample comprised 17 autistic adults and a matched sample of 27 non-autistic adults (see Table 1 for demographic details). Groups were matched for age, gender and

² Note that due to difficulties matching participant data across multiple sources, IQ data were unavailable for four participants.

intelligence, but significantly differed in terms of scores on the autism quotient (AQ) as expected. No participants had notable intellectual impairment (all IQ scores >75).

Table 1. Descriptive statistics for participant groups.

	Autistic (N=17)		Non-autistic (N=27)		
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Comparison</i>
Age	37.48	15.64	38.94	13.31	$p > .250$
Intelligence	109.86	17.36	114.58	11.55	$p > .250$
AQ	35.64	7.24	17.78	6.24	$p < .001$
Gender	5 Females, 1 Other		11 Females		$p > .250$

Note that IQ scores were unavailable for three autistic participants and one non-autistic participant. Bayesian analyses support the frequentist analyses provided with Bayes factors of (BF_{10}) of 0.484 for IQ and 0.316 for age providing anecdotal evidence to support the null hypothesis that the two groups did not differ, and $BF_{10} = 9.806 \times 10^7$ for autism quotient, indicating overwhelming evidence in favour of the alternative hypothesis that the two groups differed in their AQ scores.

Design

The primary independent variable was the participant group (autistic vs. non-autistic), and the dependent variables varied across tasks. The tasks included a false memory recognition task (DRM task 1), a stem completions task (DRM task 2), and a free association task (DRM task 3). Dependent measures included proportion of correct recognitions and false alarms (DRM task 1), primed and unprimed stem completions (DRM task 2), and generated semantic associates (DRM task 3).

Stimuli

Twenty-four DRM lists were taken from Roediger et al. (2001), using the top 12 associates to the critical lure. The lists were separated into four blocks of six lists. One block of six lists was used for DRM task 1 and 2 respectively, and two blocks of 6 lists were used for DRM task 3 (see Appendix A). Counterbalancing took place such that each block was used equally often across participants in the three DRM tasks. Lists were blocked to ensure similar average Backward Associative Strength (BAS)³ within the lists. When comparing Mean BAS (*Mean range* = 0.20-0.26) across the four blocks, there was no significant difference ($p = .18$). Word lists were also matched for word length and frequency. Across each block there was no significant difference in length (*Mean range* = 5.29-5.45, $p = .98$) or written word frequency (*Mean range* = 32.91-78.89, $p = .66$) (see Appendix A). The order of the lists within each block was random but within each list, words were presented in a fixed order of associative strength (see Roediger et al). All words were presented visually on the screen. During the presentation of the lists, participants were instructed to pay close attention to the words on the list. For the recognition task, an additional eighteen unrelated distractors were selected from unused associative lists, ensuring no associative relation to the studied words or critical lures. The

³ Backward Associative Strength (BAS) is an index of the strength of associative connections from the study words to the critical item. It is considered the most critical variable for the probability of falsely recalling the critical lure (Roediger et al 2001).

recognition test included 24 list words (1st, 3rd, 5th, and 8th words from the 6 presented lists), the six associated critical lures, and 18 distractors, all presented in a randomized order.

Procedure

All participants took part in all three DRM tasks in a single session, in the same order, but were presented with a different set of DRM lists for each of the tasks. The three tasks were built and conducted online using Gorilla Experiment Builder (gorilla.sc; Anwyl-Irvine et al., 2020). Ethical approval for the experiments was granted by King's College Research Ethics Committee (REC number: LRS-17/18-5560). Data and materials are available upon request. The study was not preregistered.

Recognition task

After providing informed consent, participants were instructed to pay close attention to six-word lists. Each word was displayed for 2 seconds with a 1-second interstimulus interval, and an asterisk marked the end of each list. Following the presentation, participants completed two timed 3-minute filler tasks: evaluating the accuracy of answers to simple sums (e.g., $4 - 5 = 12$) and identifying if there were more Upper- or Lower-case letters in text strings (e.g., MQLpUO). After 6 minutes the task advanced automatically to the recognition test. Participants were informed that they would now complete a memory test for the words shown in the study phase. Participants individually evaluated 48 test words, selecting "old" if they recognized the word from the study phase or "new" if not. The test was self-paced.

Stem completion task

After a short self-paced interval of a maximum of 2 minutes, participants proceeded to the stem completion task (DRM task 2). Participants were presented with six new word lists (unseen in DRM Task 1) under the same conditions. After the encoding phase, participants were informed that they would complete several filler tasks during a short break prior to the memory test. First, participants had to give true/false responses to 40 short statements (e.g., 10 is bigger than 2). The task was self-paced. The stem completion task, framed as another filler activity, involved 20-word stems presented sequentially on the screen. Six stems were indirectly primed by the critical lure associated with words presented at study, 6 were unprimed stems that could be completed by critical lure words from unseen DRM lists (not used in any task), and 8 other stems were fillers and created from words not related to the primed or unprimed critical lure words. The stem was presented for 1s before a text box appeared asking participants to type a word to complete the stem. The stem was always presented as the first two letters (to account for 3 letter critical lure items) and “_” denoted the letters left to complete the word. The number of letters left to be filled varied between 1-6, ($Mean = 2.6$ letters, $SD = 1.25$). Participants were instructed to complete stems with the first word that came to mind (e.g., completing "sh_ _ _" as "shirt"). No mention of the previous lists was made. The text box remained for 8s or until the participant made a response. They were given two practice stems prior to the main

stem completion task. To justify the encoding phase, participants then completed a free recall task, listing as many words as they could remember from the initial six lists.

Free Association task

The two remaining blocks of six unseen lists were used in the final free association task (DRM task 3; 12 lists in total). Word lists were presented one by one and participants were instructed to write down five words that they considered to be related, or that they thought about when they saw the list words. After 2 seconds following the presentation of the list, a text box appeared to allow participants write their response. This was self-paced. Once five words were produced, participants progressed to the next list until all 12 lists were completed. The number of times a critical lure was provided as one of the free associates for each of the 12 lists was recorded.

Results

False Recognition task (DRM Task 1)

Table 1 shows the mean proportions for correct recognition of list words and false recognition of critical lures and distractors for both groups⁴. A 2 (Group: autistic vs. non-autistic) x 3 (word type: list word, critical lure, distractor) mixed factor analysis of variance (ANOVA) showed that autistic and non-autistic participants did not significantly differ in their recognition performance, $F(1, 39) = 1.02$, $p = .32$, $\eta_p^2 = .03$. There was no significant interaction, $F(2, 78) = 1.08$, $p = .34$, $\eta_p^2 = .03$, but there was a main effect of word type, $F(2, 78) = 157.14$, $p < .001$, $\eta_p^2 = .80$. For both groups there were more correct hits to list words compared to false alarms to critical lures and distractors ($p = .03$ and $p < .001$) and more false alarms to critical lures compared to distractors ($p < .001$). A Bayesian ANOVA (conducted using default priors in JASP) support the same outcomes. There was very strong evidence for the main effect of word type ($BF_{incl} = 1.716 \times 10^{14}$), and evidence against the main effect of group, ($BF_{incl} = 0.32$) and interaction, ($BF_{incl} = 0.36$). We carried out a signal detection analysis to examine any differences in discrimination or response bias for list words and critical lures across group. We compared discrimination of critical lures from distractors and discrimination of list words from distractors (see Table 1). For critical lure discrimination, higher values equal greater levels of false alarms to the critical lure compared to distractors⁵. Discrimination and bias were analysed in separate 2 (Group: autistic vs. non-autistic) x 2 (word type: list word vs critical lure) mixed factor ANOVAs. For the discrimination analysis, there was a main effect of word type, $F(1, 39) = 11.18$, $p = .002$, $\eta_p^2 =$

⁴ Two participants from the non-autistic group and one participant from the autistic group failed to fully complete the recognition task.

⁵ We calculated memory accuracy and response bias measures for each participant in each of the conditions using discrimination sensitivity (d) and bias (c). Discrimination sensitivity (d) measures the ability to distinguish between old and new items, while c measures participants' bias to respond "old" or "new" regardless of the actual sensitivity.

Higher values of d indicate better discrimination (higher memory accuracy) whilst lower values of c indicate higher liberal bias towards the "old" response (Macmillan & Creelman, 2005). To avoid an infinite z value in computing the signal detection analysis, all hit and false-alarm rates were corrected by adding 0.5 to the frequency of hits or false alarms and dividing this adjusted frequency by $N + 1$ where N was the number of old or new trials (Snodgrass & Corwin, 1988).

.22, with better discrimination for list words compared to critical lures, but there was no main effect of group, $F(1, 39) = 0.09, p = .76, \eta_p^2 = .002$, nor interaction, $F(1, 39) = 1.38, p = .25, \eta_p^2 = .03$. For response bias, participants were most conservative for critical lure words, compared to list words, $F(1, 39) = 11.18, p = .002, \eta_p^2 = .22$, but there were no differences between groups, $F(1, 39) = 0.09, p = .76, \eta_p^2 = .002$, nor a significant interaction, $F(1, 39) = 1.38, p = .25, \eta_p^2 = .03$. A Bayesian ANOVA for discrimination and response bias support the same outcomes. For discrimination, there was strong evidence for the main effect of word type ($BF_{incl} = 42.29$), and evidence against the main effect of group, ($BF_{incl} = 0.34$) and interaction, ($BF_{incl} = 0.56$). For response bias, there was similarly strong evidence for the main effect of word type ($BF_{incl} = 41.66$), and evidence against the main effect of group, ($BF_{incl} = 0.36$) and interaction, ($BF_{incl} = 0.62$).

Stem completion task (DRM Task 2)

The *unprimed stem completion score*⁶ reflected stems completed with critical lures from unseen lists, while the *primed score* reflected completions with lures from studied lists. A 2 (Group: autistic vs. non-autistic) x 2 (Stem: primed vs. unprimed) mixed factorial analysis revealed a significant main effect of priming, $F(1, 42) = 4.65, p = .04, \eta_p^2 = .10$, but not of group, $F(1, 42) = 0.18, p = .67, \eta_p^2 = .004$. However, there was a significant interaction, $F(1, 42) = 5.44, p = .03, \eta_p^2 = .12$. Follow-up simple main effect analyses revealed that there was a priming effect only for the non-autistic group, $t(26) = 3.23, p = .003, d = .89$, and not the autistic group, $t(16) = 0.15, p = .89, d = .04$ ⁷ (see Table 2). In addition, Bayesian paired samples t-tests were conducted to analyse confidence for which null-findings can be accepted. There was substantial evidence, ($BF_{10} = 0.249$) in favour of the null hypothesis, suggesting that there was no meaningful priming difference for the autistic group, compared to strong evidence ($BF_{10} = 14.69$) in favour of a difference for the non-autistic group.

We report the free recall results for completeness but note two things. First, that this free recall test was confounded by potential production of critical words during stem completion. Second, when using the DRM paradigm, free recall usually occurs after each list. Responses were few, and analysis is based on total number of words as a proportion of word type for critical lures (6) and list items (72). There were fewer list items reported by the autistic group, $t(41) = 2.71, p = .01, d = .84$, but no significant difference in critical lures, $t(41) = 1.55, p = .13, d = .48$ (see Table 2). We also analysed the number of noncritical intrusions (all other words reported) as a proportion of total number of words reported by each participant, $t(41) = 1.40, p = .17, d = .44$ ($M = .39, SE = .05$) vs $M = .51, SE = .08$). Bayesian analysis support evidence in favour of a difference between groups for list

⁶ To note, we would not expect that a critical lure from an unseen list would be used unless it was the most obvious word to complete the stem.

⁷ Completion of stems with target critical items was low. Given the potential impact of a floor effect, we also conducted a non-parametric Wilcoxon signed-rank test comparing the indirect priming effects for each. Analyses support our original conclusions.

items, ($BF_{10} = 4.97$) and weak but supporting evidence in favour of the null hypothesis for critical lures ($BF_{10} = 0.78$), and noncritical intrusions, ($BF_{10} = 0.66$)

Free Association task (DRM Task 3)

We analysed the frequency of critical words generated as free associates to list words. Responses with typographical errors, misspellings preserving the word's identity, or plurals (e.g., chairs/chair) were counted as correct. As shown in Table 3, the mean number of associations did not differ between autistic and non-autistic groups, $t(42) = 0.22$, $p = .83$, $d = .07$. Similarly, the position of critical words among the five listed responses showed no group differences, $t(41) = 0.61$, $p = .58$, $d = .18$). Bayesian analyses suggested evidence in favour of the null hypothesis in both instances $BF_{10} = 0.312$ and $BF_{10} = 0.453$, respectively.

General Discussion

This study explored false memory production in autistic and non-autistic adults using the DRM paradigm across three tasks: a recognition task, a stem completion task, and a free association task. The findings provide insights into the mechanisms of false memory formation and their potential differences in autistic and non-autistic individuals. Results from the recognition task showed that autistic adults were equally susceptible to false memories as non-autistic adults, with both groups exhibiting better recognition of list words than distractors and more false alarms to critical lures than distractors. Signal detection analyses confirmed these patterns, revealing no differences in discrimination or response bias between groups. These findings are consistent with prior research showing comparable false memory rates in autistic and non-autistic adults (Bowler et al., 2000; Gaigg & Bowler 2009), although we note contradictory to studies reporting differences in FA rates (e.g., Beversdorf et al., 2000; Gaigg & Bowler, for emotionally charged critical lures). In the stem completion task, a priming effect was evident for non-autistic participants, who were more likely to complete stems with critical lures associated with studied lists. This effect was absent in autistic participants, suggesting reduced implicit spreading activation in this group. Finally, the free association task revealed that autistic and non-autistic participants were equally capable of generating critical lures when explicitly instructed to do so.

Our findings suggest that autistic individuals can process relations between items when directed to do so (as demonstrated by the free association task) but show reduced spontaneous activation of these associations when the task is more implicit (as evidenced by the stem completion task). The suggestion that explicit instructions lead to the generation of semantic relations supports previous research, which argues that autistic individuals can perform well on memory tasks that explicitly use semantic relations (e.g., Gaigg et al., 2008; Lebreton et al., 2021; Van der Hallen et al., 2015). However, while autistic individuals can generate strong associates with deliberate instructions,

1 they may not experience automatic spreading activation (Roediger et al., 2001; Underwood, 1965) to
2 the same extent as non-autistic individuals, which should impact false memory performance. Yet,
3 despite this expectation, our findings from the recognition test do not support this proposal, as autistic
4 participants exhibited comparable false recognition rates to non-autistic participants. We consider the
5 explanation for this next.

6 For false memory formation in the DRM, the Activation Monitoring Theory (Roediger et al.,
7 2001) posits that list items must activate semantic associates during encoding. At test, participants
8 utilize source-monitoring processes (Johnson et al., 1993) to assess whether the critical lure was
9 internally generated (i.e., activated through spreading activation at study) or externally presented (as
10 part of the list). The strength of activation of the critical lure increases the difficulty of making
11 diagnostic source-monitoring decisions (Roediger & McDermott, 1995) about the presence or absence
12 of the word in the list. We propose that autistic individuals may activate fewer critical lures during
13 encoding due to reduced spreading activation, as evidenced by their lack of priming effects in the
14 stem completion task. However, once activated, these critical lures may be misattributed to external
15 sources during retrieval, leading to false memory rates similar to those of non-autistic participants.
16 This misattribution likely stems from challenges in source-monitoring processes, which involve
17 distinguishing between internally generated and externally presented information (Johnson et al.,
18 1993). This aligns with the conclusions drawn by Wojcik et al. (2018) using the externalized free
19 recall task: autistic individuals generated fewer critical lures, but when they did, they were more likely
20 to mistakenly identify these as having been part of the studied list. Even if autistic individuals engage
21 less in spontaneous relational processing, they may encode sufficient semantic information to develop
22 a sense of familiarity with critical lures. During the recognition task, participants rely on this
23 familiarity to evaluate whether a word was part of the studied list. Thus, even if spreading activation
24 at encoding is weaker or less automatic in autistic individuals, familiarity with the list's theme and
25 difficulties with source monitoring may combine to produce comparable false memory rates.
26 Interestingly, the Fuzzy-Trace Theory (FTT; Reyna & Brainerd, 1995) provides an additional
27 framework to interpret our findings. According to FTT, false memories arise from the reliance on gist-
28 based processing rather than verbatim memory. In the DRM paradigm, the critical lure is falsely
29 recognized because participants encode the overall theme (gist) rather than the specific list words
30 (verbatim memory). Prior research suggests that autistic individuals may rely more on verbatim
31 details and engage in less automatic gist extraction. Whilst this might 'protect' against false memory
32 formation, challenges in source-monitoring may still counteract this effect, resulting in similar false
33 memory rates as we have seen our recognition test. Miller et al., (2014) argued that instead of a
34 reduction in the formation of gist-based or verbatim memories, autistic individuals may encode gist
35 but not apply it as spontaneously. Instructions that increase reliance on gist should equate
36 performance on tasks that require conceptual processing, something our explicit free association task
37 demonstrated.

Although our findings provide valuable insights into associative processing in autism, limitations to the study should be acknowledged. First, our sample size for the autistic group was relatively small. Although not unusual in this research area, given autism's heterogeneity, larger, more representative studies are needed to confirm these findings, which will also enable heterogeneity within autistic populations to be explored. Second, we fixed the order of the three DRM tasks to ensure that the free association task was always last. We chose to do this because we wanted to ensure that the same participants completed all tasks (to enable stronger inferences to be drawn) and did not want the explicit nature of the task (freely output associated words to the items presented) to impact the implicit association task that came before it. Whilst studies show that, without intervention, false memories for critical lures remain relatively stable across repeated study-test trials (i.e., Jou & Foreman 2007), we cannot rule out the possibility of order effects. Finally, whilst the tasks utilised in this study were designed to examine differences in implicit and explicit associative activation, it is possible that autistic adults do experience spontaneous spreading activation, but the level of activation may be insufficient to influence implicit tasks like stem completion. We recognise this as a potential limitation of our findings and to make conclusions such as the above, future research needs to probe encoding and retrieval processes further. Additional tasks that assess activation without the contamination of retrieval processes such as source monitoring (see Tse & Neely 2005) should be investigated. Conversely, tasks that encourage or hinder the use of source-monitoring processes at test will tell us more about the role of source-monitoring mechanisms in recognition decisions in the DRM paradigm (e.g., Hicks & Marsh, 1999). Studies could employ speeded recognition paradigms (Arndt & Gould, 2006) to minimize post-retrieval decision-making or utilise source-specifying tasks that require participants to determine the origins of their memories, (e.g., reality monitoring paradigms; Hicks & Marsh, 1999). These tasks and others that are explicitly designed to manipulate or test spreading activation at encoding or decision processes at test, could provide further insights into the mechanisms driving false memories in autism.

Our findings have implications for understanding cognitive processes in autism. The reduced spreading activation observed in autistic individuals may reflect a broader tendency toward detail-focused processing at the expense of holistic relational processing (Bowler et al., 2009, 2014; Gaigg et al., 2008, 2015). At the same time, the preserved ability to generate explicit associations suggests that relational processing is not universally reduced but varies based on task demands (see also Lebreton et al., 2021; Van der Hallen et al., 2015). Indeed, the divergence between implicit and explicit associative processing may explain the variability in DRM findings, depending on the specific cognitive demands of each task. While the current findings highlight potential differences in implicit versus explicit associative processing in autism, we stress the need for further research to disentangle encoding-based spreading activation from retrieval-based decision processes.

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Table 1. Mean proportions (and standard error) of hits to list words, false alarms to critical lures and distractors, and signal detection measures, as a function of Group for DRM Task 1.

Group	Recognition Responses			Sensitivity (d')		Response Bias (C)	
	Hits List words	FAs Critical lures	FAs Distractors	List Word	Critical lure	List word	Critical lure
Autistic Group	.80 (.14)	.75(.24)	.17(.22)	2.84 (.17)	2.60 (.19)	.52 (.09)	.64 (.10)
Non-autistic Group	.83 (.13)	.67 (.27)	.10 (.13)	2.80 (.13)	2.35 (.15)	.54 (.07)	.76 (.08)

Note. Hits = proportion (of 24 items) of correctly recognized studied words; FAs = proportion of false alarms to critical lures (of six items) and distractors (of 18 items); **Sensitivity (d')** = measure of ability to discriminate between studied words or Critical lures and FA distractors (higher values indicate better discrimination against the distractors); **Response Bias (C)** = measure of response tendency, with higher values indicating a conservative response style.

Table 2. *Proportion of stems (and standard error) completed by critical words, as a function of group and priming type for DRM Task 2. Proportion (and Standard error) of correct recall and critical lures for final free recall task.*

Group	Primed	Not Primed	Indirect prime effect	Correct recall	Critical lures
Autistic Group	.12 (.04)	.12 (.02)	.00	.10 (.02)	.12 (.04)
Non-autistic Group	.19 (.03)	.08 (.01)	.11	.25 (.04)	.23 (.05)

Note. *Primed* = proportion of stems completed with the 6 critical lures when the corresponding list was studied; *Not Primed* = proportion of stems completed with 6 critical lures from unseen lists; *Indirect prime effect* = difference between primed and unprimed completions (higher values indicate stronger priming effects); *Correct recall* = proportion of all list words recalled in free recall task; *Critical lures* = proportion of all critical lures recalled.

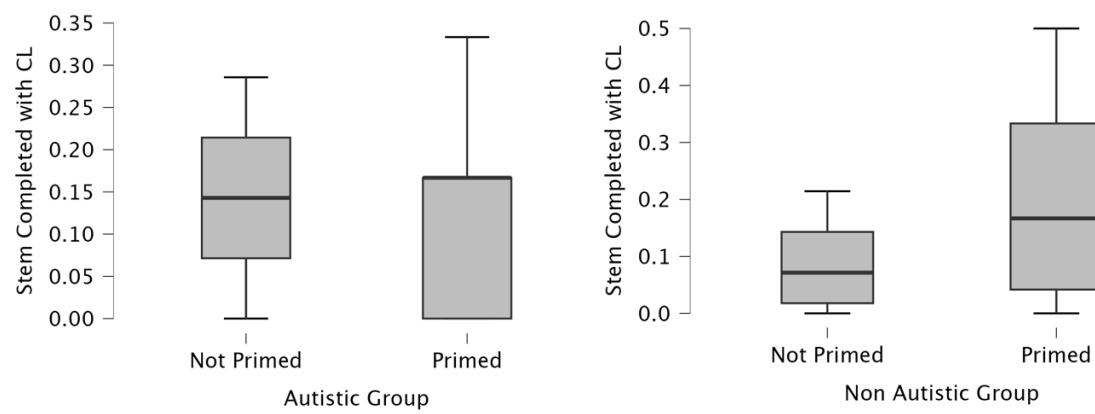


Figure 1. Proportion of stems (and standard error) completed by critical words, as a function of group and priming type.

Table 3. *Average outputs of critical lure (CL) as free associate and position in list when CL first presented as a function of group for DRM task 3*

Group	CLs as Free Associate	Position of CL
Autistic Group	4.47 (.79)	1.70 (.26)
Non-autistic	4.67 (.52)	1.86 (.13)
Group		

Note. Standard error appears in parentheses. **CLs as Free Associate** = average number of times the critical lure was generated as a free associate (out of 12); **Position of CL** = average position in the response list when the critical lure first appeared (lower values indicate earlier mention in the response sequence).

Appendix A

DRM lists utilised per block with average values for BAS, word length, and frequency per block

	Block 1	Block 2	Block 3	Block 4
	car	soft	foot	cup
	needle	army	thief	window
	chair	doctor	slow	music
	sleep	cat	man	river
	rough	cow	fruit	shirt
	mountain	smoke	bread	pen
<i>Mean BAS</i>	.24	.27	.22	.20
<i>Mean Length</i>	5.31	5.45	5.36	5.29
<i>Mean Freq</i>	51.54	32.91	78.89	43.52

Note: BAS values taken from Nelson et al (1998), SUBTL frequency norms from the SUBTLEX_{US} corpus Brysbaert (2024). In addition to the frequentist analysis in the main text, Bayesian comparisons of word list length ($BF_{10} = 0.20$) and frequency norms ($BF_{10} = 0.29$), strongly support the null hypothesis that there are no differences in these values across each block, with BAS ($BF_{10} = 0.82$) differences supporting a null hypothesis, although this is weaker.