Self-Referential Encoding Does Not Benefit Memory for Prior Remembering Across Changing Contexts

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Abstract

Changes in context across instances of memory retrieval have been shown to impair memory for acts of prior remembering. The present study examined how self-referential encoding influences memory for prior remembering that occurred with or without context change. At encoding, participants processed each target in cue-target word pairs in relation to themselves or another person. During an initial cued-recall test, targets were tested with either the studied cues or semantically related, but previously unseen cues. During a second cued-recall test, all targets were tested with the studied cues, and participants judged whether they remembered retrieving each target during the first test. Regardless of self/other-reference, semantic context change across the two tests impaired memory for prior remembering. Furthermore, the magnitude of this impairment was larger for strongly self-associated vs. other-associated targets. Our findings suggest that self-referential encoding does not benefit memory for prior remembering in the face of contextual change.

Self-Referential Encoding Does Not Benefit Memory for Prior Remembering Across Changing Contexts

In everyday life, we frequently remember events from our past. Some of these events are lived experiences (e.g., high school graduation), while other events we remember may have been mentally generated (e.g., a daydream, a worry about the future). One important form of mentally generated experience that we often try to remember is the act of memory retrieval itself (e.g., "Did I already tell you this story?"). Our ability to identify if we have previously retrieved information is referred to as *memory for prior remembering* (Arnold & Lindsay, 2002; 2005; Leppanen & Lyle, 2018). Remembering prior acts of memory retrieval is important because we often retrieve information more than once. Effective social communication benefits from not repeating the same memories, to the same people, every time we see them. Memory for prior remembering is also critical for our understanding of intrusive or involuntary memories (Brewin, 1996; Rubin & Berntsen, 2009; Verwoerd & Wessel, 2007). To identify how often we have experienced involuntary memory retrieval, we must be able to recall that an act of retrieval took place. However, research has consistently demonstrated that we may not be as accurate as we think at recalling previous acts of memory retrieval (e.g., Joslyn et al., 2001; Parks, 1999; Pope & Hudson, 1995).

A dramatic illustration of a failure to remember prior instances of remembering is provided by Schooler and his colleagues (1997). They reported cases in which victims of childhood sexual abuse falsely claimed to have "recovered" long-repressed memories of the abuse that they had never previously recounted. Yet, evidence was found that those victims had in fact mentioned their abuse to others during the period of purported repression. Coining the term "forgot-it-all-along effect", Schooler et al. (1997) speculated that during the apparent recovered-memory experience, the victims remembered the abuse in a qualitatively distinct manner than when they had previously remembered it, which impaired their ability to recall the previous instances of memory retrieval.

To empirically test for the possibility that qualitative changes in memory experience impair memory for prior remembering, Arnold and Lindsay (2002) developed a three-phase procedure as a laboratory analogue of the forgot-it-all-along effect. In the first phase of the procedure, the study phase, participants view a series of semantically-related cue-target word pairs (e.g., *hand – palm*, *dog – bark*). The second phase is an initial cued-recall test (Test 1), during which some of the targets are tested with the same cue as study (same-context targets; *hand – p_ _m*), some are tested with a semantically related, but previously unseen cue (changed-context targets; *birch – b_ _k*), and others are not tested (not-tested targets). During the third phase, participants complete a second cued-recall test (Test 2) for all the studied targets paired with the originally studied cues (e.g., *hand – p_ _m*, *dog – b_ _k*). After each cued-recall attempt on Test 2, participants are asked to report their memory for prior remembering by indicating whether they remember previously retrieving the target on Test 1. The consistent finding using this paradigm is that participants are less likely to correctly report previously retrieving a target if it had been paired with different cues across Test 1 and Test 2 than if it had been paired with the same cue on both tests (Arnold & Lindsay, 2002; 2005; Geraerts et al., 2006; Leppanen & Lyle, 2018; Raymaekers et al., 2011). In other words, changing the semantic context in which target words are retrieved impairs memory for prior remembering. The impairing effect of semantic context change on memory for prior remembering has been explained in terms of the encoding specificity principle (Tulving & Thomson, 1973): The closer the match between different instances of memory retrieval (e.g., available cues, contextual information), the higher the likelihood of successfully recalling previous acts of memory retrieval (Arnold & Lindsay, 2002; 2005).

To our knowledge, only one previous study has explored ways in which the impairing effect of context change on memory for prior remembering can be mitigated. Leppanen and Lyle (2018) adapted Arnold and Lindsay's (2002) procedure, with the only change made being what occurred during Test 1: After each cued-recall attempt, participants were asked to overtly retrieve the original study cue themselves or were simply re-presented with the study cue and were instructed to copy it. The ability to correctly retrieve the study cue on changed-context trials would require participants to first identify a change and then be reminded of the previous cue. Participants were more likely to retrieve the study cue for same-context targets than changed-context targets, demonstrating that reminding is more likely to occur when there is more overlap between the study and Test 1 phases. Importantly, memory for prior remembering of changed-context targets did not significantly differ from that of same-context targets when participants overtly retrieved study cues during Test 1 but was significantly poorer than that of same-context targets when they were simply re-presented with the cues. That is, active memory retrieval effectively eliminated the negative effect of context change on memory for prior remembering. It was proposed that when participants were reminded of the previous cue (i.e., the semantic context) via active memory retrieval, they had the opportunity to form an association between the target, both the studied and changed cues, and the cognitive operations involved in the act of memory retrieval. Later, when the study context was reinstated on Test 2, it served as an effective retrieval cue for the associations formed during Test 1.

The implication of Leppanen and Lyle's (2018) findings is that being reminded of the initial encoding context during Test 1 improves memory for prior remembering in the face of retrieval-context change. One factor that influences the likelihood of being reminded of a previous experience is the strength of the initial memory trace (i.e., accessibility of memory representations; Wahlheim, 2015). In the present study, we examined how encoding processes influence later memory for prior remembering with or without context change. We focused our examination on self-referential processing which has consistently been shown to enhance overall memory strength and episodic retrieval.

It is well-documented that information processed in relation to oneself at encoding enjoys mnemonic advantages over otherwise comparable information encoded in relation to someone else or semantically (i.e., the self-reference effect; Rogers et al., 1977; for a review, see Symons & Johnson, 1997). For instance, when individuals are asked to judge whether or not personalitytrait words are descriptive of themselves or another person, usually a familiar public figure (e.g., “Does this word describe you [Bill Clinton]?”) or to evaluate images of objects based on their own or another person’s perceived likes/dislikes (e.g., “Is this an object you [Bill Clinton] would buy?”; "Would you [Bill Clinton] like this object?”), they subsequently show better memory for items that were encoded in reference to themselves than for those encoded in reference to another person (e.g., Conway & Dewhurst, 1995; Cunningham et al., 2014; Serbun et al., 2011). This self-referential memory advantage has been attributed to enhanced elaboration and more efficient organization of incoming information supported by the rich, highly-organized structure of self-concept/knowledge (Conway & Dewhurst, 1995; Keenan & Baillet, 1980; Klein & Loftus, 1988; Symons & Johnson, 1997).

Self-referential processing is also proposed to strengthen the binding of perceptual and episodic details of an encoding event, with the self acting as “integrative glue” that allows incorporation of new information into activated self-representations (Sui & Humphreys, 2015; 2017). Support for the binding function of self-reference comes from previous findings showing that self-referential encoding increases recollection of perceptual/episodic details of the studied items (e.g., Leshikar et al., 2015; Serbun et al., 2011), and enhances not only memory for studied items themselves (i.e., item memory) but also memory for the associations between the items and their episodic context (i.e., source memory; e.g., remembering that an item was encoded in relation to oneself) across a wide age range (Andrews et al., 2020; Cunningham et al., 2014; Kim et al., 2019; Leshikar & Duarte, 2014).

In the present study, we examined the effect of self-referential encoding on memory for prior remembering by adapting the procedure used by Arnold and Lindsay (2002), with the only changes being what occurred during the study phase: Participants were asked to learn cue-target word pairs while processing each target in relation to themselves or a well-known celebrity. We reasoned that enhanced elaboration and episodic binding promoted by self-referential vs. other-referential encoding would differently affect the likelihood of spontaneous reminding of the original study context during Test 1 depending on whether the semantic context remains the same or changes, which would subsequently influence memory for prior remembering (Leppanen and Lyle, 2018).

Specifically, when the context on Test 1 stays the same as that in the study phase, we hypothesized that the enhanced binding of targets with their original semantic context promoted by self-referential encoding would make the reinstated semantic context at Test 1 more likely to spontaneously remind participants of the initial encoding context for self-referenced targets than for other-referenced targets. The increased likelihood of successful reminding of the initial encoding context for self-referenced targets should subsequently result in better memory for prior remembering of self-referenced targets than other-referenced targets when semantic context remains the same across tests. In comparison, when the context on Test 1 is different from that in the study phase, we hypothesized that the enhanced binding of targets with their original semantic context promoted by self-referential encoding would render the changed semantic context more distinct from (i.e., less similar to) the original semantic context, making spontaneous reminding of the initial encoding context less likely for self-referenced targets than for other-referenced targets. In this case, memory for prior remembering may be poorer for self-referenced targets than for other-referenced targets when semantic context changes across tests. Taking these possibilities together, we further hypothesized that the magnitude of the impairing effect of retrieval context change (i.e., the overall decrease in accuracy of memory for prior remembering when retrieval context changes vs. stays the same) would be greater for self-referenced targets relative to other-referenced targets.

Method

Participants and Design

Participants were 72 undergraduate students (38 females; M_{age} = 18.75 [*SD* = .90] years) who completed the experiment in return for course credit or payment. An a priori statistical power analysis was performed based on previous findings of medium-to-large effect sizes of the impact of context change on memory for prior remembering (*dz* = 0.77 – 2.08; Arnold & Lindsay, 2002; 2005; Geraerts et al., 2006; Leppanen & Lyle, 2018; Raymaekers et al., 2011) as well as small-to-medium effect sizes of the impact of self- vs. other-referential encoding on item-context bindings (*d* = 0.42 – 0.48; Andrews et al., 2020; Cunningham et al., 2014; Leshikar & Duarte, 2014) using G*Power (Faul et al., 2007; f = 0.2 [*d* = 0.4], α = .05, power = .80, required *N* = 52). All participants were native English speakers and had normal or corrected-to-normal vision. Participants provided informed consent in accordance with the human subject regulations of Wesleyan University. Data from 12 participants were excluded from analysis due to a computer malfunction (*N* = 3), failing to follow instructions (*N* = 2) or self-reportedly not knowing the celebrity (i.e., Tom Cruise)[1] who served as the "other" referent (see the Procedure section below, *N* = 7), leaving the final sample of 60.

The experiment had a 2 (Referent: Self, Other) × 2 (Context on Test 1: Same, Changed) factorial design with both Referent and Context on Test 1 as within-subjects factors.

Materials

The list of targets consisted of 104 homographic words selected from those originally used by Arnold and Lindsay (2002), which were obtained from various sets of normed homographs (see Arnold & Lindsay, 2002 for selection criteria). For each target word, Arnold and Lindsay (2002) selected two cue words with the highest relatedness to the word to create two distinct semantic contexts in which a target could be interpreted (e.g., the word *bark* was cued by *dog* or *birch*). Four of the target words served as primacy buffers and four as recency buffers, leaving 96 words as critical items for analysis. These critical targets were separated into two lists of 48 words each to counterbalance the appearance of targets in the Self vs. Other condition across participants. The two lists were matched in terms of the composition of parts of speech,

[1] Tom Cruise was selected as the celebrity in consultation with undergraduate research assistants. Tom Cruise was deemed a well-known, active actor who is likely to be known by most study participants since he had appeared in several blockbuster movies within a few years prior to the collection of data for the present study.

$X^2(5) = .24$, $p = .99$, to account for potential differences in the difficulty of relating target words of various parts of speech (nouns, adjectives, etc.) to a referent (Self or Other). During the study phase, each target was paired with one of the possible cues (e.g., *hand – palm*, *dog – bark*). Assignment of cues to targets for the study phase was counterbalanced, such that targets were studied in each possible semantic context equally often across participants. During the first cued-recall test, the two lists of 48 target words assigned to the Self vs. Other conditions were further organized into the three testing conditions: tested with the studied cue (16 same-context targets; e.g., *hand – p_ _m*), tested with the other, previously unseen cue (16 changed-context targets; e.g., *birch – b_ _k*), or not tested (16 not-tested targets). Assignment of targets to testing conditions was counterbalanced, such that each target appeared in each condition equally often across participants. In total, this resulted in 12 lists being created (2 Referent lists × 2 study cues × 3 Test 1 conditions), which were assigned pseudo randomly to participants. The 12 lists were matched for relative frequency/dominance of meaning (i.e., the relatedness between a target and a given cue) based on various pools of homograph norms (Azuma, 1996; Gawlick-Grendell & Woltz, 1994; Nelson et al., 1980; Twilley et al., 1994), $F(11, 178) = 1.49$, $p = .14$. In addition, the lists were matched for word length, frequency of usage, familiarity, concreteness, and imageability of target words based on the MRC Psycholinguistic Database (Cortheart, 1981), all Fs ≤ 1.38, all ps ≥ .24. During Test 2, all studied targets were tested with the studied cues.

Procedure

Participants were tested individually in a soundproof testing room using E-Prime 3.0 software (Psychology Software Tools, Pittsburgh, PA). After consent, participants were seated at a computer and read the instructions for the first phase (i.e., study phase) of the experiment. Participants were instructed to study the cue-target word pairs and were told they would see a label above each cue-target pair that would signify who they were supposed to process the target word in reference to. Participants were asked to process target words in reference to themselves (i.e., the Self condition) when prompted by a label "YOU" or in reference to the actor Tom Cruise (i.e., the Other condition) when prompted by a label "CRUISE". Specifically, participants were instructed to think about how each target word relates to themselves or to Tom Cruise and were given examples of ways they could do so (e.g., think of a self-relevant or Cruise-relevant memory associated with a word, think about how the word might make themselves or Cruise feel, or how the word could be used by themselves or Cruise). On each trial, a cue-target pair was presented alone for the first 3000ms and then a label (i.e., "YOU" or "CRUISE") was presented above the pair for the remaining 3500ms. After each trial, participants indicated how well they were able to relate the target to the referent on a 4-point Likert-type scale (1 = *not very well* to 4 = *very well*).

The second phase of the experiment was a cued-recall test for two-thirds of the studied targets (Test 1). On each trial, participants were shown a cue followed by the first and last letters of the target separated by dashes (e.g., *dog – b_ _k*). Participants were instructed to respond by typing a target they remembered seeing from the study phase. Participants were informed they must type the entire target word for the computer to track their response accurately. If a participant could not recall a target from the study phase that fit the presented stimulus, they were instructed to type “pass.” Participants were told that some of the words would be cued by the same word from study, while others would be cued by a different word that was nonetheless related to a word they had previously studied. Half of the tested targets were paired with the same cue (same-context targets) and half with the other possible cue (changed-context targets). Participants were given an example of how to respond. All responses during Test 1 were self-paced. Test 1 was followed by a five-minute retention period during which participants completed a word search activity.

The third phase of the experiment was a second cued-recall test (Test 2) in which all the studied targets were tested with the originally studied cue. Participants were again instructed to type the entire target on each trial. Following each cued-recall attempt, participants made a judgment of their memory for prior remembering (*“Did you retrieve this target during the first test? Yes [y] or No [n]*”). After making their judgment of prior remembering on each trial, participants were also asked to indicate whom the target word was referred to during the study phase on a 4-point Likert-type scale (1 = *Definitely Yourself* to 4 = *Definitely Cruise*). All responses during Test 2 were self-paced.

Upon completion of the experimental phases, participants were asked to indicate whether or not they knew Tom Cruise who served as the “other” referent. Data from seven participants who responded they did not know the celebrity were excluded from analysis.

Statistical Analyses

In addition to the conventional frequentist analyses, we used Bayesian analyses to quantify the strength of evidence in support of the presence or absence of any effects of interest. For each of the frequentist analyses, we report the associated Bayes Factor (BF) which represents how likely one hypothesis (e.g., the alternative hypothesis [H_1]) is relative to another hypothesis (e.g., null hypothesis [H_0]) given the observed data (Wagenmakers, Marsman, et al., 2018; Wagenmakers, Love et al., 2018). BF_{10} represents the likelihood of H_1 over H_0, while its reverse, BF_{01}, represents the likelihood of H_0 over H_1. For instance, a BF_{10} value of 4 indicates that the data are 4 times more likely under H_1 than under H_0. Although BFs are to be interpreted as continuous values, a conventional classification scheme (Jeffreys, 1961; Wagenmakers, Love, et al., 2017) provides the following guidelines for interpretation: No evidence when BF = 1, “weak” evidence when $1 < BF \leq 3$, “moderate” evidence when $3 < BF \leq 10$, “strong” evidence when $10 < BF \leq 30$, “very strong” evidence when $30 < BF \leq 100$, and “extreme” evidence when $BF > 100$.

Bayesian analyses were conducted using the JASP statistical software (JASP Team, 2019, version 0.11.1) with their default “objective” priors (for t-tests: Cauchy distribution scaling factor *r* = 0.707; for analyses of variances [ANOVAs]: *r* = 0.5, 1, and 0.354 for fixed effects, random effects, and covariates, respectively). For Bayesian ANOVA results, we report a $BF_{Inclusion}$ value for each factor in the model (i.e., a main effect or an interaction effect) which indicates the likelihood of the data under models that included a given factor relative to matched models that are stripped of that factor. Because post-hoc tests have not yet been fully developed in the Bayesian ANOVA framework (Wagenmakers, Love et al., 2018), the reported BFs for any post-hoc tests (i.e., $BF_{10,\,U}$) are uncorrected for multiple comparisons.

Results

The primary focus of the present study was on memory for prior remembering, but we also report cued-recall performance (in line with previous research; Arnold & Lindsay, 2002; 2005; Leppanen & Lyle, 2018) as well as memory for the referent (self or other) that was queried during Test 2. We initially ran all statistical analyses including our counterbalancing factors as between-subjects variables to determine if there were any consistent effects of counterbalancing on memory performance. We found inconsistent effects of counterbalancing on cued-recall performance, like those reported by Arnold and Lindsay (2002, Footnote 1, p. 523), and crucially, no significant effects of counterbalancing factors on the judgments of memory for prior remembering on which our hypotheses were based, all Fs ≤ 1.77, all ps $\geq .19$. Given this, we collapsed the reported analyses across counterbalancing factors. It should be noted that analyses were conditionalized by particular types of responses, and some participants did not have responses of a given type. As such, degrees of freedom between analyses sometimes differed.

Cued-Recall Performance

We first analyzed cued-recall performance on Test 1. A 2 (Referent: self, other) × 2 (Context on Test 1: same, changed) repeated-measures ANOVA conducted on the proportion of targets correctly recalled on Test 1 revealed significant main effects of Referent, $F(1, 59) = 4.43$, $p = .04$, $\eta_p^2 = .07$, $BF_{Inclusion} = 1.66$, and Context on Test 1, $F(1, 59) = 63.06$, $p < .001$, $\eta_p^2 = .52$, $BF_{Inclusion} = 7.43 \times 10^{14}$, but no significant interaction between them, $F(1, 59) = 2.63$, $p = .11$, $BF_{Inclusion} = 0.45$. Overall, participants recalled significantly more self-referenced targets (M = .74, SD = .14) than other-referenced targets (M = .71, SD = .16), and significantly more same-context targets (M = .79, SD = .14) than changed-context targets (M = .66, SD = .15).

For cued-recall performance on Test 2, a 2 (Referent: self, other) × 3 (Context on Test 1: same, changed, not-tested) repeated-measures ANOVA conducted on the proportion of targets correctly recalled on Test 2 revealed a significant main effect of Context on Test 1, $F(1.720, 101.505) = 29.95$, $p < .001$, $\eta_p^2 = .34$ (Greenhouse-Geisser corrected for nonsphericity), $BF_{Inclusion} = 5.83 \times 10^{12}$, but no significant main effect of Referent or an interaction, all Fs ≤ 1.02, all ps $\geq .36$, all $BF_{Inclusion}$s ≤ 0.12. Bonferroni-corrected pairwise comparisons showed that same-context targets (M = .84, SD = .12) were remembered better than not-tested targets (M = .80, SD = .13), $p = .001$, $BF_{10,\,U} = 168.42$, which were in turn remembered better than changed-context targets (M = .72, SD = .14), $p = .001$, $BF_{10,\,U} = 3206.42$.

Memory for the Referent

Before presenting the memory for prior remembering results, we report the results for how well participants could recall who they originally related the target words to (i.e., memory for the referent [self vs. other]) that was assessed during Test 2. The proportion correct memory for each referent was calculated by subtracting the proportion of targets that were incorrectly judged to be associated with the wrong referent from the proportion of targets that were correctly remembered being associated with the experimentally assigned, correct referent.

The proportion correct memory for the referent was submitted to a 2 (Referent: self, other) × 3 (Context on Test 1: same, changed, or not-tested) repeated-measures ANOVA. The main effect of Referent was significant, $F(1, 59) = 5.49$, $p = .023$, $\eta_p^2 = .09$, $BF_{Inclusion} = 20.03$, with participants more likely to correctly remember when the referent was themselves ($M = .68$, $SD = .17$) than when it was the celebrity ($M = .63$, $SD = .19$). The main effect of Context on Test 1 was also significant, $F(1.671, 98.573) = 38.30$, $p < .001$, $\eta_p^2 = .39$ (Greenhouse-Geisser corrected for nonsphericity), $BF_{Inclusion} = 4.41 \times 10^7$. Bonferroni-corrected pairwise comparisons showed that participants' memory for the referent was worse for changed-context targets ($M = .57$, $SD = .18$) compared to both same-context targets ($M = .69$, $SD = .18$), $p < .001$, $BF_{10, U} = 46280.75$, and not-tested targets ($M = .71$, $SD = .17$), $p < .001$, $BF_{10, U} = 1.43 \times 10^7$, with no significant difference between the latter two types of targets, $p = .79$, $BF_{10, U} = 0.17$. These main effects were qualified by a significant interaction between Referent and Context on Test 1, $F(1.750, 103.256) = 18.56$, $p < .001$, $\eta_p^2 = .24$ (Greenhouse-Geisser corrected for nonsphericity), $BF_{Inclusion} = 21238.17$. Simple effects analyses revealed that for both same-context and not-tested targets, memory for the referent was better for self-referenced targets (same-context: $M = .77$ [$SD = .17$]; not-tested: $M = .75$ [$SD = .16$]) than for other-referenced targets (same-context: $M = .61$ [$SD = .20$]; not-tested: $M = .66$ [$SD = .19$]), all $t(59)$s ≥ 3.09, all *ps* $\leq .003$, all *ds* $\geq .40$, all BF_{10}s ≥ 9.92. In comparison, for changed-context targets, memory for the referent did not significantly differ between self-referenced targets ($M = .53$, $SD = .19$) and other-referenced targets ($M = .60$, $SD = .17$), $t(59) = 1.73$, $p = .088$, $BF_{10} = 0.58$.

Memory for Prior Remembering

Memory for prior remembering data were analyzed contingent upon correct target retrieval on both Test 1 and Test 2 (see the bolded rows in Table 1). Judgments of prior remembering were considered correct when participants responded "yes" to either type of previously tested target (same-context or changed-context). We suspected that any effects of self/other-reference at encoding on memory for prior remembering may be critically affected by how well participants related a target to a given referent during the study phase (assessed on a scale of 1 [*not very well*] to 4 [*very well*]). As such, responses were further conditionalized by grouping ratings of 1 or 2 as having "weak" reference strength and ratings of 3 or 4 as having "strong" reference strength.[2] A 2 (Referent: self, other) × 2 (Reference Strength: strong, weak) × 2 (Context on Test 1: same, changed) repeated-measures ANOVA conducted on the proportion of correct judgments of prior remembering revealed a significant main effect of Context on Test 1, $F(1, 51) = 21.75$, $p < .001$, $\eta_p^2 = .30$, $BF_{Inclusion} = 8.61 \times 10^6$, with better memory for prior

[2] We reasoned that conditionalizing trials based on reference strength ratings made at encoding rather than memory for the referent assessed at Test 2 would better capture any effects that self/other-reference at encoding had on memory for prior remembering across changing contexts. We made this decision given that (a) reference strength ratings were made prior to the introduction of any change in context and (b) memory for the referent was itself affected by the Context on Test 1 factor as described in the previous "Memory for the Referent" section.

Table 1

Mean Number of Targets and Mean Proportion of Targets Judged as "Recalled" as a Function of Recall Status on Test 1 and Test 2

Test 1/Test 2 Recall Status	Number of Targets	Proportion Judged as "Recalled" on Test 1
	Self-Referenced Targets	
	Same cue*	
Recalled/Recalled	**12.37**	**.87 (.02)**
Recalled/Not Recalled	.68	.87 (.06)
Not Recalled/Not Recalled	1.85	.35 (.06)
Not Recalled/Recalled	1.10	.54 (.07)
	Changed cue*	
Recalled/Recalled	**10.05**	**.73 (.03)**
Recalled/Not Recalled	.50	.62 (.09)
Not Recalled/Not Recalled	3.83	.26 (.04)
Not Recalled/Recalled	1.62	.32 (.06)
	Not tested*	
NA/Recalled	12.62	.57 (.05)
NA/Not Recalled	3.38	.35 (.05)
	Other-Referenced Targets	
	Same cue*	**.86 (.02)**
Recalled/Recalled	**12.05**	.32 (.12)
Recalled/Not Recalled	.27	.30 (.05)
Not Recalled/Not Recalled	2.25	.60 (.07)
Not Recalled/Recalled	1.43	
	Changed cue*	
Recalled/Recalled	**9.98**	**.74 (.03)**
Recalled/Not Recalled	.47	.52 (.10)
Not Recalled/Not Recalled	4.03	.27 (.05)
Not Recalled/Recalled	1.52	.32 (.06)
	Not tested*	
NA/Recalled	12.88	.53 (.05)
NA/Not Recalled	3.12	.31 (.05)

Note. NA = Not applicable. * Context on Test 1. Numbers in parentheses are standard errors of the mean. Lines in bold are those for which statistical analyses are reported in the text.

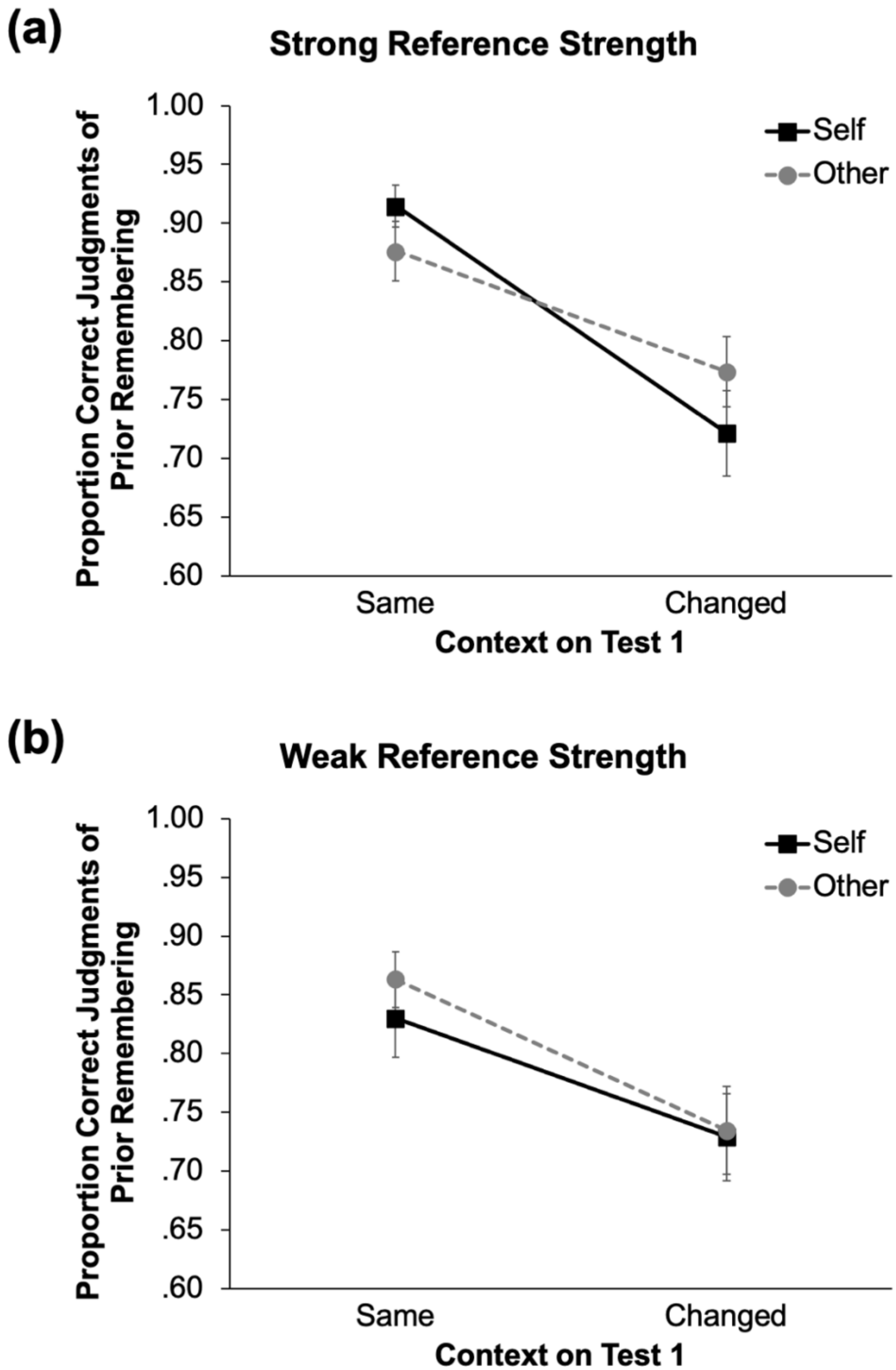
remembering for same-context targets (*M* = .87, *SD* = .20) than for changed-context targets (*M* = .76, *SD* = .26). No other main effects or interactions were found to be significant, all *F*s ≤ 2.43, all *p*s ≥ .13, all $BF_{Inclusion}$s ≤ 0.45, except a marginally significant 3-way interaction among Referent, Reference Strength, and Context on Test 1, $F(1, 51) = 3.86$, $p = .055$, $\eta_p^2 = .07$, $BF_{Inclusion} = 1.49$. Because this interaction was both theoretically informed and hypothesized a priori, we followed it up with 2 (Referent: self, other) × 2 (Context on Test 1: same, changed) repeated-measures ANOVAs conducted separately on targets with strong vs. weak reference strength.

For targets with strong reference strength, there was a significant main effect of Context on Test 1, $F(1, 54) = 25.88$, $p < .001$, $\eta_p^2 = .32$, $BF_{Inclusion} = 4.60 \times 10^6$, with better memory for prior remembering for same-context targets (*M* = .90, *SD* = .16) than for changed-context targets (*M* = .75, *SD* = .25). The main effect of Referent was not significant, $F(1, 54) = 0.04$, $p = .85$, $BF_{Inclusion} = 0.15$. Importantly, the main effect of Context on Test 1 was qualified by a significant interaction between Referent and Context on Test 1, $F(1, 54) = 5.20$, $p = .027$, $\eta_p^2 = .09$, $BF_{Inclusion} = 2.31$. As shown in Figure 1, simple effects analyses revealed that while memory for prior remembering was better when the context stayed the same between Test 1 and Test 2 than when it changed for both self-referenced targets (*M*s = .91 [*SD* = .14] vs. .73 [*SD* = .28]) and other-referenced targets (*M*s = .88 [*SD* = .19] vs. .77 [*SD* = .22]), all *t*s ≥ 2.97, all *p*s ≤ .005, all *d*s ≥ .40, all BF_{10}s ≥ 7.25, the magnitude of the impairing effect of context change (i.e., the proportion correct same-context memory for prior remembering minus the proportion correct changed-context memory for prior remembering) was significantly greater for self-referenced targets (*M* = .19, *SD* = .27) relative to other-referenced targets (*M* = .10, *SD* = .25), $t(54) = 2.28$, $p = .027$, $d = .31$, $BF_{10} = 2.58$.

For targets with weak reference strength, there was a significant main effect of Context on Test 1, $F(1, 56) = 11.99$, $p = .001$, $\eta_p^2 = .18$, $BF_{Inclusion} = 352.09$, with better memory for prior remembering for same-context targets (*M* = .84, *SD* = .22) than for changed-context targets (*M* = .73, *SD* = .29). No other main or interaction effects were significant, all *F*s ≤ 2.52, all *p*s ≥ .11, all $BF_{Inclusion}$s ≤ 0.32.

Figure 1

Memory for Prior Remembering of Targets with (a) Strong Reference Strength or (b) Weak Reference Strength, as a Function of Context on Test 1 and Referent



Discussion

In the present study, we examined whether self-referential encoding would have an impact on subsequent memory for prior remembering with or without semantic context change. We found that regardless of who participants related target words to during encoding (self vs. other), memory for prior remembering was significantly impaired by changes to semantic context between Test 1 and Test 2. Follow-up analyses showed that self-referential encoding led to a more impairing effect of semantic context change than other-referential encoding, but only when the initial relationship formed between the targets and the referent (self or other) was self-reported as strong. These findings suggest that self-referential encoding does not benefit memory for prior remembering in the face of contextual change. Rather, self-referential encoding seems to exacerbate the negative consequences of retrieval context change on one's ability to remember prior instances of remembering.

Our findings provide further evidence for the consistent impairing effect of semantic context change on memory for prior remembering (Arnold & Lindsay, 2002; 2005; Leppanen & Lyle, 2018). The most parsimonious explanation for this finding is a violation of the encoding specificity principle (Tulving & Thomson, 1973). When participants attempt to recall a previous act of retrieving a target, the accuracy of that judgment will be directly influenced by the amount of overlap between the two acts of retrieval. For same-context targets, there will be significant overlap in the cue, the target, the semantic context, and the act of retrieval itself. This overlap consistently results in accurate memory for prior remembering. For changed-context targets, the change in semantic context creates a discrepancy between the information associated with the act of retrieval across the two tests. Despite participants retrieving the same orthographic word form on both tests (e.g., *bark*), the change in meaning established by the semantic context renders a previous act of retrieval significantly less accessible than if the meaning had remained the same.

Our novel finding was that self-referential encoding did not benefit memory for prior remembering in the face of retrieval-context change. In fact, targets strongly encoded in a self-referential manner were found to suffer more from semantic context change across instances of memory retrieval than targets strongly encoded in an other-referential manner. Previous theories on the mechanisms underlying the self-reference effect in memory have suggested that self-referential encoding leads to more elaborate memory traces (Conway & Dewhurst, 1995; Keenan & Baillet, 1980; Klein & Loftus, 1988; Symons & Johnson, 1997). Our findings suggest that any elaboration that results from self-referential encoding is context-specific, providing support for the idea that self-reference enhances episodic binding (Sui & Humphreys, 2015; 2017). If someone encodes the word *bark* with respect to themselves by remembering their own *dog's* bark, this representation is highly context-specific and unlikely to later be associated with tree bark (unless one's dog happens to be an avid tree climber). Thus, the representation is highly distinct from other forms of the word *bark* and will have fewer overlapping associations with other representations of *bark*. When one is later presented with *bark* in the context of *birch* they may be less likely to be reminded of how they previously thought about *bark* in the context of their own dog. Without that reminding, it becomes less likely that they will form an association between both cues (i.e., semantic contexts) associated with the word *bark* and the act of retrieval itself. Subsequently, on Test 2 the word *dog* will then be an ineffective retrieval cue for the Test 1 recall attempt that occurred in the context of *birch* and memory for prior remembering will be significantly impaired. We argue that our results suggest that self-referential encoding leads to the formation of highly distinct representations that are subsequently more likely to be impaired by the effects of retrieval contextual change.

Replicating previous findings of the self-reference effect (for review, see Symons & Johnson, 1997), we found that Test 1 cued recall was better for targets encoded in reference to oneself relative to targets encoded in reference to a celebrity. This self-referential memory advantage did not interact with the change in semantic context, demonstrating that self-referent targets were generally remembered better on Test 1 than other-referent targets. After a delay, this self-reference effect disappeared on Test 2. While cued-recall performance overall increased from Test 1 to Test 2, performance for other-referent targets disproportionately increased relative to that for self-referent targets. One possibility is that after the delay participants' memory for the exact encoding activity performed on a target (self- or other-reference) may have faded. With access to that episodic feature reduced, the reinstated semantic context may have acted as a stronger retrieval cue and outshined any effects of other associated features/contexts (Smith, 1988; 1994). Under these circumstances, participants may have been able to retrieve semantic associates of the cues equally well for self- and other-referent targets.

We also demonstrated a self-reference effect on memory for the referent from the study phase. Participants were significantly more likely to correctly remember that a target had previously been related to themselves than to the celebrity. This effect was qualified by an interaction with the context in which the target had been tested during Test 1. For targets that were tested in the same context across Test 1 and Test 2 and those that were not tested at all during Test 1, there was a significant self-reference effect. However, when the semantic context changed between Test 1 and Test 2, participants were no more likely to remember a target was originally related to themselves than they were to remember that targets had been related to the celebrity. In other words, semantic context change eliminated the benefit of self-referential encoding on memory for the referent. We propose that a similar reminding mechanism influenced memory for the referent and memory for prior remembering. During Test 1 when the semantic context remained the same, spontaneous reminding of the original study context would have reinforced the association between the referent and a target, resulting in a preserved distinction between self- and other-referent targets. In contrast, when the semantic context changed during Test 1, spontaneous reminding of the original study context would have been less likely, allowing little opportunity to strengthen the relationship between the referent and a target within the originally learned semantic context. Under those circumstances, the link between the target and the referent may instead have been subject to retroactive interference from the new association formed between the target and the changed Test 1 semantic context. As would be expected under conditions of retroactive interference, even when the original semantic context was reinstated on Test 2, participants would have been less likely to retrieve the original association between the cue, the target, and the referent on changed-context trials, regardless of who the referent was.

The present study has a number of limitations that could be addressed in future research. First, the present study only assessed how self- vs. other-reference at *encoding* influences memory for prior remembering. As such, in the current design, self- or other-reference simply functioned as an *additional* feature that accompanied the original semantic context for a target. A more direct assessment of the role of self-reference in memory for prior remembering would be to manipulate self/other-reference *across acts of memory retrieval*. For example, future studies may change the reference context per se between instances of memory retrieval without changing the semantic meaning of a target. We are currently exploring the role of self/other-reference at memory retrieval through object ownership as a naturalistic way to associate items with the self (Pierce et al., 2003; see also Beggan, 1992; Cunningham et al., 2008; Golubickis et al., 2018). It remains to be seen whether self-reference at *memory retrieval* influences the accuracy of memory for prior remembering in a similar manner as self-reference at *encoding* does.

Another limitation of the present study is that we did not include a direct measure of spontaneous reminding of the original study context during Test 1. Future studies employing such a measure are desirable to provide further evidence for the differential impact of self- vs. other-reference on memory for prior remembering across retrieval-context changes. For example, one may follow a procedure like that used by Wahlheim and Jacoby (2013), in which participants would be asked to identify during Test 1 whether they detected a change in the cue word (i.e., the semantic context). Upon detecting a change, participants could be asked to identify what the cue was changed from and to indicate who the original referent had been. Alternatively, a procedure like Leppanen and Lyle (2018) could be used, in which participants would simply be asked to retrieve the original study cue and the referent on *every* Test 1 trial. Such a procedure would result in explicit reminding, as opposed to spontaneous, but may nonetheless provide valuable insight into what participants remember about referential information following semantic context change.

While not the focus of the present study, our results could be extended by future research into participants' metacognitive awareness about memory for prior remembering (i.e., a comparison of Type-1 to Type-2 performance; Fleming & Lau, 2014). Type-1 performance has been used to describe objective task performance (e.g., perceptual discrimination, memory, decision making), while Type-2 performance refers to subjective performance (often measured as confidence; Fleming & Dolan, 2012, Maniscalco & Lau, 2014). Memory for prior remembering can be interpreted as a subjective metacognitive judgment about objectively measured prior recollection (Test 1). In the present study we observed a main effect of self-referential encoding on the accuracy of Test 1 cued-recall (i.e., Type-1 performance). However, there was no main effect of Referent on judgments of prior remembering (i.e., Type-2 performance). Our observation that context change was more detrimental for strongly-encoded self-referent targets than strongly-encoded other-referent targets, despite better cued recall in the reverse direction, was an example of better objective performance failing to lead to better subjective performance. We proposed earlier that the distinctiveness of self-referential memory representations led to greater impairment in the face of context change. What we did not measure in the present study was whether participants' confidence in their judgments of prior remembering also differed as a function self-referential encoding. Future research should explore whether self-reported confidence in memory for prior remembering differs between self-referent targets and other-referent targets. Though we did not measure participants' confidence in their judgments of prior remembering, past research (Arnold & Lindsay, 2005) has demonstrated that participants are often confident when they incorrectly believe that a target had not previously been retrieved. Knowing whether participants are more or less confident in their incorrect judgments of prior remembering for self-referent targets would lead to a better understanding of individual differences in the metacognitive task of memory for prior remembering and a more nuanced explanation for the present observations.

In sum, the present study showed that self-reference at encoding exacerbates the negative impact of retrieval context change on our ability to remember prior instances of memory retrieval. The present findings suggest that encoding processes that strengthen the binding of targets to their initial context may negatively impact memory for prior remembering in the face of retrieval context change. Continuing to delineate the boundary conditions of successful memory for prior remembering will further our understanding of how we remember our own internal processing and whether memory for prior remembering operates on similar principles to memory for other types of events.

References

Andrews, G., Murphy, K., & Dunbar, M. (2020). Self-referent encoding facilitates memory binding in young children: New insights into the self-reference effect in memory development. *Journal of Experimental Child Psychology*, *198*, 104919. https://doi.org/10.1016/j.jecp.2020.104919

Arnold, M. M. & Lindsay, D. S. (2002). Remembering remembering. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28,* 521-529. https://doi.org/10.1037/0278-7393.28.3.521

Arnold, M. M. & Lindsay, D. S. (2005). Remembrance of remembrance past. *Memory, 13,* 533-549. https://doi.org/10.1080/09658210444000214

Azuma, T. (1996). Familiarity and relatedness of word meanings: Ratings from 110 homographs. *Behavior Research Methods, Instruments, & Computers*, *28*, 109-124. https://doi.org/10.3758/BF03203645

Beggan, J. K., (1992). One the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology, 62,* 229-237. https://doi.org/10.1037/0022-3514.62.2.229

Brewin, C. R. (1996). Intrusive thoughts and intrusive memories in a nonclinical sample. *Cognition and Emotion, 10,* 107-112. https://doi.org/10.1080/026999396380411

Conway, M. A., & Dewhurst, S. A. (1995). The self and recollective experience. *Applied Cognitive Psychology, 9,* 1-19. https://doi.org/10.1002/acp.2350090102

Cortheart, M. (1981). The MRC Psycholinguistic Database. *Quarterly Journal of Experimental Psychology, 33A,* 497-505. https://doi.org/10.1080/14640748108400805

Cunningham, S. J., Brebner, J. L., Quinn, F., & Turk, D. J. (2014). The self-reference effect on memory in early childhood. *Child Development*, *85*, 808-823. https://doi.org/10.1111/cdev.12144

Cunningham, S. J., Turk, D. J., Macdonald, L. M., & Macrae, C. N. (2008). Yours or mine? Ownership and memory. *Consciousness and Cognition, 17,* 312-318. https://doi.org/10.1016/j.concog.2007.04.003

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power3: A flexible statistical power analysis program for the social, behavioural, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191. https://doi.org/10.3758/BF03193146

Fleming, S. M., & Dolan, R. J. (2012). The neural basis of metacognitive ability. *Philosophical Transactions of the Royal Society B, 367,* 1338-1349. https://doi.org/10.1098/rstb.2011.0417

Fleming, S. M., & Lau, H. C. (2014). How to measure metacognition. *Frontiers in Human Neuroscience*, 8:443. https://doi.org/10.3389/fnhum.2014.00443

Gaulick-Grendell, L. A., & Woltz, D. J. (1994). Meaning dominance norms for 120 homographs. *Behavior Research Methods, Instruments, & Computers*, *26*, 5-25. https://doi.org/10.3758/BF03204557

Geraerts, E., Arnold, M. M., Lindsay, D. S., Merckelbach, H., Jelicic, M., & Hauer, B. (2006).

Forgetting of prior remembering in persons reporting recovered memories of childhood sexual abuse. *Psychological Science, 17*, 1002-1008. https://doi.org/10.1111/j.1467-9280.2006.01819.x

Golubickis, M., Falbén, J. K., Cunningham, W. A., & Macrae, C. N. (2018). Exploring the self-ownership effect: Separating stimulus and response biases. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *44*, 295-306. https://doi.org/10.1037/xlm0000455

JASP Team (2019). *JASP* (Version 0.11.1). [Computer software]. https://jasp-stats.org

Jeffreys, J. (1961). *Theory of probability* (3rd ed.). Oxford University Press.

Joslyn, S., Loftus, E., McNoughton, A., & Powers, J. (2001). Memory for memory. *Memory & Cognition, 29,* 789-797. https://doi.org/10.3758/BF03196408

Keenan, J. M., & Baillet, S. D. (1980). Memory for personally and socially significant events. In R. S. Nickerson (Ed.), *Attention and performance* (Vol. 8, pp. 651-669). Erlbaum.

Kim, K., Johnson, J. D., Rothschild, D. J., & Johnson, M. K. (2019). Merely presenting one's own name along with target items is insufficient to produce a memory advantage for items: A critical role of relational processing. *Psychonomic Bulletin & Review, 26,* 360-366. https://doi.org/10.3758/s13423-018-1515-9

Klein, S. B., & Loftus, J. (1988). The nature of self-referent encoding: The contribution of elaborative and organizational processes. *Journal of Personality and Social Psychology*, *55,* 5-11. https://doi.org/10.1037/0022-3514.55.1.5

Leshikar, E. D., & Duarte, A. (2014). Medial prefrontal cortex supports source memory for self-referenced materials in young and older adults. *Cognitive, Affective, & Behavioral Neuroscience*, *14,* 236–252. https://doi.org/10.3758/s13415-013-0198-y

Leshikar, E. D., Dulas, M. R., & Duarte, A. (2015). Self-referencing enhances recollection in both young and older adults. *Aging, Neuropsychology, and Cognition*, *22,* 388-412. https://doi.org/10.1080/13825585.2014.957150

Leppanen, M. L. & Lyle, K. B. (2018). Making remembering more memorable. *Memory*, *26*, 960-973. https://doi.org/10.1080/09658211.2017.1422270

Maniscalco B., & Lau H. (2014). Signal detection theory analysis of Type 1 and Type 2 data: Meta-*d′*, response-specific meta-*d′*, and the unequal variance SDT model. In S. M. Fleming & C. D. Frith (Eds.), *The Cognitive Neuroscience of Metacognition*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-45190-4_3

Nelson, D. L., McEvoy, C. L., Walling, J. R., & Wheeler, J. W. (1980). The University of South Florida homograph norms. *Behavior Research Methods & Instrumentation*, *12*, 16-37. https://doi.org/10.3758/BF03208320

Parks, T. E. (1999). On one aspect of the evidence for recovered memories. *The American Journal of Psychology, 112,* 365-370. https://doi.org/10.2307/1423636

Pierce, J. L., Kostova, T., & Dirks, K. T. (2003). The state of psychological ownership: Integrating and extending a century of research. *Review of General Psychology*, *7*, 84-107. https://doi.org/10.1037/1089-2680.7.1.84

Pope, H. G. & Hudson, J. L. (1995). Can memories of childhood sexual abuse be repressed? *Psychological Medicine*, *25*, 121-126. https://doi.org/10.1017/S0033291700028142

Psychology Software Tools, Inc. (2016). *E-Prime* (Version 3.0). https://www.pstnet.com.

Raymaekers, L., Peters, M. J. V., Smeets, T., Abidi, L., & Merckelbach, H. (2011). Underestimation of prior remembering and susceptibility to false memories: Two sides of the same coin? *Consciousness and Cognition, 20*, 1144-1153. https://doi.org/10.1016/j.concog.2010.12.010

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology, 35*, 677-688. https://doi.org/10.1037/0022-3514.35.9.677

Rubin, D. C., & Berntsen, D. (2009). The frequency of voluntary and involuntary autobiographical memories across the life span. *Memory & Cognition*, *37*, 679-688. https://doi.org/10.3758/37.5.679

Schooler, J. W., Bendiksen, M., & Ambadar, Z. (1997). Taking the middle line: Can we accommodate both fabricated and recovered memories of sexual abuse? In M. A. Conway (Ed.), *False memories and recovered memories* (pp. 251-292). Oxford University Press.

Serbun, S. J., Shih, J. Y., & Gutchess, A. H. (2011). Memory for details with self-referencing. *Memory*, *19*, 1004–1014. https://doi.org/10.1080/09658211.2011.626429

Smith, S. M. (1988). Environmental context-dependent memory. In D. M. Thomson & G. M. Davies (Eds.), *Memory in context: Context in memory* (pp. 13-34). Wiley.

Smith, S. M. (1994). Theoretical principles of context-dependent memory. In P. Morris & M. Gruneberg (Eds.), *Theoretical aspects of memory* (2nd ed., Vol. 2, pp. 168-195). Routledge.

Sui, J., & Humphreys, G. W. (2015). The integrative self: How self-reference integrates perception and memory. *Trends in Cognitive Sciences*, *19*, 719-728. https://doi.org/10.1016/j.tics.2015.08.015

Sui, J., & Humphreys, G. W. (2017). The ubiquitous self: What the properties of self-bias tell us about the self. *Annals of the New York Academy of Sciences*, 1396, 222-235. https://doi.org/10.1111/nyas.13197

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin*, *121*, 371-394. https://doi.org/10.1037/0033-2909.121.3.371

Tulving, E. & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*, 352-373. https://doi.org/10.1037/h0020071

Twilley, L. C., Dixon, P., Taylor, D., & Clark, K. (1994). University of Alberta norms of relative meaning frequency for 566 homographs. *Memory & Cognition*, *22*, 111-126. https://doi.org/10.3758/BF03202766

Verwoerd, J., & Wessel, I. (2007). Distractibility and individual differences in the experience of involuntary memories. *Personality and Individual Differences, 42,* 325-334. https://doi.org/10.1016/j.paid.2006.07.014

Wagenmakers, E.-J., Love, J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., Selker, R., Gronau, G. F., Dropmann, D., Boutin, B., Meerhoff, F., Knight, P., Raj, A., van Kesteren, E.-J., van Doorn, J., Smira, M., Epskamp, S., Etz, A., Matzke, D., … Morey, R. D. (2018). Bayesian inference for psychology. Part II: Example applications with JASP. *Psychonomic Bulletin & Review*, *25*, 58-76. https://doi.org/10.3758/s13423-017-1323-7

Wagenmakers, E.-J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., Love, J., Selker, R., Gronau, Q. F., Smira, M., Epskamp, S., Matzke, D., Rouder, J. N., & Morey, R. D. (2018). Bayesian inference for psychology. Part I: Theoretical advantages and practical ramifications. *Psychonomic Bulletin & Review*, *25*, 35-57. https://doi.org/10.3758/s13423-017-1343-3

Wahlheim, C. N. (2015). Testing can counteract proactive interference by integrating competing information. *Memory & Cognition*, *43*, 27-38. https://doi.org/10.3758/s13421-014-0455-5

Wahlheim, C. N., & Jacoby, L. L. (2013). Remembering change: The critical role of recursive remindings in proactive effects of memory. *Memory & Cognition*, *41*, 1–15. https://doi.org/10.3758/s13421-012-0246-9