Routledge
Taylor & Francis Group

Aging, Neuropsychology, and Cognition

A Journal on Normal and Dysfunctional Development

ISSN: 1382-5585 (Print) 1744-4128 (Online) Journal homepage: www.tandfonline.com/journals/nanc20

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To cite this article: Gratiela Chirtop, Chloe M. Bates & Andrew K. Martin (02 Sep 2025): The self and friend reference effects in episodic memory are maintained in older adults, Aging, Neuropsychology, and Cognition, DOI: 10.1080/13825585.2025.2554155

To link to this article: https://doi.org/10.1080/13825585.2025.2554155

Published online: 02 Sep 2025.

AGING, NEUROPSYCHOLOGY, AND COGNITION
https://doi.org/10.1080/13825585.2025.2554155

The self and friend reference effects in episodic memory are maintained in older adults

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ABSTRACT

Self-referential information is better remembered than information encoded via semantic processing or in relation to others. Friend-referencing also enhances memory compared to more distant others, but its impact relative to self-referencing remains less understood. While older adults typically show declines in memory performance, it is unclear whether self- and friend-referencing advantages are preserved with age. Additionally, little is known about metacognitive monitoring in self- versus friend-encoded information in older adults. Participants completed a surprise recognition memory task for adjectives encoded in relation to the self, a close friend, or a celebrity. Item and source memory accuracy were assessed, along with metacognitive monitoring performance using confidence ratings. Both young and older adults exhibited a self-reference effect, outperforming friend- and celebrity-referenced conditions. A friend-referencing advantage was also observed compared to celebrity-referenced items. Metacognitive sensitivity (meta d′) and efficiency (meta d′/d′) were comparable across age groups. A self-referencing effect for source memory was identified but was limited to positive words. Despite lower overall source memory accuracy, older adults showed similar biases in self- and friend-referencing as younger adults. Self- and friend-referencing effects on episodic memory remain robust in older adults, offering potential strategies for improving memory retrieval in aging populations.

ARTICLE HISTORY
Received 27 April 2025
Accepted 21 August 2025

KEYWORDS
Self-reference effect; source memory; metamemory; aging; friendship

Introduction

Information is remembered better when encoded in relation to the self than when processed semantically or in reference to another person. This self-referential effect (SRE) in episodic memory is consistently observed in young adults and persists even when contrasted with encoding in relation to close others such as friends or relatives (Symons & Johnson, 1997). Including close friends as comparison targets in memory research allows for the examination of cognitive markers that reflect social connectedness. For example, individuals who report higher levels of loneliness tend to show less

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cognitive differentiation between close friends and strangers (Kokici et al., 2023). Given that reduced social connectedness is linked to negative physical and mental health outcomes in later life (Chen et al., 2014; Rook & Charles, 2017; Steptoe et al., 2013; Uchino, 2013), it is critical to determine whether cognitive distance between the self and close others is preserved in older adults. Moreover, because emotional factors also shape the SRE (D'Argembeau et al., 2005), it is important to examine how emotion interacts with age-related changes in self- and other-referential processing.

The SRE is supported by the Levels of Processing framework (Craik F & Lockhart R, 1972), which posits that deeper levels of encoding lead to better memory retrieval. Self-referential encoding is considered a particularly deep form of processing and has been shown to enhance memory relative to both semantic and other-referent encoding (Rogers et al., 1977). While distant others (e.g., celebrities or politicians) are often employed as comparison referents (Martin et al., 2019, 2021; Santiesteban et al., 2012), research has investigated whether familiar others, such as close friends or mothers, elicit similar cognitive biases in encoding and retrieval. Studies suggest that familiar others may engage processes similar to self-referential encoding (Aron et al., 1991; Bower & Gilligan, 1979) and benefit from a comparable memory bias, yet others provide evidence for a unique self-bias (Gutchess et al., 2007; Heatherton et al., 2006; Kokici et al., 2023) with close others falling intermediate to self and distant others.

Several studies indicate that the SRE is maintained in older adults (Clarkson et al., 2025; Daley et al., 2020, 2024; Fields et al., 2021; Gutchess & Kensinger, 2018; Gutchess et al., 2007, 2015; Hamami et al., 2011; Leshikar et al., 2015; Mueller et al., 1986; Yang et al., 2012). However, most existing research contrasts self-encoding with semantic or celebrity-encoding, with fewer studies investigating close-other encoding. The extended self theory (Belk, 2016) proposes that individuals incorporate close relationships and possessions into their sense of self. However, empirical support for extended-self memory effects in older adults is limited. One study found both self- and friend-referential encoding benefited episodic memory in older adults (AiBao et al., 2015), and a related study on perceptual matching revealed that older adults showed a greater friend-over-stranger bias and a reduced self – friend distinction compared to younger adults (Sui & Humphreys, 2017). In young adults, friend-referential memory falls between self- and celebrity-referential memory (Kokici et al., 2023), suggesting that close others may function as an intermediate category within the broader self-concept. However, it remains an open question how differences in self-concept between young and older adults may influence referential memory effects (Lang, 2017).

Episodic memory entails the recollection of both content and context, including source memory, which refers to the ability to remember when or how information was originally encountered. Item and source memory are thought to rely on distinct neural and cognitive processes (Davachi et al., 2003; Glisky et al., 1995; Slotnick et al., 2003), though some argue for overlap (Guo et al., 2021). Source memory shows greater age-related decline than item memory (Glisky et al., 2001), highlighting the importance of distinguishing between the two. While SREs have been observed in source memory (Durbin et al., 2017; Serbun et al., 2011), the evidence is mixed and may depend on the valence of the stimuli (Kokici et al., 2023; Pereira et al., 2021). For example, Durbin et al. (Durbin et al., 2017) found that self-referential encoding improved source memory accuracy only for positive items, unlike general SREs identified in item memory (Kokici et al., 2023),

suggesting that item and source memory rely on at least partially distinct cognitive processes, at least concerning the interaction with emotion. Although item and source memory may dissociate at a general cognitive level, it remains unclear whether the self-referential biases observed in each reflect shared or distinct mechanisms. Previous research has found only weak correlations between self-biases across cognitive domains, suggesting the involvement of distinct underlying mechanisms (Amodeo et al., 2021; Nijhof et al., 2020). However, evidence regarding self-biases in different aspects of memory remains limited.

Memory performance alone may not fully reflect the quality of underlying memory representations. Second-order processes such as metacognition, thinking about one's own thinking, can dissociate from first-order performance (Besken & Mulligan, 2013; Hanczakowski et al., 2021). For instance, individuals may remember something accurately but report low confidence in their memory. Metacognitive sensitivity reflects the extent to which confidence ratings track actual memory performance, while metacognitive efficiency quantifies this relationship independent of first-order performance (Fleming & Lau, 2014; Maniscalco & Lau, 2012). Aging is associated with changes in metacognition, with some studies showing reduced metacognitive accuracy or overconfidence in older adults (Bender & Raz, 2012; Castel et al., 2012; Dodson et al., 2007; Palmer et al., 2014; Wong et al., 2012). However, metacognitive effects may be domain-specific (Rouault et al., 2018); for example, age-related declines are more evident in perceptual tasks than in memory tasks (Palmer et al., 2014). Previous studies of metacognition and self-referential encoding have typically employed feeling-of-knowing or judgment-of-learning paradigms, which assess predicted rather than actual performance. These paradigms indicate that self-referential encoding is associated with greater metacognitive accuracy (Boduroglu et al., 2015) and higher confidence in anticipated recall (Hou et al., 2024), but they are limited by reliance on predictive measures and stimulus-driven effects (Townsend & Heit, 2011). In our prior research, we demonstrated higher metacognitive sensitivity for self-referentially encoded items compared to celebrity-encoded items, with friend-referential encoding again occupying an intermediate position (Kokici et al., 2023). However, these effects appear to reflect differences in memory performance rather than metacognitive efficiency. That is, while self-referencing enhances both memory accuracy and confidence, it does not selectively enhance the alignment between confidence and accuracy. Whether similar patterns emerge in older adults remains an open question.

Emotional valence plays a central role in how memories are encoded, retrieved, and evaluated. Numerous studies have demonstrated that emotionally salient events, are more likely to be remembered than neutral events (Kensinger & Schacter, 2008). Importantly, the self-reference effect often co-occurs with emotional processing: self-relevant information in everyday life is rarely emotionally neutral. From a theoretical perspective, valence is not merely a confounding feature but a core dimension that shapes the structure and vividness of episodic memories. In particular, positively valenced self-referential information has been shown to elicit stronger memory performance than negative information (D'Argembeau et al., 2005; Sanz, 1996; Sedikides & Green, 2000), although evidence is less consistent for recognition memory (Durbin et al., 2017; Green et al., 2008; Hudson et al., 2020; Pauly et al., 2013; Pereira et al., 2021; Yang et al., 2012). Including valence in studies of self-referential processing is therefore not only ecologically valid, but also necessary for unpacking how different encoding mechanisms contribute to

memory performance. The issue of valence is even more pertinent in the context of aging. Older adults frequently exhibit a positivity bias in memory, prioritizing positive over negative or neutral information (Carstensen & Mikels, 2005; Charles et al., 2003; Mather & Carstensen, 2005). This bias has been linked to motivational shifts in socioemotional goals with age and has been proposed as a compensatory mechanism for emotional regulation (Carstensen & Mikels, 2005). However, recent work has questioned the consistency and boundary conditions of this effect (Fernandes et al., 2008; Grühn et al., 2005; Murphy & Isaacowitz, 2008). It remains unclear whether such positivity effects generalize across referents (e.g., self vs. others), and how they may shape not only memory accuracy but also subjective confidence in memory. Given that emotional and social information are tightly interwoven in everyday contexts, examining emotional valence alongside referential encoding allows for a more complete understanding of how affective and social-cognitive mechanisms interact to shape memory across the lifespan.

Finally, metacognitive monitoring may also be influenced by emotional valence. For example, positive content is often associated with increased confidence, regardless of actual accuracy (Kensinger, 2009). In aging, such patterns could lead to differential calibration of confidence for positive vs. negative memories, particularly when self-relevance is high. Investigating how valence modulates both memory performance and metacognitive sensitivity in young and older adults may thus provide key insights into age-related changes in memory quality, awareness, and emotional regulation.

Taken together, aging affects episodic memory, metacognition, and emotional biases, but these domains have rarely been examined together in a single paradigm. The current study investigates how self-, friend-, and celebrity-referential encoding influence item memory, source memory, and metacognitive monitoring in young and older adults. We also examine how emotional valence interacts with these encoding conditions. Based on prior findings, we hypothesize that self-referential encoding will yield superior memory performance relative to celebrity-referential encoding, with friend-referential encoding showing intermediate effects. This pattern is expected to emerge in both item memory and metacognitive sensitivity, though not necessarily in metacognitive efficiency, consistent with findings reported in younger adults (Kokici et al., 2023). Source memory is hypothesized to show a self-referential advantage, particularly for positively valenced items. Although older adults may show reduced memory performance overall, we expect them to retain the relative benefits of self- and friend-referential encoding, consistent with findings in younger populations.

Method

Participants

120 adults, sixty young (Mean age = 19.33 yrs, sd = 1.32, range = 18-24 yrs; 41 female) and sixty older adults (Mean age = 69.20, sd = 6.34, range = 60-84 yrs; 38 female) were recruited from The University of Kent research participation scheme and from the broader community between December 2021 and December 2022. The sample was sufficient to detect medium effects (cohen's f = 0.3) with an alpha of 0.05 and power = 0.90 (for analyses without exclusions) and 0.85 (for metacognitive efficiency analysis), as determined by a power analysis for a within-between interaction using an ANOVA, conducted

using WebPower (Zhang & Yuan, 2018). Large effects of encoding agent (self v friend v celebrity) were identified in our previous study in young adults (Kokici et al., 2023), but we powered for medium effect sizes to identify differences attributable to age group. Participants received course credit or a small monetary amount as compensation for their time. All participants self-reported that they were free from a current neurological or psychiatric condition, and all had normal or corrected-to-normal vision and spoke English fluently. The study was approved by the ethics committee within The School of Psychology at The University of Kent. All participants provided written consent.

Procedure

Testing was completed online using Qualtrics (https://www.qualtrics.com) for all questionnaires and Pavlovia (https://pavlovia.org) for the encoding and memory tasks. Participants were required to make judgments about themselves, a close friend, or a celebrity. We assessed incidental memory encoding, as participants were unaware that the study contained a memory test. All participants nominated a close friend, and their name was used as a prompt throughout the study. Prior to the encoding session, participants were asked how close they were to their friend and how familiar was Boris Johnson, both on a scale between 1 (not close/familiar) to 9 (very close/familiar). After the encoding session and prior to the memory recognition test, participants completed a visual perceptual task for approximately 5 minutes (results not reported here) to separate the encoding and recognition stages.

Memory task

In the encoding task, participants were presented with 60 adjectives and asked to respond on a 9-point scale from 1 (very inaccurate) to 9 (very accurate), how well the adjective described themselves, a close friend, or the UK Prime Minister (at the time of testing) – Boris Johnson (20 adjectives for each condition). The words were presented in a pseudo-random intermixed order. To control for potential order and familiarity effects, three counterbalanced randomizations were employed, such that items encoded in relation to the self in one condition were encoded in relation to a friend or celebrity in the corresponding conditions for other participants. All word lists were selected from Warriner and colleagues (2013) and each list and encoding condition (self, friend, celebrity) was matched for arousal and valence (10 positive and 10 negative words for each condition). All encoding was self-paced with no time limitations. Although the encoding task involved rating adjectives rather than recalling specific life events, we refer to the resulting memory performance as involving episodic memory because participants were later required to make item and source memory judgments about those specific encoding episodes. According to Tulving's (Tulving, 1985) framework, episodic memory entails the ability to retrieve contextually bound information from a specific moment in the past, a condition met in this task through judgments about which agent the word had been paired with during encoding. Thus, while the encoding content was semantic (i.e., trait adjectives), the retrieval demands implicate episodic processes involving contextual reinstatement and self-referential tagging.

In the recognition stage, the 60 encoded words and 60 additional distractor words (matched for valence and arousal), were randomized. Each word appeared in the center of the screen and participants were asked, "Do you remember this word?" and instructed to respond "Yes" or "No." Following this they were asked how confident they were in their decision from 1 (Not at all confident) to 9 (very confident). If participants had responded "Yes" that they do remember the word, they were asked a follow up question, "Who was the word in reference to?" Participants had to answer with either "Yourself," "Your Friend," or "Boris Johnson." The recognition stage was self-paced with no time restrictions.

Statistical analyses

All final analyses were completed in JASP (version 0.18.3, http://www.jasp-stats.org).

To estimate signal detection measures of item memory sensitivity (d'), metacognitive sensitivity (meta-d'), and metacognitive efficiency (meta-d'/d'), we employed the group-level hierarchical Bayesian model implemented in the HMeta-d toolbox (Fleming, 2017) in MATLAB R2021a. Specifically, we used the fit_meta_d_group function to compute estimates across participants for each of the three encoding conditions (self, friend, celebrity). Input data consisted of trial-wise accuracy and confidence ratings for each participant and condition. Confidence was rated on a 10-point scale and binned accordingly. For each condition, we compared target items specific to that encoding context (e.g., self-encoded words) against the same set of 60 distractor items. These data were aggregated into the format required by HMeta-d (a 2×10 matrix per participant and condition, representing the number of correct and incorrect responses at each confidence level).

We used the default priors provided by the toolbox and did not constrain group-level parameters. The model estimates group-level d' and meta-d' values for each condition, from which we derived metacognitive efficiency (meta-d'/d'). Although meta-d' is theoretically bounded at zero, when estimated using an unbounded maximum likelihood procedure it can return negative values. These negative values are considered estimation artifacts and were retained in the analysis to ensure consistency across participants. However, participants with extremely low memory sensitivity ($d' < 0.1$) in any condition were excluded from metacognitive efficiency analyses, as low first-order accuracy severely biases the M-ratio estimate (Fleming & Lau, 2014). This exclusion resulted in the removal of 19 participants (12 older adults, 7 younger adults).

Both metacognitive sensitivity and metacognitive efficiency were included to capture distinct aspects of metacognitive performance. Metacognitive sensitivity reflects the extent to which confidence judgments discriminate between correct and incorrect responses – that is, whether participants are more confident in correct answers than in errors. However, this measure is positively correlated with memory performance and does not account for differences in first-order accuracy. To address this limitation, we also examined metacognitive efficiency, which indexes the degree to which participants make optimal use of the available memory evidence when making confidence judgments, controlling for their memory sensitivity. This distinction is particularly important in aging research, where declines in memory performance may not be paralleled by declines in metacognitive monitoring. By including both metrics, we aimed to assess not only how well participants could monitor their memory, but also how efficiently they calibrated their confidence relative to their actual performance.

Source memory was calculated using first order sensitivity (d') as described for item memory. Mixed design ANOVAs were used as above. One younger adult was removed from the analysis due to a negative d' score, indicating a failure to understand the task. Six older adults were removed due to scoring zero in one of the item memory categories, thus rendering a source memory score impossible. Therefore, the total sample for the source memory analysis was 59 younger adults and 54 older adults.

The study employed mixed-design RM-ANOVAs to examine the effects of AGE GROUP (Young vs. Older Adults), AGENT (Self, Friend, Celebrity-encoded words), and VALENCE (Positive vs. Negative words) on a specific memory performance measure. Post hoc comparisons were conducted using Holm-corrected -values to control for multiple comparisons.

Inverted raincloud plots (Allen et al., 2021) were computed using ggplot2 in R (R Core Team, 2020) and are used throughout to display key results.

Results

Before examining our main memory outcomes, we first assessed whether participants' ratings of closeness to their selected friend or familiarity with the celebrity (Boris Johnson) were associated with self-reference effects in memory. Participants generally reported feeling very close to the friend selected for the study (= 8.33 out of 9). Likewise, Boris Johnson was rated as familiar (= 6.63 out of 9). Self-reference effects were operationalized as the difference in performance between the self condition and each comparison condition, computed by subtracting friend or celebrity scores from self scores. Closeness to the friend did not correlate with the self-reference effect (friend condition) for item memory, (58) = −0.14, = .27, or source memory, (58) = −0.07, = .57. Similarly, familiarity with Boris Johnson was not associated with the self-reference effect (celebrity condition) for item memory, (58) = −0.17, = .18, or source memory, (58) = 0.23, = .08.

Descriptive statistics for item memory, metacognitive sensitivity, metacognitive efficiency, and source memory are presented in Table 1.

Means and standard deviations across item memory, metacognitive sensitivity, metacognitive efficiency, and source memory, for young and older adults.

	Young Adults		Older Adults	
	Positive Mean (sd)	Negative Mean (sd)	Positive Mean (sd)	Negative Mean (sd)
Self	1.81 (0.78)	1.57 (0.69)	1.53 (0.68)	1.16 (0.64)
Friend	1.54 (0.70)	1.33 (0.57)	1.25 (0.58)	0.95 (0.55)
Celebrity	1.24 (0.75)	1.17 (0.56)	1.08 (0.52)	0.84 (0.46)
	Positive	Negative	Positive	Negative
Self	1.23 (1.15)	1.31 (1.17)	1.20 (1.07)	1.11 (0.89)
Friend	0.98 (1.04)	1.02 (0.96)	0.85 (0.83)	0.97 (0.78)
Celebrity	0.77 (1.05)	0.86 (0.93)	0.73 (0.67)	0.84 (0.62)
	Positive	Negative	Positive	Negative
Self	0.69 (0.48)	0.86 (0.59)	0.81 (0.59)	0.90 (0.54)
Friend	0.60 (0.55)	0.84 (0.68)	0.74 (0.75)	1.10 (0.89)
Celebrity	0.59 (0.66)	0.76 (0.82)	0.82 (0.71)	0.98 (0.73)
	Positive	Negative	Positive	Negative
Self	2.20 (0.81)	2.36 (0.89)	1.80 (0.82)	2.12 (0.85)
Friend	2.08 (0.72)	2.14 (0.86)	1.98 (0.65)	1.82 (0.83)
Celebrity	1.95 (0.86)	2.35 (0.87)	1.76 (0.69)	2.15 (0.69)

Item memory sensitivity (d')

In the complete sample of 60 younger and 60 older adults, a 2 (Age Group: younger, older) × 2 (Valence: positive, negative) × 3 (Agent: self, friend, celebrity) repeated-measures ANOVA was conducted on item memory sensitivity (d′). There were significant main effects of age group, agent, and valence. Younger adults showed greater memory sensitivity than older adults, $(1, 118) = 13.34$, $< .001$, $\eta p^2 = .10$. A main effect of agent was also observed, $(2, 236) = 49.93$, $< .001$, $\eta p^2 = .30$, reflecting a robust self-reference effect. Post hoc comparisons across the combined cohort indicated higher memory sensitivity for self-related words than both friend-related ($= 5.70$, $< .001$, $= 0.40$) and celebrity-related words ($= 9.96$, $< .001$, $= 0.69$), as well as a smaller friend-over-celebrity advantage ($= 4.26$, $< .001$, $= 0.30$). There was also a main effect of valence, $(1, 118) = 28.50$, $< .001$, $\eta p^2 = .19$, with higher memory sensitivity for positive compared to negative words.

None of the interaction terms reached significance. The age group × agent interaction was not significant, $(2, 236) = 0.82$, $= .44$, $\eta p^2 = .01$, nor were the valence × agent interaction, $(2, 236) = 2.49$, $= .09$, $\eta p^2 = .02$, or the valence × age group interaction, $(1, 118) = 2.16$, $= .14$, $\eta p^2 = .02$. The three-way interaction between valence, agent, and age group was also non-significant, $(2, 236) = 0.13$, $= .87$, $\eta p^2 < .01$. See Figure 1 for key results.

Metacognitive sensitivity

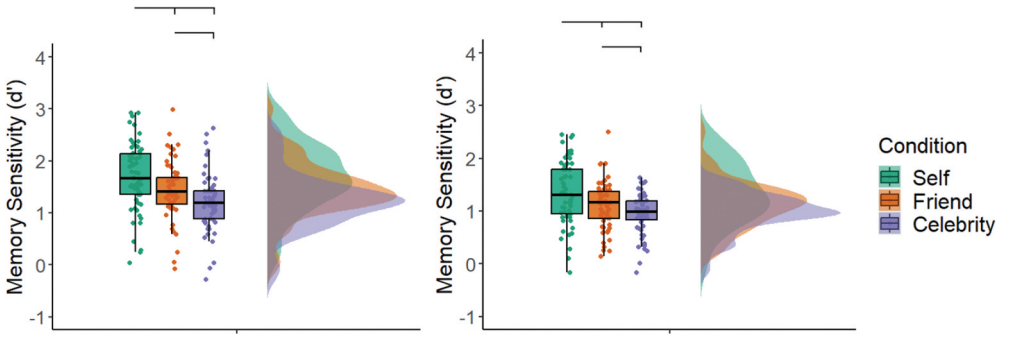
In the complete sample of 60 younger and 60 older adults, a 2 (Age Group: younger, older) × 2 (Valence: positive, negative) × 3 (Agent: self, friend, celebrity) repeated-measures ANOVA was conducted on metacognitive sensitivity (meta-d′). A significant main effect of agent was observed, $(1, 236) = 42.97$, $< .001$, $\eta p^2 = .27$, indicating that metacognitive sensitivity differed by encoding condition. In contrast, there was no main effect of age group, $(2, 118) = 0.27$, $= .60$, $\eta p^2 = .002$, and no main effect of valence, $(1, 118) = 1.79$, $= .18$, $\eta p^2 = .02$.

No significant interaction effects were identified. The age group × agent interaction was not significant, $(2, 236) = 0.54$, $= .59$, $\eta p^2 = .01$, nor were the interactions between age group and valence, $(1, 118) = 0.07$, $= .80$, $\eta p^2 < .001$, agent and valence, $(2, 236) = 1.19$, $= .31$, $\eta p^2 = .01$, or the three-way interaction among agent, valence, and age group, $(2, 236) = 1.85$, $= .16$, $\eta p^2 = .02$.

Post hoc comparisons across the combined cohort revealed significantly greater metacognitive sensitivity for self-encoded words compared to both friend-encoded ($= 5.71$, $< .001$, $= 0.27$) and celebrity-encoded words ($= 9.18$, $< .001$, $= 0.44$). A smaller but significant advantage was also observed for friend over celebrity-encoded words ($= 3.47$, $< .001$, $= 0.17$). See Figure 2 for visualization of results.

Metacognitive efficiency

In a reduced sample of 53 younger adults and 48 older adults, a 2 (Age Group: younger, older) × 2 (Valence: positive, negative) × 3 (Agent: self, friend, celebrity) repeated-measures ANOVA was conducted on metacognitive efficiency (meta-d′/d′). A significant



Item memory accuracy (d') for self, friend, and celebrity-encoded words for young (left) and older (right) adults. A self-referential effect was identified in comparison to both friend and celebrity encoded words. In addition, a friend-referential effect was identified in comparison to celebrity encoded words. Although overall memory performance was lower in older adults, the self-referential and friend-referential effects were comparable across the two age-groups. Boxplots represent the interquartile range and median and the whiskers extend to the furthest datapoint within 1.5 standard deviations from the mean. Distributions are also provided. Bars indicate significant differences between conditions.

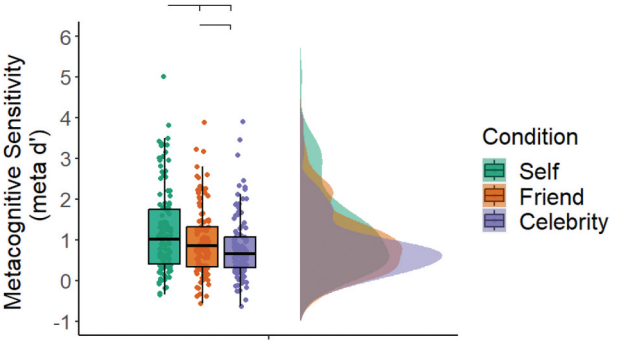
main effect of valence was observed, (2, 198) = 17.77, < .001, ηp^2 = .15, with greater metacognitive efficiency for negative words compared to positive words. In contrast, the main effects of age group and agent were not supported. The effect of age group was not supported, (1, 99) = 2.41, = .12, ηp^2 = .02, and no main effect of agent was found, (2, 198) = 0.45, = .64, ηp^2 = .005.

None of the interaction effects reached significance. There was no significant age group × agent interaction, (2, 198) = 1.99, = .14, ηp^2 = .02, nor an agent × valence interaction, (2, 198) = 2.81, = .06, ηp^2 = .03. Similarly, the age group × valence interaction was not significant, (1, 99) = 0.01, = .91, ηp^2 < .001, and there was no significant three-way interaction among age group, agent, and valence, (2, 198) = 0.90, = .41, ηp^2 = .009.

Source memory

In a reduced sample of 59 younger adults and 54 older adults, a 2 (Age Group: younger, older) × 2 (Valence: positive, negative) × 3 (Agent: self, friend, celebrity) repeated-measures ANOVA was conducted on source memory sensitivity. A main effect of age group was observed, (1, 111) = 4.55, = .04, ηp^2 = .04, with younger adults performing better than older adults. A significant main effect of valence was also identified, (2, 111) = 9.52, = .003, ηp^2 = .08, with higher source memory sensitivity for negative than positive words. However, no main effect of agent was found, (2, 222) = 2.56, = .08, ηp^2 = .02, and no significant age group × agent interaction, (2, 222) = 0.90, = .41, ηp^2 = .01. Likewise, there was no significant valence × age group interaction, (1, 111) = 0.02, = .89, ηp^2 < .001, nor a three-way interaction between age group, valence, and agent, (2, 222) = 2.19, = .11, ηp^2 = .02.

Importantly, the main effect of valence was subsumed under a significant valence × agent interaction, (2, 222) = 12.47, < .001, ηp^2 = .10. To follow up the significant



Metacognitive sensitivity for self-encoded words was higher than both friend and celebrity-encoded words across both young and older adults. Metacognitive sensitivity was higher for friend-encoded words compared with celebrity-encoded words. Boxplots represent the interquartile range and median and the whiskers extend to the furthest datapoint within 1.5 standard deviations from the mean. Distributions are also provided. Bars indicate significant differences.

Valence × Agent interaction, we conducted planned post hoc comparisons of Agent levels separately within each level of Valence, using Holm-corrected -values to control for multiple comparisons.

For positive words, a main effect of agent was found, $(2, 224) = 3.83$, $= .02$, $\eta p^2 = .03$. Post hoc t-tests indicated that both self-encoded ($= 2.16$, $= .07$, $= 0.20$) and friend-encoded words ($= 2.46$, $= .046$, $= 0.23$) were sourced with somewhat greater sensitivity than celebrity-encoded words, although the evidence for self compared to celebrity words did not reach significance. No difference was observed between self- and friend-encoded words ($= -0.36$, $= .72$, $= -0.05$).

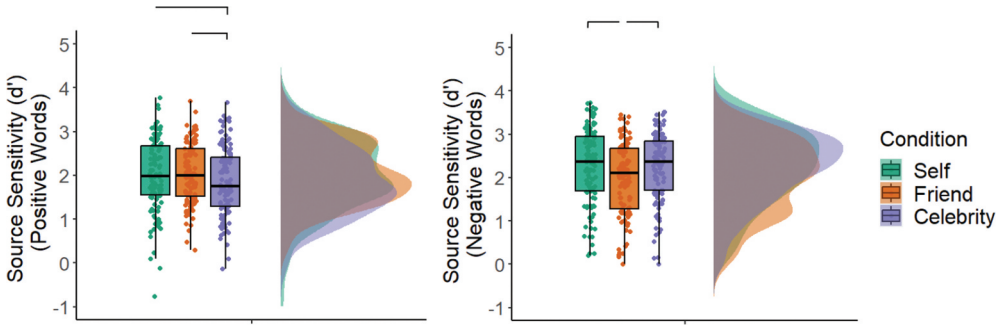
For negative words, a significant main effect of agent was observed, $(2, 224) = 10.49$, $< .001$, $\eta p^2 = .09$. Self-encoded words were sourced with greater sensitivity than friend-encoded words ($= 3.89$, $< .001$, $= 0.39$), and celebrity-encoded words were also sourced with greater sensitivity than friend-encoded words ($= -4.04$, $< .001$, $= -0.43$). No difference was found between self- and celebrity-encoded words ($= -0.22$, $= .83$, $= -0.01$). See Figure 3 for visualization of these effects.

Relationship between self-biases in item and source memory

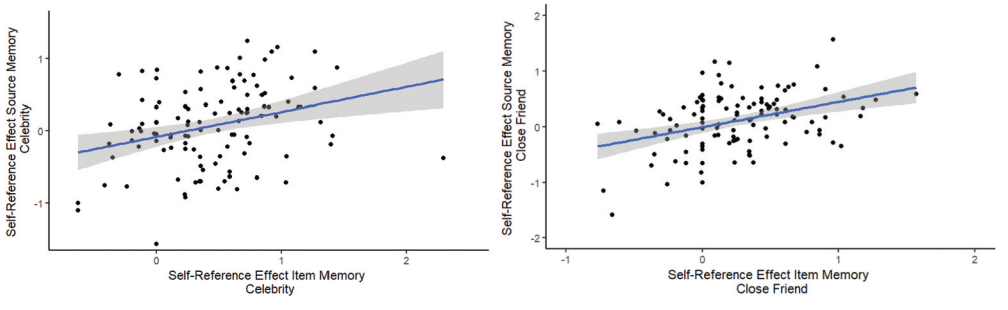
Self-referential biases in item and source memory were moderately correlated when compared against celebrity, $r(111) = 0.30$, $= .001$, or a close friend, $r(111) = 0.38$, $< .001$. See Figure 4.

Discussion

The aim of the present study was to investigate the self-reference effect in episodic memory, source memory, and the metacognitive monitoring of memory in healthy young and older adults. In sum, we show that despite reduced memory performance overall, a self-referential bias is maintained in older adults, and likewise for the intermediate friend-referential bias, when compared against items encoded in relation to



Source memory sensitivity for positive and negative words in the combined cohort of young and older adults. A self and friend-reference effect was supported for positive words, whereas, both self and celebrity-encoded negative words were sourced with greater accuracy. Boxplots represent the interquartile range and median and the whiskers extend to the furthest datapoint within 1.5 standard deviations from the mean. Distributions are also provided. Bars indicate significant differences between conditions.



Scatterplot showing the positive relationship between the self-referential effect in item and source memory when compared against both a celebrity (left) and a close friend (right). The blue line represents the line of best fit, and the grey shaded area represents the 95% confidence interval.

a celebrity. We also provide further evidence that the self-reference effect is observable in metacognitive sensitivity and novel evidence that this is maintained into advanced age. A similar pattern emerged for source memory, with reduced accuracy in older adults coupled with the same self-referential bias for positive encoded words. Finally, we show that self-referential biases in item and source memory rely on both common and unique cognitive processes.

Consistent with previous studies (Aron et al., 1991; Craik F & Lockhart R, 1972; Talmi, 2013), we demonstrate a robust self-reference effect for item memory, with better recognition for words encoded in relation to the self compared to a well-known celebrity. Extending this work, we also found that friend-encoded words conferred an intermediate memory advantage, greater than celebrity-encoded items but weaker than self-encoded ones, an effect that was preserved across both younger and older adults. This partially contrasts with earlier research reporting equivalent memory performance for self- and close-other encoding (Aron et al., 1991; Santiesteban et al., 2012), but aligns with findings suggesting a persistent self-referential advantage even relative to close others (Kokici et al., 2023). The intermediate friend-referencing effect observed here may reflect the

specific cognitive demands of the task, which required participants to explicitly evaluate personality traits in relation to themselves, a close friend, or a public figure. It is likely that participants found it easier or more intuitive to assess traits about themselves than to assess those traits in others, even those they feel close to.

These findings are consistent with theoretical models of the extended self, which propose that certain close others, such as romantic partners, family members, and close friends, are integrated into the self-concept and are processed with similar cognitive and motivational priority (Aron et al., 1991). This inclusion of close others in the self may account for the enhanced memory observed for friend-referenced material. However, the persistence of a self-reference advantage even over friend encoding suggests that the degree of self – other overlap may vary depending on both relationship closeness and the nature of the task. In the current study, the explicit nature of the adjective-judgment task, combined with the demands of source memory and metacognitive monitoring, may have required participants to make more fine-grained distinctions between representations of self and other, reducing the typical friend-referencing advantage found in simpler recognition tasks.

Additionally, our findings can be interpreted through the lens of source monitoring theory (Johnson et al., 1993), which posits that memory for the origin of information depends on the richness and accessibility of contextual features encoded with that information. Words encoded in relation to the self, likely benefited from more elaborate and distinctive internal cues, such as emotional salience or autobiographical relevance, enhancing both item and source memory. Friend-related encoding may have produced moderately rich contextual tags, while celebrity-related encoding likely involved more generic or semantic processing. The stability of self- and friend-referencing effects across age groups further suggests that these mechanisms of self – other differentiation and social memory remain functionally intact in healthy aging.

Evidence for aging effects on the metacognitive monitoring of memory are mixed with some studies showing impaired metacognitive monitoring (Guerrero-Sastoque et al., 2021; Sacher et al., 2013; Thomas et al., 2012), whilst other studies have shown comparable metacognitive monitoring performance across young and older adults (Froger et al., 2012; Hertzog & Hultsch, 2000; Perrotin & Isingrini, 2010; Souchay & Isingrini, 2004). We provide evidence for comparable metacognitive monitoring in older adults that also reflects self and close-other processing as observed in memory accuracy. The evidence against any self-referential or friend-referential effects for metacognitive efficiency suggests that second-order confidence judgments consistently matched first-order accuracy sensitivity across the self, friend, and celebrity encoding conditions. Although metacognitive efficiency did not differ across encoding conditions we did find strong support for greater efficiency for negative words in both young and older adults. This replicates previous evidence in young adults only (Kokici et al., 2023) and extends the evidence to include older adults. One possibility is that negative information is encoded with greater distinctiveness or receives enhanced cognitive elaboration, potentially supporting more accurate confidence judgments. The finding that metacognitive efficiency was preserved across age groups, and did not vary by referential condition, suggests that second-order monitoring processes may be more robust to age-related decline than first-order memory. This aligns with dual-process models of metacognition, in which confidence judgments may rely on heuristic cues or affective evaluations that are relatively preserved in aging

(Palmer et al., 2014). The enhanced efficiency for negative information further suggests that salience may play a stronger role in guiding metacognitive judgments than self-relevance per se.

Self and friend referential biases extended to source memory, although only weak evidence supported an effect specific to positively valanced items. Previous research, showing a self-referential effect on source memory, has focussed on action-related source memory (Rosa & Gutchess, 2011) or contextual details at the time of encoding (Leshikar & Duarte, 2012; Serbun et al., 2011). One explanation for the limited source memory effect in the current study is the nature of the encoding, namely considering the appropriateness of an adjective in relation to the self or another person. In the study by Rosa and Gutchess (Rosa & Gutchess, 2011), a self-referential advantage effect for source memory was identified when members of a triad had to perform or observe others perform an action (e.g., placing something in a suitcase). In the present study, participants were completing the task independently and simply reflecting on their opinion of their friend's or the celebrity's personality. Therefore, it could be that self-referential advantage in source memory is facilitated through interpersonal interaction or as suggested by the authors, that sensorimotor cues associated with the actions may aid memory and result in a self-reference effect in source memory. The results are consistent with previous research showing a self-referential bias in encoding only for positive items (Durbin et al., 2017). The source monitoring framework (Johnson et al., 1993) predicts that items that align with notions of the self will show a self-referential advantage. For example, when encoding adjectives attached to the self, such as "I am polite," these receive processing priority via top-down mechanisms through motivation to maintain a positive self-view (D'Argembeau & Van der Linden, 2008; Mezulis et al., 2004).

It should also be noted that although negative words did not benefit from a self-referential bias, source memory for negative words was more accurate across both self and celebrity encoding conditions. A negative bias in sourcing memories to the self has previously been identified in younger adults (Dent & Martin, 2023), and the current findings extend this effect to show it is consistent across both young and older adults. This suggests that, while there is a general positivity bias in memory encoding, favoring the retention of positive content, negative information may elicit deeper contextual processing, particularly when it relates to the self (Talmi, 2013). In other words, negative, self-relevant experiences may be more richly encoded in their context, possibly due to their emotional salience or their relevance to identity. The negativity bias observed for celebrity-encoded words may align with the source monitoring framework (Johnson et al., 1993), which proposes that the qualitative characteristics of memories, such as emotional tone, inform source attributions. A negative perception of politicians (Mutz, 2015) may have biased memory encoding toward negative information (Benjamin Ashton & Kal Munis, 2021). However, future research explicitly testing this hypothesis is required.

The interaction between valence and age was not observed in the current study for either item or source memory, despite prior research reporting a positivity bias in older adults' memory (e.g (Mather & Carstensen, 2005). According to Socioemotional Selectivity Theory (SST), older adults tend to prioritize emotionally meaningful and positive experiences due to a shift in motivational goals with age. This typically manifests as enhanced memory for positive over negative material. However, the absence of such an age-related positivity effect in our data suggests that this bias may not be universal and could depend

on contextual factors such as task demands, stimulus type, or encoding strategy. Previous research has shown task-specific positivity biases, especially in false positive memories (Fernandes et al., 2008). The use of sensitivity analyses correcting for false positives may explain the lack of positivity effect identified in the present study.

The results of the current study should be interpreted in context of several limitations. The study was completed online and whilst incentives were in place to motivate performance, lab-based experiments offer greater control. To more fully understand how self- and other-referential memory effects operate in naturalistic settings, future research would benefit from pairing these paradigms with detailed social network analyses. Such an approach would allow for assessment of memory and metacognitive performance across a range of close others varying in relationship type, emotional closeness, and social role. This would provide a more nuanced understanding of how self – other overlap modulates encoding and monitoring processes, and whether memory advantages generalize across different categories of close others beyond a single nominated friend. Whilst Boris Johnson was rated as highly familiar by most participants, future research may wish to include other celebrities or well-known individuals to assess similarities and differences across age-groups. Family members may show greater overlap with the self than close friends and should also be considered in future research. A potential confound in the current paradigm is the overlap between self-relevance and valence. Self-referential processing is typically accompanied by a positivity bias, such that individuals may reinterpret or downplay the negativity of traits when applied to themselves (Watson et al., 2007). As a result, even negative adjectives may be perceived as less aversive when self-referenced compared to when they are associated with another person. This could reduce the effective difference between positive and negative stimuli in the self condition, complicating interpretations of valence effects on memory or metacognition. Future work could address this by including subjective ratings of perceived valence across conditions or by matching words on self-relevance intensity. The study was completed by undergraduate students and a cohort of older adults from the area surrounding Canterbury, UK. A more diverse sample would improve generalizability. Longitudinal studies provide stronger evidence for cognitive change in older adults and should be considered in future research. It should also be noted that the study was completed during the Covid-19 pandemic, and this may have affected self-other cognitive processing. Although we show clear valence effects on memory, the absence of a neutral condition limits the ability to determine whether observed effects reflect emotion-related enhancements or impairments, and future studies should include neutral stimuli to better isolate the impact of valence.

In sum, we identified a self and friend referential effect in item memory with metacognitive judgments showing similar biases. We show biases in source memory consistent with a source monitoring framework that prioritizes information that we are motivated to remember. Despite reduced overall memory compared with young adults, older adults showed comparable self-referential and friend-referential biases as the younger adults across both item and source memory. These findings contribute to our understanding of how socioemotional memory systems are maintained in later life and highlight the importance of preserving self- and relationship-based memory processes, both for theoretical models of cognitive aging and for practical applications in contexts such as clinical assessment, caregiver relationships, and social interventions for older adults.

Acknowledgments

We would like to thank the participants for their time. We thank Frank Gasking for help with coding and running the experiment.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Open science statement and data availability

The analyses were not preregistered. All data and code are provided at https://osf.io/aydt5/

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