The role of attention in the emergence of the evaluative and incidental self-reference effects

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Abstract

The self-reference effect (SRE) is a memory advantage produced by encoding information in a self-relevant manner. The ‘evaluative’ SRE arises when people engage in explicit self-evaluation/reflection to process to-be-remembered items, while the ‘incidental’ SRE occurs when self-referential information (e.g., one’s own name) is co-presented with to-be-remembered items but is irrelevant to a given task. Using a divided-attention paradigm, the present study examined potential differences in the attentional requirements of the evaluative and incidental SREs. During encoding, personality-trait words were presented simultaneously with the participant’s own or a celebrity’s name. The participants’ task was either to evaluate whether each word described themselves/the celebrity (evaluative encoding) or to indicate the location of each word (incidental encoding), in the presence or absence of a secondary task. A subsequent recognition test with a remember/know procedure showed better overall recognition and enhanced episodic recollection for words presented with one’s own name vs. another name, with this SRE being larger in the evaluative than incidental encoding condition. Critically, divided attention at encoding attenuated the magnitudes of both evaluative and incidental SREs to a comparable degree in overall recognition and episodic recollection. These findings suggest that both the evaluative and incidental SREs are resource-demanding, effortful mnemonic benefits.

The role of attention in the emergence of the evaluative and incidental self-reference effects

Encoding information in a self-relevant manner produces a memory advantage over other kinds of encoding processes, a phenomenon termed the self-reference effect (SRE; Rogers et al., 1977; for review, see Symons & Johnson, 1997). The SRE has typically been observed following an encoding task that explicitly requires people to evaluate some, but not other, stimuli in relation to themselves. For instance, the most widely used self-referencing paradigm requires participants to judge whether personality-trait words are characteristic of themselves or another person (e.g., "*Does 'honest' describe you [a celebrity]?*"), and words judged in reference to oneself are later better remembered than those judged in reference to another person (e.g., Conway & Dewhurst, 1995; Kuiper & Rogers, 1979, Maki & McCaul, 1985). Encoding tasks like this trait-evaluation task require people to engage in explicit self-evaluation/reflection in order to determine the self-relevancy of incoming stimuli, and as such, the SRE resulting from such explicit, evaluative self-referencing tasks is sometimes referred to as the 'evaluative' SRE.

The evaluative SRE is thought to arise from enhanced elaboration and organization of incoming information, afforded by the use of a rich body of episodic and semantic self-knowledge to scaffold the information (Conway & Dewhurst, 1995; Klein & Loftus, 1988; Symons & Johnson, 1997). Indeed, the evaluative SRE is characterized by strong recollective characteristics, reflecting more elaborate memory representations of items encoded self-referentially vs. other-referentially. For example, using a trait-evaluation task in combination with the "remember-know" procedure (Tulving, 1985) as a subjective measure of recollection vs. familiarity (Jacoby, 1991; Mandler, 1980), Conway and colleagues (Conway & Dewhurst, 1995; Conway et al., 2001) found that the evaluative SRE only emerged in recognition judgments accompanied by recollection of contextual details of the encoding episode (i.e., "remember" responses) but not in recognition based on a feeling of familiarity without any recollection (i.e., "know" responses). Leshikar et al. (2015) replicated and extended these findings in both subjective (i.e., "remember" responses, self-reported amount of episodic details remembered) and objective measures of recollection (i.e., memory for contextual features associated with an encoding episode [source memory]; Johnson et al., 1993).

Notably, moving beyond the evaluative self-referencing tasks, more recent studies on the role of the self in memory have shown that the SRE can emerge in the absence of explicit self-evaluation/reflection (e.g., Cloutier & Macrae, 2008; Cunningham et al., 2008; Turk et al., 2008). Of particular relevance to the present investigation is the work by Turk et al. (2008). In this study, participants were shown personality-trait words appearing above or below a self-relevant or other-relevant cue (i.e., the participant's own or a celebrity's name or face), and were asked to judge whether each word was descriptive of the person represented by the cue (evaluative encoding) or whether each word appeared above the cue (incidental encoding). In a subsequent recognition test, the evaluative encoding task produced a typical evaluative SRE, with better memory for words judged in reference to oneself vs. the celebrity. More importantly, the incidental encoding task also produced a SRE, with better memory for words co-presented with the self-relevant vs. other-relevant cue, albeit to a lesser extent than did the evaluative encoding task. This latter kind of the SRE arising from a simultaneous presentation of stimuli with a self-relevant cue under an encoding context in which the identity/self-relevance of the cue is irrelevant to the task at hand is referred to as the ‘incidental’ SRE. The incidental SRE has been replicated and extended in subsequent studies with children and adults (Cunningham et al., 2014; Hutchison et al., 2021; Jeon et al., 2021; Kim et al., 2018, 2019; Ross et al., 2020).

Compared to the evaluative SRE requiring recourse to one’s self-knowledge structures, the incidental SRE is proposed to be underpinned by relatively lower-level, attentional processes: Self-relevant information tends to automatically capture/hold attention (e.g., Alexopoulos et al., 2012; Bargh, 1982; Gray et al., 2004; H. Yang et al., 2013; but see Gronau et al., 2003; Harris & Pashler, 2004; Kawahara & Yamada, 2004), and this transient increase in attentional resources is in turn suggested to facilitate the encoding of stimuli co-occurring with self-relevant vs. other-relevant information (Cunningham et al., 2014; Turk et al., 2008; see also Kim et al., 2019 for task-context-dependent modulation of the incidental SRE). The incidental SRE has been reliably found not only in recognition of the to-be-remembered items themselves but also in recollection of source features associated with the items (e.g., remembering that an item was presented with one’s own face/name) (Andrews et al., 2020; Cunningham et al., 2014; Hutchison et al., 2021; Kim et al., 2019; Ross et al., 2021), indicating more elaborate memory representations of items encoded alongside self-relevant vs. other-relevant information.

Elaborative or “deep” processing (Gardiner, 1988; Mäntylä, 1997; Rajaram, 1993) as well as undivided, full attention at encoding (Gardiner et al., 2001; Gardiner & Parkin, 1990; Yonelinas, 2002) have been shown to increase recollection but not familiarity. In addition, elaborative processing tends to be cognitively effortful in nature, as shown by its high susceptibility to disruptions by secondary tasks under dual-task divided-attention conditions (Craik et al., 1996; Mulligan, 2008). Given the close relationship among elaborative processing, recollection, and the availability of attentional resources at encoding, the enhanced recollective experience for items encoded in an evaluatively or incidentally self-relevant context, together with the distinct cognitive processes proposed to underlie the evaluative vs. incidental SREs, raises an important question of whether these two types of self-related memory advantages are differentially reliant on resource-intensive, controlled processes vs. relatively more effortless, automatic processes during encoding. Do both types of SREs represent resource-demanding, cognitively effortful mnemonic advantages? Is one type of SRE more cognitively effortful than the other?

For the evaluative SRE, we are aware of only one previous study that directly examined its attentional requirement: Using a divided-attention paradigm in combination with a trait-evaluation task with both young and older participants, L. Yang et al. (2012) showed that the magnitudes of the evaluative SRE in both recall and recognition did not significantly vary with the division of attention during encoding or aging, providing initial evidence that self-referential encoding processes that give rise to the evaluative SRE may occur spontaneously and effortlessly, requiring little or no attentional resources. L. Yang et al. suggested that self-referential processing may have become exceptionally efficient because people habitually use it in their daily life as a default mode of information processing (see also Symons & Johnson, 1997; Tacikowski et al., 2017). A more recent study by Jackson et al. (2019), however, provided indirect evidence for the resource-demanding nature of evaluative self-referential processing by showing that the magnitude of the evaluative SRE was significantly reduced when participants engaged in self-oriented writing (i.e., describing oneself or a specific event from one's personal past) vs. non-self-oriented writing (i.e., describing a specific visual scene) just prior to completing the trait-evaluation task. Although this study did not directly manipulate the availability attentional resources during self-referential encoding, its findings nonetheless suggest that self-referential encoding processes giving rise to the evaluative SRE may require limited-capacity cognitive resources that support activation of episodic/semantic self-knowledge.

To our knowledge, no study to date has directly investigated the attentional requirement of the incidental SRE. Yet, a related study by Turk et al. (2013) on the ownership-induced SRE (i.e., better memory for items imagined to belong to oneself vs. another person) suggests a possibility that sufficient attentional resources at encoding may be necessary for the incidental SRE to emerge. Specifically, in this study, participants performed an imagined ownership task in which they were asked to categorize items as "self-owned" vs. "other-owned" based on a cue, either in the presence or absence of a secondary task in which they were asked to monitor a series of visually presented digits, and after every six trials, to report either how many even digits had appeared in the preceding six digits (the easy condition) or the exact order of the preceding six digits (the difficult condition). Turk et al. showed that regardless of the difficulty of the secondary task, divided attention at encoding led to a complete abolishment of the ownership-induced SRE in both overall recognition and episodic recollection, by selectively impairing memory for "self-owned" items vs. "other-owned" items. These findings suggest that this kind of the non-self-evaluative SRE critically relies on effortful, resource-intensive elaborative encoding processes that can only occur when sufficient attentional resources are available (see also Turk et al., 2011 for the attention-grabbing property of self- vs. other-ownership cues). Despite a commonality that neither task requires explicit self-evaluation/reflection, the imagined ownership task in which self-relevance (i.e., self-owned vs. other-owned) serves as a key task-relevant feature is critically different from the afore-described incidental SRE task in which the presence of a self-relevant cue (i.e., one's name or face) is purely incidental and completely irrelevant to the task at hand. Thus, it remains to be empirically determined whether the incidental SRE represents a resource-intensive, cognitively effortful mnemonic advantage as does the ownership-induced SRE.

By directly examining potential differences in the attentional requirements of the evaluative and incidental SREs, in the present study, we sought to further elucidate the nature of encoding operations through which the self exerts its influence on memory. During encoding, participants were shown personality-trait words simultaneously with a name (the participant's own or a celebrity's name). Their task was to judge either the self/other-descriptiveness of each word (evaluative encoding) or the location of each word (incidental encoding), in the presence or absence of a secondary task (divided vs. full attention) (adapted from Turk et al., 2008; 2013). Participants' memory for target words was subsequently tested using a surprise recognition test with the remember/know procedure.

Given limited and mixed findings on the cognitively effortful vs. relatively spontaneous, effortless nature of the evaluative and incidental SREs, we refrained from formulating specific hypothesis regarding whether there would be differential attentional requirements for these two different kinds of self-memory advantages. Instead, we expected to observe one of the following informative patterns of results: (a) if both the evaluative and incidental SREs mainly rely on effortful, resource-intensive encoding processes, then the magnitudes of these SREs would be attenuated or even eliminated under divided attention compared to full attention, producing an interaction between "referent" (self vs. other) and "attention" (full vs. divided) factors. Alternatively, (b) if both SREs mainly arise from effortless, relatively automatic encoding processes, then their magnitudes would not significantly vary according to the availability of attentional resources during encoding, revealing a main effect of "referent" in the absence of a "referent" × "attention" interaction. Finally, (c) if the attentional requirements of the evaluative and incidental SREs significantly differ from one another, this would be manifested by a three-way interaction between "referent", "attention", and "encoding" (evaluative vs. incidental) factors. Based on previous findings showing greater sensitivity of recollection vs. familiarity to the availability of attentional resources at encoding (e.g., Gardiner & Parkin, 1990; Jennings & Jacoby, 1993), we further expected that the impact of divided attention during encoding on the SREs, if any, would be especially pronounced for recognitions accompanied by "remember" responses rather than "know" responses.

Method

Participants and Study Design

Two hundred undergraduate students (136 female; mean age = 19.32 [*SD* = 1.33] years) participated in exchange for course credit or payment. All participants were primary English speakers and had normal or corrected-to-normal vision and normal color perception. Informed consent was obtained from each participant in accordance with the human subject regulations of Wesleyan University. Data from five additional participants were excluded from analysis due to poor performance on the encoding task (responding to less than 50% of the trials [$n = 1$ from the evaluative encoding], achieving less than 50% accuracy [$n = 1$ from the incidental encoding], or both [$n = 3$ from the incidental encoding]).

The experiment had a 2 (Referent: Self or Other) × 2 (Encoding: Evaluative or Incidental) × 2 (Attention: Full or Divided) mixed factorial design with Referent as a within-subjects factor and both Encoding and Attention as between-subjects factors. A sample size of 50 in each of the 2 (Encoding) × 2 (Attention) combinations of the conditions was predetermined based on the effect sizes previously reported for the evaluative SRE ($dz = 0.50$; Symons & Johnson, 1997) and the incidental SRE ($dz = 0.44 – 0.53$; Kim et al., 2018, 2019; Turk et al., 2008) in recognition memory, using G*Power (Faul et al., 2007; $dz = 0.44$, $\alpha = .05$ [two-tailed], power = 0.8, required

N = 43). To test both (a) whether memory for self-referent vs. other-referent materials was differently affected by the full vs. divided attention (i.e., Referent × Attention interaction) and (b) whether the magnitudes of the evaluative and incidental SREs were differentially modulated by the attention manipulation (i.e., Referent × Encoding × Attention interaction), this sample size afforded over 85% power to detect a small-to-medium effect size (i.e., f = 0.175 [*d* = 0.35]; PANGEA, v. 0.2; Westfall, 2015).

Stimuli

A total of 126 personality-trait adjectives (e.g., cheerful, honest) drawn from N. H. Anderson (1968) were divided into three lists of 42 words each that were matched for likeability and meaningfulness based on N. H. Anderson's (1968) norms, all *F*s ≤ 0.17, all *p*s ≥ .85, all $BF_{Inclusion}$s ≤ 0.09, as well as for word length and syllable length, all *F*s ≤ 0.28, all *p*s ≥ .76, all $BF_{Inclusion}$s ≤ 0.10. The first two lists served as critical items that were presented in the encoding phase (i.e., "old" items). The assignment of these critical lists to the self-referent or other-referent condition was counterbalanced across participants. During encoding, a random half of the critical words in each Referent condition were presented above and the other half were presented below a name (the participant's own or someone else's). The remaining list served as foils in the subsequent memory test (i.e., "new" items).

The name stimuli consisted of each participant's own full name and the name of a gender-congruent familiar celebrity (i.e., Angelina Jolie or Hugh Jackman).

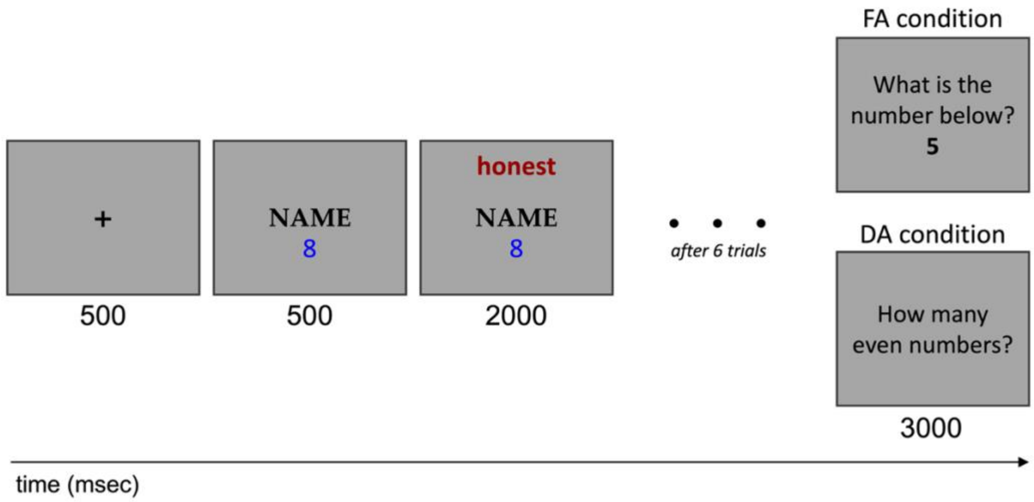
Procedure

The experiment was conducted online via a website specifically designed for the present study, and all participants completed the experiment individually in a single study session conducted over Zoom video conferencing software. Participants first provided informed consent electronically. Then, they were guided through each phase of the experiment with verbal instructions read by an experimenter. The experiment had the following two phases:

Encoding. A schematic view of the encoding phase is shown in Figure 1. Each trial began with a fixation cross presented in the center of the screen for 500 ms. Then, a name (either the participant's own name or that of a gender-congruent celebrity) was presented in black uppercase letters in the center of the screen for 2500 ms, along with a single digit presented closely beneath the name in blue. Five-hundred ms after the onset of the name and the digit, a personality-trait word was presented either above or below the name in red lowercase letters for 2000 ms. In the evaluative encoding condition, participants were asked to judge whether or not each word described the person whose name appeared on the screen (i.e., the self or the celebrity), by pressing "Y (yes)" or "N (no)" key on their keyboards, respectively. In the incidental encoding condition, participants were asked to indicate whether or not each word appeared above the name in the middle, by using the same "Y" and "N" keys. Across both encoding conditions, the participants in the full attention condition were asked to ignore the digits presented beneath a name, and after every six trials, to simply copy a given digit that would appear on the screen. In comparison, those in the divided attention condition were asked to closely monitor the digits presented beneath a name, and after every six trials, to report how many even digits had appeared

Figure 1

A schematic view of the encoding phase. FA = full attention; DA = divided attention.



in the preceding six trials. All participants were presented with exactly the same series of digits, and in both the full and divided attention conditions, participants were given 3 s to type in their numerical responses. The order of self-referent and other-referent trials (42 trials each) were randomly determined for each participant.

Recognition Test with Remember/Know/Guess Judgments. Immediately following the encoding phase, participants underwent a surprise recognition test. The 84 “old” words from the encoding phase along with the 42 “new” words were presented individually in black lowercase letters in the center of the screen. For each word, participants were first asked to indicate whether or not they had previously seen the word, by pressing “O (old)” or “N (new)” key on their keyboard. If the participants indicated that a word was “old”, they were further asked to specify the basis of their recognition decision. Specifically, participants were asked to give a “remember” response if they could consciously recollect any specific details associated with their previous encounter with the word (e.g., the word’s spatial location on the screen, the name with which the word was presented, their response to the word in the encoding phase, etc.). In comparison, they were asked to give a “know” response if they were confident that they saw the word in the preceding encoding phase but could not recollect any specific details associated with their prior encounter with the word. Finally, they were asked to give a “guess” response if they had no clue if the word had appeared previously but simply guessed that the word was old. It was emphasized to the participants that the distinction between remember vs. know judgments is not equivalent to the distinction between high vs. low confidence/certainty. To indicate “remember”, “know”, and “guess” judgments, participants pressed “R”, “K”, and “G” keys, respectively. For both old/new recognition and remember/know/guess judgments, participants were allowed as much time as they needed to make their judgments.[1]

After the recognition test, participants completed a post-experimental questionnaire that assessed whether they knew the celebrity who served as the "other" referent, if they had any guesses concerning the hypothesis of the study, and if they had any difficulty seeing stimuli on their computer monitor during the study. All participants indicated they knew their respective celebrity, and none correctly guessed the experimental hypothesis or reported having experienced difficulty seeing stimuli during the study. Following completion of the questionnaire, participants were debriefed and thanked for their participation.

Statistical Analyses

We conducted both frequentist and Bayesian analyses using JASP statistical software (JASP Team, 2022, version 0.16.3). The latter was used to quantify and evaluate the strength of evidence for the presence or absence of any effects of interest. For frequentist analyses, an alpha level of .05 was used as the criterion for statistical significance, and we report partial eta-squared (η_p^2) values and Cohen's *d*s, respectively, for analyses of variance (ANOVAs) and t-tests, as measures of effect sizes.

For each of the frequentist analyses performed, we report the associated Bayes factor (BF) which expresses an odds ratio of evidence for vs. against the null hypothesis (H_0). BF_{10} represents the relative likelihood of the alternative hypothesis (H_1) over H_0, whereas its reverse, BF_{01} (i.e., $1/BF_{10}$), represents the relative likelihood of H_0 over H_1. For example, a BF_{10} value of *x* indicates that the data are *x* times more likely under H_1 than under H_0. Although BFs are to be interpreted as continuous values, a conventional rule-of-thumb classification scheme (Jeffreys, 1961; Kass & Raftery, 1995) provides the following guidelines for interpretation: "No" evidence (i.e., the data are equally likely under H_1 and H_0) when BF = 1, "weak/anecdotal" evidence when $1 < BF \leq 3$, "substantial" evidence when $3 < BF \leq 10$, "strong" evidence when $10 < BF \leq 30$, "very strong" evidence when $30 < BF \leq 100$, and "decisive" evidence when $BF > 100$.

Bayesian analyses were conducted using default "objective" priors (i.e., Cauchy prior with width of 0.707; Rouder et al., 2017; Rouder et al., 2009; Wagenmakers et al., 2018). 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 compared to matched models without the factor.

Results

Performance on the Divided-Attention Task

In both the evaluative and incidental encoding conditions, participants' accuracy on the secondary divided-attention task (i.e., digit monitoring) was calculated as the proportion of

[1] A response deadline at test has been shown to decrease recollection, a relatively slower process (Düzel et al., 1997; Woodruff et al., 2006), while leaving familiarity largely unaffected (e.g., Benjamin & Craik, 2001; Yonelinas & Jacoby, 1994). Given our specific focus on examining attentional demands of self-related *encoding* processes giving rise to the evaluative and incidental SREs, we chose not to impose a response deadline during the memory test.

correct responses (i.e., the number of times that the participant correctly answered how many even digits had appeared in the preceding six trials, out of the total number of 14 digit-probe trials). The mean response time was calculated based on correct responses only. Independent-samples t-tests showed that participants' performance did not significantly differ between the evaluative and incidental encoding conditions for both accuracy (evaluative: M = .86 [SD = .14] vs. incidental: M = .88 [SD = .15]), $t(98) = 0.64$, $p = .53$, $BF_{10} = 0.25$, and response times (evaluative: M = 1259.79 ms [SD = 292.27 ms] vs. incidental: M = 1290.66 ms [SD = 253.51 ms]), $t(98) = 0.56$, $p = .57$, $BF_{10} = 0.24$. These results indicate that equivalent performance on the concurrent digit-monitoring task was maintained across the two encoding conditions.

Overall Recognition

Table 1 presents hit rates (i.e., the proportion of old words correctly recognized as "old") and false-alarm rates (i.e., the proportion of new words incorrectly judged as "old"). Corrected hit rates were calculated by subtracting false-alarm rates from hit rates, and were submitted to a 2 (Referent: Self or Other) × 2 (Encoding: Evaluative or Incidental) × 2 (Attention: Full or Divided) mixed-model ANOVA[2] (Figure 2A). There were significant main effects of Referent, Encoding, and Attention, all $F(1, 196)$s ≥ 23.35, all ps < .001, all η_p^2s ≥ .11, all $BF_{Inclusion}$s ≥ 5892.29, such that participants correctly recognized more words in the self-referent (M = .41, SD = .23) vs. other-referent condition (M = .33, SD = .18), in the evaluative encoding (M = .52, SD = .16) vs. incidental encoding condition (M = .22, SD = .12), and under full attention (M = .42, SD = .21) vs. divided attention (M = .33, SD = .20).

There was also a significant Referent × Encoding interaction, $F(1, 196) = 22.06$, $p < .001$, $\eta_p^2 = .10$, $BF_{Inclusion} = 7728.44$. Simple effects analysis using paired- and independent-samples t-tests revealed that while memory was significantly better for self-referent words than for other-referent words in both the evaluative encoding (self-referent: M = .58 [SD = .18] vs. other-referent: M = .46 [SD = .14]), $t(99) = 9.57$, $p < .001$, $d = 0.96$, $BF_{10} = 6.81 \times 10^{12}$, and incidental encoding conditions (self-referent: M = .25 [SD = .14] vs. other-referent: M = .20 [SD = .11]), $t(99) = 4.24$, $p < .001$, $d = 0.42$, $BF_{10} = 342.32$, the magnitude of this SRE was significantly larger in the evaluative encoding vs. incidental encoding condition, $t(198) = 4.65$, $p < .001$, $d = 0.66$, $BF_{10} = 2588.11$.

In addition, of primary interest, a significant Referent × Attention interaction was observed, $F(1, 196) = 6.22$, $p = .013$, $\eta_p^2 = .03$, $BF_{Inclusion} = 8.20$. Simple effects analysis using paired- and independent-samples t-tests showed that while memory was significantly better for self-referent words than other-referent words under both full attention (self-referent: M = .47 [SD = .23] vs. other-referent: M = .37 [SD = .18]), $t(99) = 7.95$, $p < .001$, $d = 0.80$, $BF_{10} = 2.63 \times 10^9$, and divided attention (self-referent: M = .36 [SD = .22] vs. other-referent: M = .30 [SD = .18]), $t(99) = 5.62$, $p < .001$, $d = 0.56$, $BF_{10} = 72339.84$, the magnitude of this SRE was significantly larger under full attention than divided attention, $t(198) = 2.38$, $p = .018$, $d = 0.34$, $BF_{10} = 2.11$.

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[2] A parallel set of analyses using d-prime (d') as the dependent measure yielded exactly the same pattern of significant and nonsignificant effects.

Table 1

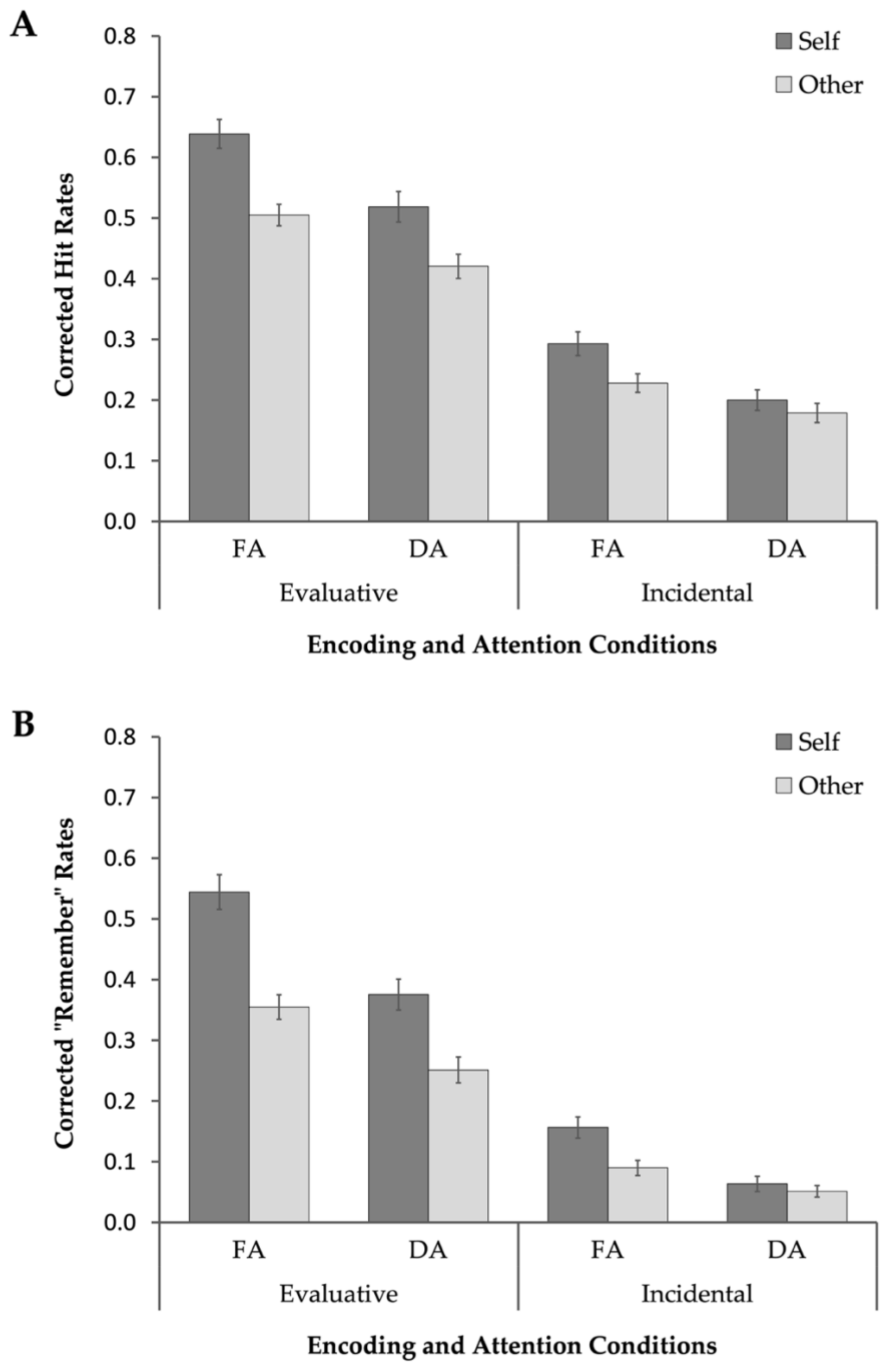
Mean uncorrected hit and false-alarm rates (standard deviation) as a function of Referent, Encoding, and Attention conditions.

	Evaluative		Incidental	
	Self	Other	Self	Other
Hit Rates				
Overall Recognition				
FA	.81 (.13)	.68 (.15)	.61 (.20)	.54 (.18)
DA	.77 (.17)	.67 (.16)	.47 (.16)	.44 (.18)
Remember				
FA	.59 (.20)	.40 (.15)	.20 (.15)	.14 (.13)
DA	.44 (.18)	.32 (.19)	.09 (.09)	.08 (.07)
Know				
FA	.09 (.08)	.13 (.10)	.20 (.08)	.23 (.09)
DA	.14 (.07)	.20 (.10)	.19 (.10)	.21 (.10)
Guess				
FA	.13 (.11)	.14 (.09)	.20 (.14)	.18 (.18)
DA	.18 (.12)	.16 (.11)	.18 (.13)	.15 (.12)
False-Alarm Rates				
Overall Recognition				
FA	.17 (.13)		.31 (.18)	
DA	.25 (.15)		.27 (.14)	
Remember				
FA	.05 (.05)		.05 (.06)	
DA	.07 (.09)		.03 (.04)	
Know				
FA	.05 (.05)		.07 (.06)	
DA	.08 (.07)		.06 (.06)	
Guess				
FA	.08 (.07)		.19 (.16)	
DA	.10 (.08)		.18 (.11)	

Note. FA = full attention; DA = divided attention. There were no separate false-alarm rates per each referent condition in each of the 2 (Encoding) × 2 (Attention) combinations of conditions, as “new” items did not belong to a referent condition.

Figure 2

(A) Overall recognition and (B) episodic recollection as a function of Referent, Encoding, and Attention conditions. Error bars represent standard error of the mean. FA = full attention; DA = divided attention.



This reduction of the self-memory advantage in overall recognition under divided vs. full attention appeared to arise due to a relatively larger recognition decrement under divided attention for self-relevant words (*M* = .11, *SD* = .21) than for other-relevant items (*M* = .07, *SD* = .18), although this comparison did not reach statistical significance, $t(198) = 1.40$, $p = .16$, $BF_{10} = 0.38$.

Neither the Encoding × Attention interaction, $F(1, 196) = 0.74$, $p = .39$, $BF_{Inclusion} = 0.12$, nor the Referent × Encoding × Attention interaction, $F(1, 196) = 0.53$, $p = .82$, $BF_{Inclusion} = 0.21$, was statistically significant.

“Remember” Responses

Participants’ corrected remember rates were calculated by subtracting “remember” false-alarm rates (i.e., the proportion of new words given a “remember” response) from “remember” hit rates (i.e., the proportion of old words given a “remember” response) (see Table 1 and Figure 2B). A 2 (Referent: Self or Other) × 2 (Encoding: Evaluative or Incidental) × 2 (Attention: Full or Divided) mixed-model ANOVA
conducted on the corrected remember rates revealed significant main effects of Referent, Encoding, and Attention, all $F(1, 196)$s ≥ 34.25, all *p*s ≤ .001, all η_p^2s ≥ .15, all $BF_{Inclusion}$s ≥ 4.90×10^5, such that remember rates were significantly higher in the self-referent (*M* = .28, *SD* = .24) vs. other-referent condition (*M* = .19, *SD* = .17), in the evaluative encoding (*M* = .38, *SD* = .18) vs. incidental encoding condition (*M* = .09, *SD* = .10), and under full attention (*M* = .29, *SD* = .22) vs. divided attention (*M* = .19, *SD* = .18).

There was also a significant Referent × Encoding interaction, $F(1, 196) = 41.18$, $p < .001$, $\eta_p^2 = .17$, $BF_{Inclusion} = 1.33 \times 10^7$. Simple effects analysis using paired- and independent-samples t-tests showed that while remember rates were significantly higher for self-referent words than for other-referent words in both the evaluative encoding (self-referent: *M* = .46 [*SD* = .21] vs. other-referent: *M* = .30 [*SD* = .16]), $t(99) = 10.04$, $p < .001$, $d = 1.00$, $BF_{10} = 6.56 \times 10^{13}$, and incidental encoding conditions (self-referent: *M* = .11 [*SD* = .12] vs. other-referent: *M* = .07 [*SD* = .08]), $t(99) = 3.83$, $p < .001$, $d = 0.38$, $BF_{10} = 86.05$, the magnitude of this SRE was significantly larger in the evaluative encoding vs. incidental encoding condition, $t(171.137) = 6.28$, $p < .001$ (corrected for non-equal variances), $d = 0.89$, $BF_{10} = 4.52 \times 10^6$.

In addition, a significant Referent × Attention interaction was observed, $F(1, 196) = 10.50$, $p = .001$, $\eta_p^2 = .05$, $BF_{Inclusion} = 24.30$. Simple effects analysis using paired- and independent-samples t-tests showed that while remember rates were significantly higher for self-referent words than for other-referent words under both full attention (self-referent: *M* = .35 [*SD* = .26] vs. other-referent: *M* = .22 [*SD* = .18]), $t(99) = 8.29$, $p < .001$, $d = 0.83$, $BF_{10} = 1.35 \times 10^{10}$, and divided attention (self-referent: *M* = .22 [*SD* = .21] vs. other-referent: *M* = .15 [*SD* = .15]), $t(99) = 5.34$, $p < .001$, $d = 0.53$, $BF_{10} = 2.23 \times 10^4$, the magnitude of this SRE was significantly larger under full attention than divided attention, $t(191.639) = 2.96$, $p = .003$ (corrected for non-equal variances), $d = 0.42$, $BF_{10} = 8.78$. This reduction of the self-memory advantage in episodic recollection under divided vs. full attention was due to a significantly larger decrease in remember responses under divided attention for self-relevant words (*M* = .13, *SD* = .20) than for other-relevant words (*M* = .07, *SD* = .17), *t*(198) = 2.21, *p* = .028, *d* = 0.31, BF_{10} = 1.50.

Finally, there was a significant Encoding × Attention interaction, *F*(1, 196) = 4.33, *p* = .039, η_p^2 = .02, $BF_{Inclusion}$ = 3.23. Simple effects analysis using independent-samples t-tests showed that while mean remember rates were significantly higher under full attention than divided attention for both the evaluative encoding (full attention: *M* = .45 [*SD* = .16] vs. divided attention: *M* = .31 [*SD* = .15]), *t*(98) = 4.48, *p* < .001, *d* = 0.90, BF_{10} = 910.50, and incidental encoding conditions (full attention: *M* = .12 [*SD* = .09] vs. divided attention: *M* = .06 [*SD* = .07]), *t*(98) = 4.06, *p* < .001, *d* = 0.81, BF_{10} = 223.12, the difference in remember rates under full vs. divided attention was significantly larger in the evaluative encoding condition than the incidental encoding condition, *t*(73.161) = 2.14, *p* = .036 (corrected for non-equal variances), *d* = 0.43, BF_{10} = 1.58.

The Referent × Encoding × Attention interaction was not statistically significant, *F*(1, 196) = 0.09, *p* = .77, $BF_{Inclusion}$ = 0.11.

“Know” Responses

“Know” responses were calculated using the independent “remember/know” method (Jacoby et al., 1997; Yonelinas & Jacoby, 1995) in which the proportion of “know” responses is divided by the proportion of items that were not given a “remember” response (i.e., *P*(independent know) = *P*(“know”) / [1 – *P*(“remember”)]). Participants’ corrected know rates were calculated by subtracting “know” false-alarm rates (i.e., the proportion of new words given a “know” response / [1 – the proportion of new words given a “remember” response]) from “know” hit rates (i.e., the proportion of old words given a “know” response / [1 – the proportion of old words given a “remember” response]) (see Table 1). A 2 (Referent: Self or Other) × 2 (Encoding: Evaluative or Incidental) × 2 (Attention: Full or Divided) mixed-model ANOVA conducted on the corrected independent know rates revealed no significant main or interaction effects, all *F*(1, 196)s ≤ 2.26, all *p*s ≥ .14, all $BF_{Inclusion}$s ≤ 0.61.

Discussion

The present study examined if and how the magnitudes of the evaluative and incidental SREs were affected by the division of attention during encoding. Replicating previous findings of both evaluative and incidental SREs (e.g., Conway & Dewhurst, 1995; Maki & McCaul, 1985; Cunningham et al., 2014; Kim et al., 2018, 2019; Turk et al., 2008), we found that items encoded in an evaluatively or incidentally self-referent context were associated with better overall recognition and enhanced episodic recollection compared to those encoded in an other-referent context. Also replicating Turk et al. (2008), evaluative encoding led to a significantly larger self-memory advantage compared to incidental encoding. Most important to the present inquiry, divided attention during encoding significantly attenuated the magnitudes of both evaluative and incidental SREs in both overall recognition and episodic recollection, with the size of these SRE attenuations being equivalent between the evaluative and incidental SREs, as evidenced by the absence of a significant three-way interaction between Reference, Encoding, and Attention (corroborated by substantial Bayesian evidence for the null interaction). This attenuation of SREs was driven by divided attention more negatively affecting memory, especially episodic recollection, for self-referent items than for other-referent items. Additionally, in line with previous findings showing that self-reference (e.g., Conway & Dewhurst, 1995; Conway et al., 2001) or divided attention during encoding (e.g., Gardiner & Parkin, 1990; Jennings & Jacoby, 1993) has little or no effect on familiarity, we found that recognition accompanied by feelings of familiarity was not significantly affected by our experimental manipulations.

The present finding of the negative impact of divided attention on the evaluative SRE is in line with previous work by Jackson et al. (2019) suggesting that the activation of episodic/ semantic self-knowledge structures occurs via limited-capacity cognitive resources, but at odds with L. Yang et al. (2012) proposing that the evaluative SRE is supported by spontaneous, automatic encoding processes based on the null interaction found between Referent and Attention. The many differences between L. Yang et al. (2012) and the present study (e.g., Referent as a between-subjects vs. within-subjects factor, self-paced vs. timed encoding trials, the use of Likert-type vs. binary response options, etc.) make it difficult to provide clear explanations for the contradictory findings. Yet, upon close examination, we figured one factor that could have contributed to the contradictory findings is the sample size. The sample size in L. Yang et al. (n = 138) is smaller than the sample size of the present study (n = 200), and it is possible that L. Yang et al. might not have sufficient power to detect the interaction between Referent and Attention. Specifically, in the present study, the effect sizes for the Referent × Attention interaction for overall recognition and episodic recollection were η_p^2 = .03 and .05, respectively, and post-hoc power-analyses suggest that the sample size of L. Yang et al. did not provide sufficient power to detect an interaction of this effect-size range (with achieved powers less than .80, two-tailed).

To our knowledge, the present study is the first to directly examine the attentional requirement of the incidental SRE. In doing so, we also replicated and extended previous findings on the incidental SRE from item recognition and source memory to phenomenological, subjective experience of episodic recollection as assessed by “remember” responses. Our finding that divided attention during encoding significantly reduced the magnitude of the incidental SRE, by negatively affecting memory for self-referent items to a greater extent than that for other-referent items, is in line with Turk et al. (2013) showing selective impairments of memory for self-owned vs. other-owned items by divided attention at encoding that led to an abolishment of the ownership-induced SRE. In addition, the present finding coincides very well with recent studies demonstrating the dependence of the incidental SRE on conscious perception/awareness of self-relevant information (Kim et al., 2018) and on the task-relevance of the stimulus dimension in which self/other-relevant information is presented (Kim et al., 2019). The absence of the incidental SRE when self-relevant information was presented below the threshold of conscious perception or within a stimulus dimension that was completely irrelevant to an encoding task (i.e., judging the color of target words that appear simultaneously with one’s own or another person's name) suggests that encoding processes that contribute to the incidental SRE may not be spontaneous and automatic but rather critically dependent on conscious, controlled processes that require considerable attentional resources (Hasher & Zacks, 1979; Schneider et al., 1984; see also Nakane et al., 2015). Our finding also joins other studies outside the domain of long-term memory casting doubt to the automatic nature of prioritized processing of self-related information, such as the lack of the self-prioritization effect in working memory under high vs. low cognitive load (Constable et al., 2019) and the attenuation of processing advantages for self-relevant vs. other-relevant reward under conditions of distracted attention (i.e., the presentation of a distracting stimulus in a visual display, Zhu & Zhan, 2019).

Although divided attention at encoding significantly attenuated the magnitudes of the SREs in the present study, the fact that it did not completely abolish the self-memory advantages suggests that multiple processing routes, both spontaneous/automatic and resource-demanding/controlled processes, may contribute to the emergence of the evaluative and incidental SREs. Yet, even in the case that these mechanisms are at play in parallel, our finding that the SREs were smaller following divided vs. full attention at encoding suggests that the latter, controlled/attention-demanding processes contribute to a greater extent to the SREs than the former, relatively more automatic processes. In the present study, we chose a low-demand digit-monitoring task previously shown to be associated with high response accuracy (i.e., the easy divided-attention condition in Turk et al., 2013) as a secondary task in order to avoid a potential floor effect for items encoded under incidental encoding, given the mean corrected hit rates between .10 - .35 reported in previous studies (e.g., Jeon et al., 2021; Kim et al., 2018; 2019; Turk et al., 2008). The main effect of attention (i.e., the overall impairment in memory performance when attention was divided vs. full during encoding) observed in the present study replicates the negative mnemonic consequences of attention reduction at encoding (e.g., N. D. Anderson et al., 1998; Craik et al., 1996; Naveh-Benjamin et al., 2000), attesting to the effectiveness of our digit-monitoring task in reducing the attentional resources available for encoding to-be-remembered items. Nonetheless, whether the use of a more strenuous secondary task would result in a complete elimination of the SREs awaits future investigation. In a related vein, future studies could utilize trial-by-trial response times to a secondary task as a way to quantify the amount of attentional resources expended for encoding self-referent vs. other-referent items that could subsequently be linked to differential levels of episodic recollection across the items. Alternatively, future studies may systematically manipulate the availability of attentional resources at encoding (e.g., via a cognitive load manipulation) to more precisely characterize the sensitivity of the SREs to resource-demanding, elaborative encoding processes. To the extent that both the evaluative and incidental SREs are mainly due to controlled, attention-dependent encoding processes, both self-memory advantages may completely fail to emerge under an encoding context in which attentional/processing resources are sufficiently taxed.

Despite the equivalent performance on the secondary task between the evaluative and incidental encoding conditions as well as the substantial Bayesian evidence against the three-way interaction between Referent, Encoding, and Attention that suggest equivalent attentional requirements of the evaluative and incidental SREs, the magnitude of the SRE was still significantly larger under evaluative than incidental encoding context. Together, these findings raise the question about the precise kinds/characteristics of processes that were engaged by the participants during the evaluative vs. incidental encoding of self-referent vs. other-referent items. In the present study, one's own and another person's names were presented across both the evaluative and incidental encoding conditions, and therefore lower-level, attentional processes (i.e., preferential attention to one's own name than another name) are likely to have contributed to both the evaluative and incidental SREs, at least in an early phase of encoding. In addition to these lower-level processes, evaluative self-referent encoding is likely to promote elaboration of incoming stimuli within the rich network of self-knowledge (e.g., creating connections between the stimuli with self-schema and/or autobiographical episodic memories cued by the stimuli; Conway & Dewhurst, 1995), in line with Conway's self-memory system framework (Conway, 2005; Conway & Pleydell-Pearce, 2000) in which the "working self," as a set of active goals and associated self-images, guides access to and from long-term memory, thereby regulating the ongoing formation of the autobiographical knowledge base. For instance, during evaluative encoding, people may spontaneously retrieve a memory of an occasion in which they exhibited a certain personality-trait reflected in a given incoming stimulus (e.g., "*I* felt quite *generous* when *I* donated to a charity last winter"), thereby forging a strong link between the stimulus and one's episodic self-knowledge. When it comes to incidental encoding, the transient increase in attentional resources due to the presentation of self-relevant information, in the absence of a task demand to engage in explicit self-evaluation/reflection, may simply lead to enhanced semantic processing and elaboration of the incoming stimuli in general (e.g., binding of to-be-remembered items with their contextual details, with the self-relevant information simply serving as one specific contextual feature; "The word *generous* is presented above/below *my name*"), in accordance with the idea that self-reference serves as "associative glue" that strengthens the binding of perceptual and episodic details of an experience (Sui & Humphreys, 2015; 2017). Incidental encoding may also occasionally result in processing of the incoming stimuli in explicit reference to the self, albeit to a much lesser extent relative to the evaluative encoding condition. Future studies could help delineate the specific characteristics of encoding processes engaged for self-relevant vs. other-relevant stimuli (e.g., the extent of perceptual/semantic processing, elaboration) under evaluative and incidental encoding contexts, for example, by utilizing self-report questionnaires assessing the use of any specific encoding/learning strategies as well as any thought processes that occurred during encoding. In line with previous studies showing greater mnemonic benefits of episodic elaboration over and above the reliance on semantic self-knowledge during encoding (e.g., Trelle et al., 2015; see also McDonough & Gallo, 2008), one possibility is that the evaluative and incidental encoding contexts differ in the degree to which they "cue" the activation of autobiographical, episodic memories, with greater likelihood of activating relevant personal experiences and elaborating incoming stimuli with these retrieved memory representations under evaluative encoding (see also Conway et al., 2001; Dewhurst et al., 2017).

Finally, it is worth noting that unlike the evaluative and incidental SREs that were attenuated but still present in the divided-attention condition in the present study, the ownership-induced SRE was shown to be completely eliminated by the presence of the same divided-attention task in Turk et al. (2013). These differing patterns of results suggest that the self-related encoding processes giving rise to the ownership-induced SRE may be more cognitively demanding and effortful than those contributing to the evaluative/incidental SREs. Although speculative, one possibility is that elaborating on incoming stimuli and organizing them into the “me/mine” vs. “not-me/not-mine” categories are relatively less effortful in the presence vs. absence of highly self-referential information such as own’s own name or face, as well as for personality-trait words vs. objects with temporary self/other-ownership, given the central position that one’s own name or face (e.g., Cole, 1999; Kang, 1972) and one’s personality attributes (e.g., Klein & Lax, 2010) hold for their self-concept/identity. Indeed, as children grow into adolescence, their conceptions of the self tend to focus more on abstract psychological aspects such as personality attributes than on concrete aspects such as possessions (e.g., Hart et al., 1993; Montemayor & Eisen, 1977), suggesting that compared to objects, personality-trait words would typically be deemed more goal-relevant by the working self that guides the retrieval of relevant episodic memories and the integration of goal-relevant information to the autobiographical knowledge base (Conway, 2005; Conway & Pleydell-Pearce, 2000), at least for adults. In addition, compared to the cues of temporary self- vs. other-ownership of objects, the presence vs. absence of one’s own name or face during encoding may more efficiently aid the perpetual goal of the self-memory system to preferentially attend to and retain self-relevant information through selectively enhanced elaboration and organization, in line with previous findings showing more privileged attentional processing of familiar stimuli with pre-existing self-associations (e.g., one’s own face) vs. stimuli with no such self-associations that experimentally acquired self-relevance (e.g., geometric shapes arbitrarily assigned to the self vs. other) (e.g., Żochowska et al., 2023; see also Svensson et al., 2023).

In summary, the present findings underscore the importance of attentional resources at encoding in the emergence of both the evaluative and incidental SREs, by showing that these self-memory advantages were attenuated in the face of competing processes that also placed demands on limited attentional resources. Our findings suggest that both the evaluative and incidental SREs represent resource-demanding, cognitively effortful mnemonic advantages that are critically dependent on controlled, attention-dependent encoding processes.

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