Self-Reference and Cognitive Effort: Source Memory for Affectively Neutral Information Is Impaired Following Negative Compared to Positive Self-Referential Processing

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Abstract

Previous research suggests a close relationship between self-reference and emotional valence. The present study investigated potential differences in cognitive resources required for positive vs. negative self-referential processing by examining how self/other-referential processing of positive/negative information affects memory for subsequently presented items. On each encoding trial, participants first judged whether a positive or negative trait adjective described themselves or another person. Then, they were shown a neutral noun and indicated its screen location. Subsequent memory tests showed better memory for self-referenced than other-referenced trait adjectives, and the size of this self-reference effect was not modulated by emotional valence. Although memory for nouns was not affected by preceding positive/negative self/other-referential processing, memory for their associated contextual features was significantly impaired following negative vs. positive self-referential processing. Our findings suggest that negative self-referential processing requires more cognitive resources than positive self-referential processing, thereby leaving relatively less cognitive resources to encode subsequently presented information.

Self-Reference and Cognitive Effort: Source Memory for Affectively Neutral Information Is Impaired Following Negative Compared to Positive Self-Referential Processing

Encoding information in reference to oneself has been reliably found to produce a mnemonic advantage over other kinds of encoding activities (for a review, see Symons & Johnson, 1997). For instance, when individuals are asked to process personality-trait words in relation to themselves or another person ("*Does this word describe you [a familiar celebrity]?*"), or for the words' general meaning ("*Does this word mean the same as [a different word]?*") at encoding, they subsequently show better memory for words that were encoded in reference to themselves than for those encoded in reference to another person or semantically. Termed the self-reference effect (SRE; Rogers et al., 1977), this self-memory advantage is suggested to arise because self-referential encoding allows enhanced elaboration and/or organization of incoming information within a rich network of semantic and autobiographical self-knowledge/concept (Conway & Dewhurst, 1995; Klein & Loftus, 1988).

Previous work suggests that most healthy individuals' self-concept contains predominantly more positive than negative attributes (Kendall et al., 1989; Schwartz, 1986) and that people strive to maintain or enhance the positivity of their self-views (i.e., self-enhancement) and avoid or minimize the negativity of their self-views (i.e., self-protection) (for a review, see Alicke & Sedikides, 2009). For example, healthy individuals tend to evaluate their own attributes, skills and abilities more favorably than those of an average peer (for a review, see Zell et al., 2020), believe that positive (or negative) events are more (or less) likely to happen to them than to others (Regan et al., 1995; Weinstein, 1980), and attribute positive outcomes to their enduring personal characteristics and negative outcomes to specific external causes (for a review, see Mezulis et al., 2004). They endorse more positive than negative traits as self-descriptive and more negative than positive traits as non-self-descriptive (Cai et al., 2016; Kwan et al., 2007; Pauly et al., 2013). Furthermore, they are faster to claim positive traits as self-descriptive than non-self-descriptive while slower to claim negative traits as self-descriptive than non-self-descriptive (Cai et al., 2016; Moran et al., 2006; Watson et al., 2007). Taken together, previous findings of this 'self-positivity bias' suggest a tight relationship between self-referential processing and the emotional valence of incoming information.

Whether the emotional valence of incoming information modulates the magnitude of the SRE has been examined in several studies, and the findings have been mixed. While studies that measured recall generally reported a larger SRE for positive compared to negative stimuli (i.e., better memory for positive than negative stimuli only when they were encoded with reference to the self; e.g., D'Argembeau et al., 2005 [Experiment 1]; Sanz, 1996; Sedikides & Green, 2000, 2004; but see Hudson et al., 2020 [Experiment 1]; L. Yang et al., 2012), those that measured recognition yielded inconsistent findings (no impact of emotional valence: e.g., D'Argembeau et al., 2005 [Experiment 2]; Green et al., 2008; Pauly et al., 2013; L. Yang et al., 2012; a larger SRE for positive than negative stimuli: e.g., Durbin et al., 2017 [Experiment 2]; Hudson et al., 2020 [Experiment 2]; Pereira et al., 2021). Of note, the findings of a recent study (Hudson et al.,

2020) suggest that at least some of the previous mixed findings in recognition could be due to differences in basic aspects of task design. Specifically, Hudson et al. found a larger SRE in recognition of positive than negative trait adjectives when self-referent and other-referent encoding trials were randomly intermixed (Experiment 2) but not when they were blocked (i.e., all trials within a block pertaining to a single referent; Experiment 1). These findings suggest that the self-positivity bias in self-referential processing/memory may be more pronounced when the task design renders the differences between the self vs. other more salient by requiring intermittent referent processing (i.e., referent as a within-subjects factor in an intermixed design) rather than prolonged referent processing (i.e., referent as a between-subjects factor or as a within-subjects factor in a blocked design).

The effects of emotional valence on the SRE are suggested to operate at multiple stages of memory processing, influencing how individuals initially process information (i.e., encoding) and/or how they remember the information later (i.e., retrieval). At encoding, individuals may process positive self-relevant information more elaboratively than negative self-relevant information (Sedikides & Green, 2009; Zengel et al., 2018). Indeed, there is evidence that memory for contextual features of an encoding event (i.e., source memory; Johnson et al., 1993) reflecting rich, elaborate memory representations is enhanced for positive compared to negative self-relevant stimuli (Durbin et al., 2017 [Experiment 1]; Pereira et al., 2019, 2021; Rowell & Jaswal, 2021). At retrieval, individuals may exert control over their own remembering by selectively enhancing access to positive vs. negative self-relevant information (D’Argembeau et al., 2005; D’Argembeau & Van der Linden, 2008; see also Conway & Pleydell-Pearce, 2000), which should have a more pronounced impact in a recall test in which individuals must generate their own retrieval cues than in a recognition test in which retrieval cues are directly available.

Notwithstanding that the aforementioned encoding- and retrieval-related processes are not necessarily mutually exclusive, in the present study, we focused on the processes occurring at encoding in order to further examine the nature of processing positive vs. negative self-relevant information. Specifically, we asked how processing positive self-relevant information would compare to processing negative self-relevant information in terms of cognitive resources required. That is, is positive self-referential processing more cognitively effortful than negative self-referential processing or vice versa?

Previous findings remain inconclusive in this regard. Some studies suggest that positive self-referential processing may be more cognitively taxing than negative self-referential processing by showing that divided attention at encoding selectively impaired memory for positive self-relevant stimuli while leaving memory for negative self-relevant stimuli virtually unaffected (Zengel et al., 2018 [Study 3]) and that the amplitude of an event-related potential (ERP) component thought to reflect effortful processing, sustained attention and stimulus encoding (i.e., late-positive potential [LPP]) was enhanced during the processing of positive compared to negative self-relevant stimuli (e.g., Auerbach et al., 2015; Herbert, Herbert, et al., 2011; Shestyuk & Deldin, 2010). Other studies suggest the opposite possibility that negative self-referential processing may be more cognitively taxing than positive self-referential processing by showing enhanced LPP amplitude (e.g., Cai et al., 2016; Herbert, Pauli et al., 2011) and other neural signatures of cognitive/mental efforts (e.g., increased theta-band event-related synchronization; Fossati et al., 2003; Mu & Han, 2010) during the processing of negative compared to positive self-relevant stimuli. Still, other studies suggest that the amount of cognitive resources required for self-referential processing may not be modulated by the emotional valence of incoming information by showing that neither divided attention at encoding nor the emotional valence of stimuli significantly affected the magnitude of the SRE (L. Yang et al., 2012; but see Turk et al., 2013 showing that divided attention at encoding eliminated the SRE by selectively impairing memory for items encoded in a self-relevant vs. other-relevant context) and that the amplitude of LPP during the processing of positive vs. negative self-relevant stimuli did not significantly differ (e.g., Hudson et al., 2020; Pereira et al., 2021). These mixed findings are compounded by the use of different task/study designs (e.g., blocked vs. intermixed referent design, other-referential vs. semantic encoding as the comparison condition, presence vs. absence of an explicit task) and stimuli (e.g., trait adjectives, nouns, statements describing personality-related behaviors, multi-sentence vignettes) across the studies.

In the present study, we adopted an intermixed referent design suggested to enhance the self-positivity bias in self-referential processing/memory (Hudson et al., 2020) to investigate potential differences in cognitive resources required for positive vs. negative self-referential processing when encoding takes its natural course in the absence of factors designed to disrupt encoding processes (e.g., divided attention). Specifically, given that episodic memory encoding draws on capacity-limited cognitive resources (Baddeley et al., 1984; Craik et al., 1996), we examined how self/other-referential processing of positive/negative information affects memory for subsequently presented neutral items. Based on previous findings showing that the depletion of limited cognitive/attentional resources by the processing/encoding of preceding items (e.g., negative pictures, low-frequency words) has a lingering negative impact on the processing/encoding of items that directly follow (e.g., Morriss et al., 2013; Popov et al., 2021), we reasoned that the amount of cognitive resources occupied by preceding positive/negative self/other-referential processing should determine the amount of cognitive resources left available to encode subsequently presented items, thereby influencing the mnemonic fate of those items. During incidental encoding, participants were first shown positive and negative personality-trait adjectives and were asked to judge whether each adjective was descriptive of themselves (i.e., self-reference) or a familiar celebrity (i.e., other-reference). Shortly after each self/other-referential judgment, participants were presented with an affectively neutral noun and were asked to indicate its location on the screen (top or bottom). Participant's memory for trait adjectives as well as their memory for nouns and their associated source feature (i.e., a noun's location on the screen during encoding) were subsequently probed in two separate recognition tests.

For memory for trait adjectives, we expected to replicate the findings of Hudson et al. (2020) by observing a larger SRE for positive than negative words. For memory for subsequently presented nouns, we expected to observe one of three informative patterns of results: (a) *impaired* memory for nouns following positive compared to negative self-referential processing if processing of positive self-relevant information is more cognitively taxing than processing of negative self-relevant information; (b) *enhanced* memory for nouns following positive compared to negative self-referential processing if processing of positive self-relevant information is less cognitively taxing than processing of negative self-relevant information; or (c) *comparable* memory for nouns following positive vs. negative self-referential processing if the emotional valence of incoming stimuli does not modulate the amount of cognitive resources required for self-referential processing. For the former two possibilities, it was expected that the impact of preceding positive vs. negative self-referential processing on memory for nouns might be more pronounced in source memory (i.e., memory for a noun's location) than in item memory (i.e., memory for the nouns themselves), based on previous findings showing more disruptive effects of reduced cognitive resources (i.e., divided attention) at encoding on subsequent memory for item-context/item-item combinations vs. item information alone (e.g., Castel & Craik, 2003; Reinitz et al., 1994; Troyer et al., 1999). Given only a few studies with conflicting findings regarding whether or not self-referential processing is more cognitively effortful than other-referential processing (Turk et al., 2013; L. Yang et al., 2012), no a priori prediction was made with respect to potential differences in cognitive resources required for self- vs. other-referential processing.

Method

Participants and Design

One hundred and four undergraduate students (50 females; mean age = 19.12 [*SD* = 1.09] years) participated in exchange for course credit. The sample size was predetermined based on an effect size slightly lower than the effect size of an interaction between referent and emotional valence on recognition memory found in Hudson et al. (2020; *dz* = 0.40) using G*Power (Faul et al., 2007; f = 0.15 [*d* = 0.30], α = .05 [two-tailed], power = 0.9, required *N* = 81) and counterbalancing constraints. All participants were native English speakers and had normal color vision. Participants provided informed consent in accordance with the human subject regulations of Wesleyan University. Data from two additional participants were excluded from analysis due to a computer malfunction.

The experiment had a 2 (Referent: self, other) × 2 (Valence: positive, negative) factorial design with both Referent and Valence as within-subjects factors.

Stimuli

The stimuli included 120 personality-trait adjectives (60 positive [e.g., sincere, warm], 60 negative [e.g., rude, selfish]) drawn from Anderson (1968) and 120 affectively neutral nouns (e.g., alley, table) drawn from Bradley and Lang's (1999) Affective Norms for English Words (ANEW) database (valence range = 4.35 – 6.49 on a 9-point scale).

The trait adjectives were divided into three lists of 40 words each (20 positive and 20 negative) that were matched for overall valence, arousal, and meaningfulness, based on the norms of Warriner et al. (2013) and Anderson (1968), all Fs $\leq$ 1.14, all ps $\geq$ .32. The three lists were also matched for word length and syllable length, all Fs ≤ 0.22, all ps ≥ .81. The first two lists served as critical items that were presented in the encoding phase (i.e., "old" trait adjectives). The assignment of these critical lists to the self-referent or other-referent condition was counterbalanced across participants. The remaining list served as foils in the item recognition test for trait adjectives (i.e., "new" trait adjectives). Across the three lists, the mean valence ratings (1 = *unhappy*; 9 = *happy*) were significantly higher for positive adjectives (M = 6.83, SD = 0.64) than for negative adjectives (M = 3.21, SD = 0.75), $t(118) = 28.44$, $p < .001$, d = 2.60, while the mean arousal (1 = *excited*; 9 = *calm*) and meaningfulness ratings (0 = *no idea of the meaning*; 4 = *a very clear understanding of the meaning*) did not significantly differ between positive (arousal: M = 4.27, SD = 1.01; meaningfulness: M = 3.58, SD = 0.17) and negative adjectives (arousal: M = 4.54, SD = 0.82; meaningfulness: M = 3.61, SD = 0.15), all ts ≤ 1.62, all ps ≥ .11. In addition, the valence, arousal, and meaningfulness ratings for positive adjectives and those for negative adjectives did not significantly differ between the three lists, all Fs ≤ 1.07, all ps ≥ .35.

The nouns were divided into five lists that were matched for valence, arousal, concreteness, imageability, familiarity, frequency, word length, and syllable length based on the norms from Bradley and Lang (1999) and the MRC Psycholinguistic Database (Coltheart, 1981), all Fs ≤ 1.04, all ps ≥ .39. The first four lists included 20 words each and served as critical "old" items that were presented in the encoding phase. The assignment of these critical lists to 2 (Referent) x 2 (Valence) combinations of the conditions was counterbalanced across participants. The remaining list included 40 words and served as foils in the item recognition/source memory test for nouns.

Procedure

Participants completed the experiment individually in a soundproof testing room. The experiment had the following three phases:

Encoding. On each trial, participants performed two tasks successively. The first task was a trait evaluation task in which participants were asked to judge whether a given trait adjective was descriptive of themselves or a celebrity (Tom Hanks)[1]. The second task was a noun location judgment task in which participants had to indicate the location of a given noun that appeared after the offset of the trait adjective. Each trial began with the presentation of a referent cue ("SELF" or "HANKS") in black at the top center of the screen. Five-hundred ms after the onset of the referent cue, a trait adjective was presented in red in lower case in the middle of the screen for 2.5 s. For "SELF" trials, participants were asked to judge whether or not the trait adjectives described themselves by pressing one of two keys representing "yes" or "no" response. For "HANKS" trials, participants were asked to judge whether the trait adjectives described Tom Hanks using the same two keys. One-hundred-and-fifty-ms after the offset of

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[1] Tom Hanks was chosen as the "other" referent in consultation with undergraduate research assistants. Tom Hanks was deemed to be a celebrity that most study participants would be familiar with, given his appearance in a number of movies within a few years preceding the data collection for the present study.

both the referent cue and trait adjective, a noun appeared in blue in lower case either at the top or the bottom of the screen for 1.5 s. For each noun, participants were asked to indicate its location on the screen (top or bottom) by pressing one of two keys that were different from those used for the trait evaluation task. Trials were separated by a 500-ms fixation period, and the self- and other-referent trait adjectives as well as nouns were presented in a random order for each participant. Participants were asked to complete both the trait evaluation and noun location judgment tasks to the best of their ability. Participants had eight practice trials (with stimuli different from those used in the experimental trials) to familiarize themselves with the tasks. They were not informed about the upcoming memory tests.

Item Recognition Test for Trait Adjectives. Immediately following the encoding phase, participants took a memory test for trait adjectives. The 80 "old" trait adjectives from the encoding phase along with the 40 "new" trait adjectives were presented individually in black in lower case in the center of the screen. For each adjective, participants were asked to indicate whether or not they had seen it in the encoding phase by pressing one of two keys representing "old" or "new" response within 4 s. Trials were separated by a 500-ms fixation period, and the trait adjectives were presented in a random order for each participant.

Item Recognition/Source Memory Test for Nouns. Immediately following the memory test for trait adjectives, participants took a memory test for nouns. The 80 "old" nouns from the encoding phase and the 40 "new" nouns were presented individually in black in lower case in the center of the screen. For each noun, participants were first asked to indicate whether or not they had seen it in the encoding phase by pressing one of two keys representing "old" or "new" response within 4 s. For each noun called "old," participants were further asked to indicate the location in which the word was presented during the encoding phase (top or bottom) by pressing of one of two keys that were different from those used for old/new judgments within 4 s. Trials were separated by a 500-msec fixation period and the nouns were presented in a random order for each participant.

Upon completion of the experimental phases, participants were asked to indicate whether or not they knew Tom Hanks who served as the "other" referent. All participants indicated they knew the celebrity.

Statistical Analyses

In addition to the conventional frequentist analyses, we conducted Bayesian analyses in order to quantify the strength of evidence for the presence or absence of any effects of interest. For each of the frequentist analyses performed, we report the associated Bayes factor (BF) which expresses an odds ratio of evidence for vs. against a null hypothesis (H_0). BF_{10} expresses the likelihood of the alternative hypothesis (H_1) over H_0, and its reverse, BF_{01} (i.e., $1/BF_{10}$), expresses the likelihood of H_0 over H_1. For example, a BF_{10} value of *x* indicates that the observed data are *x* times more likely under H_1 than under H_0. According to a conventional rule-of-thumb classification scheme (Jeffreys, 1961; Kass & Raftery, 1995), a BF value of 1 is considered to provide "no" evidence (i.e., the observed data are equally likely under H_0 and H_1); 1 – 3 "weak/anecdotal" evidence; 3 – 10 "substantial" evidence; 10 – 30 "strong" evidence, 30 –

10 “very strong” evidence, and > 100 “decisive” evidence.

Bayesian analyses were conducted using JASP statistical software (JASP Team, 2019, version 0.11.1) with their 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 analysis of variance (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 observed data under models that included a given factor compared to matched models stripped of that factor.

Results

Encoding Performance: Trait Endorsement and Noun Location Judgments

For the trait evaluation task, the proportions of positively endorsed trait adjectives were computed for each referent condition separately for each valence and were entered into a 2 (Referent: self, other) × 2 (Valence: positive, negative) repeated-measures ANOVA. There was a significant main effect of Referent, $F(1, 103) = 18.53$, $p < .001$, $\eta_p^2 = .15$, $BF_{Inclusion} = 9.55$, such that participants endorsed more adjectives in the self-referent condition (*M* = .54, *SD* = .13) than in the other-referent condition (*M* = .49, *SD* = .16). The main effect of Valence was also significant, $F(1, 103) = 1074.37$, $p < .001$, $\eta_p^2 = .91$, $BF_{Inclusion} = 2.66 \times 10^{148}$, such that participants endorsed more positive (*M* = .82, *SD* = .15) than negative adjectives (*M* = .21, *SD* = .15). The Referent × Valence interaction was not significant, $F(1, 103) = 1.33$, $p = .25$, $BF_{Inclusion} = 0.30$. A 2 (Referent) × 2 (Valence) repeated-measures ANOVA conducted on mean response times (RTs in ms; including both positive and negative endorsement)[2] revealed a significant

[2] To take into account participants’ responses to trait adjectives (i.e., positive or negative endorsement), mean RTs were also analyzed using a 2 (Referent: self, other) × 2 (Valence: positive, negative) × 2 (Response: yes, no) repeated-measures ANOVA. It should be noted that because this additional 2 x 2 x 2 repeated-measures ANOVA and its follow-up simple effect analyses reported in this footnote were conditionalized by particular type of responses with some participants’ having no response of a given type (e.g., no positive endorsement of negative adjectives in the self-referent condition), degrees of freedom between analyses sometimes differed. The 2 x 2 x 2 repeated-measures ANOVA yielded a number of significant effects (Referent [$F(1, 77) = 9.13$, $p = .003$, $\eta_p^2 = .11$, $BF_{Inclusion} = 22.81$], Response [$F(1, 77) = 11.88$, $p = .001$, $\eta_p^2 = .13$, $BF_{Inclusion} = 4.78$], Valence × Response [$F(1, 77) = 208.26$, $p < .001$, $\eta_p^2 = .73$, $BF_{Inclusion} = 6.92 \times 10^{37}$]) that were qualified by a significant Referent × Valence × Response interaction, $F(1, 77) = 4.70$, $p = .033$, $\eta_p^2 = .06$, $BF_{Inclusion} = 2.60$. Follow-up analyses revealed that while participants were faster to positively endorse positive adjectives and slower to positively endorse negative adjectives in both the self-referent (Positive adjectives: Yes [*M* = 1157.43, *SD* = 217.66] vs. No [*M* = 1514.44, *SD* = 348.29]; Negative adjectives: Yes [*M* = 1474.01, *SD* = 311.43] *vs.* No [*M* = 1248.23, *SD* = 213.41]) and other-referent conditions (Positive adjectives: Yes [*M* = 1274.05, *SD* = 254.73] vs. No [*M* = 1521.51, *SD* = 359.02]; Negative adjectives: Yes [*M* = 1489.60, *SD* = 307.67] vs. No [*M* = 1321.75, *SD* = 234.70]), all *t*s ≥ 5.49, all *p*s < .001, all *d*s ≥ 0.57, all BF_{10}s $\geq 3.63 \times 10^4$, the size of the RT difference between positive vs. negative endorsement was significantly larger in the self-referent condition than in

main effect of Referent, $F(1, 103) = 26.70$, $p < .001$, $\eta_p^2 = .21$, $BF_{Inclusion} = 5.68 \times 10^5$, with faster responses in the self-referent condition ($M = 1248.03$, $SD = 214.96$) than in the other-referent condition ($M = 1320.67$, $SD = 245.11$). The main effect of Valence was also significant, $F(1, 103) = 17.25$, $p < .001$, $\eta_p^2 = .14$, $BF_{Inclusion} = 124.17$, with faster responses to positive ($M = 1260.15$, $SD = 240.75$) than negative adjectives ($M = 1308.56$, $SD = 219.32$). There was also a significant Referent × Valence interaction, $F(1, 103) = 15.37$, $p < .001$, $\eta_p^2 = .13$, $BF_{Inclusion} = 44.09$. Simple effects analyses showed that while participants were significantly faster to respond to positive ($M = 1202.17$, $SD = 222.42$) than negative adjectives ($M = 1293.90$, $SD = 207.49$) in the self-referent condition, $t(103) = –5.65$, $p < .001$, $d = 0.55$, $BF_{10} = 8.63 \times 10^4$, their response times to positive ($M = 1318.13$, $SD = 259.08$) vs. negative adjectives ($M = 1323.22$, $SD = 231.14$) did not significantly differ in the other-referent condition, $t(103) = –0.32$, $p = .75$, $BF_{10} = 0.11$.

For the noun location judgment task, accuracy was calculated as the proportion of nouns associated with correct location judgments, computed separately for those preceded by self- or other-referential processing of each valence. The mean RTs were calculated based on correct trials only. A 2 (Referent) × 2 (Valence) repeated-measures ANOVA conducted on accuracy revealed no significant main or interaction effect, all Fs ≤ 2.16, all ps $\geq .15$, all $BF_{Inclusion}$s ≤ 0.33. For the Referent × Valence combinations of self-positive, self-negative, other-positive, and other-negative conditions, the mean accuracies were .98 ($SD = .05$), .98 ($SD = .06$), .98 ($SD = .05$), and .98 ($SD = .05$), respectively. A 2 (Referent) × 2 (Valence) repeated-measures ANOVA conducted on mean RTs revealed no significant main or interaction effect, all Fs ≤ 3.78, all ps $\geq .055$, all $BF_{Inclusion}$s ≤ 0.58. For the Referent × Valence combinations of self-positive, self-negative, other-positive, and other-negative conditions, the mean RTs were 719.41 ($SD = 167.39$), 734.96 ($SD = 171.05$), 733.14 ($SD = 162.12$), and 733.05 ($SD = 162.73$), respectively.

Item Recognition for Trait Adjectives

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 identified as old) for item recognition of trait adjectives. As a measure of item recognition accuracy, corrected hit rates were calculated by subtracting the false-alarm rates for each valence from the hit rates for the corresponding valence, separately for each referent condition. A 2 (Referent) × 2 (Valence) repeated-measures ANOVA conducted on corrected hit rates revealed a significant main effect of Referent, $F(1, 103) = 264.59$, $p < .001$, $\eta_p^2 = .72$, $BF_{Inclusion} = 2.31 \times 10^{39}$, with better recognition of self-referenced adjectives ($M = .65$, $SD = .17$) relative to other-referenced adjectives ($M = .45$, $SD = .19$), as shown in Figure 1. There was neither a significant main effect of Valence, $F(1, 103) = 2.09$, $p = .15$, $BF_{Inclusion} = 0.49$, nor a significant Referent × Valence interaction, $F(1, 103) = 0.46$, $p = .50$, $BF_{Inclusion} = 0.16$.

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the other-referent condition for positive adjectives, $t(89) = –2.67$, $p = .009$, $d = 0.28$, $BF_{10} = 3.29$, but not for negative adjectives, $t(88) = 1.26$, $p = .21$, $BF_{10} = 0.25$.

Table 1

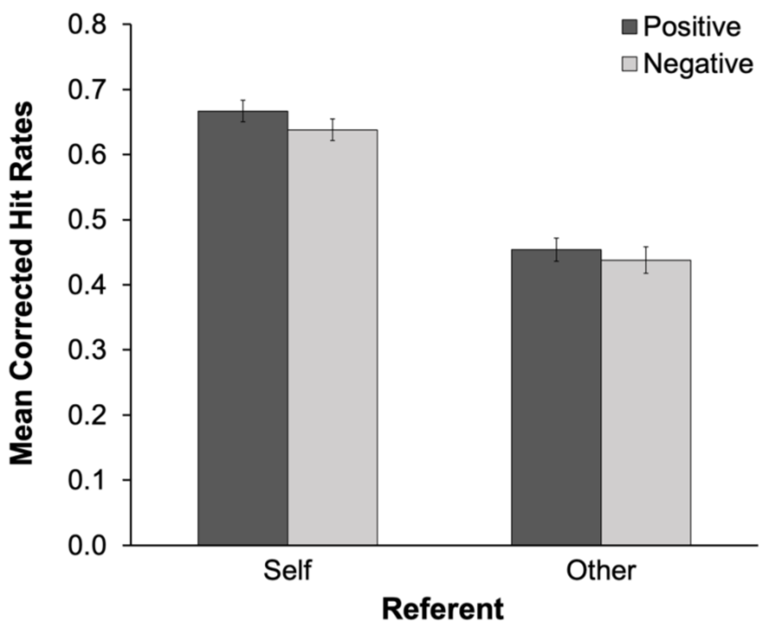
Mean proportion (standard deviation) of hits and false alarms for item recognition of trait adjectives as a function of Referent and Valence conditions

	Positive		Negative	
	Self	Other	Self	Other
Hits	.86 (.12)	.65 (.15)	.82 (.12)	.62 (.17)
False Alarms	.20 (.12)		.19 (.11)	

Note. There were no separate false-alarm rates per each referent condition as new positive and negative adjectives did not belong to a referent condition.

Figure 1.

Item recognition memory for trait adjectives as a function of Referent and Valence. Error bars represent standard error of the mean.



Item Recognition and Source Memory for Subsequently Presented Nouns

Table 2 presents hit rates and false-alarm rates for item recognition of nouns. Item recognition accuracy was calculated as corrected hit rates (i.e., the hit rates minus the false-alarm rates) computed separately for nouns that were preceded by self- or other-referential processing of each valence. A 2 (Referent) × 2 (Valence) repeated-measures ANOVA conducted on corrected hit rates revealed no significant main or interaction effect, all Fs ≤ 0.94, all ps $\geq .33$, all $BF_{Inclusion}$s ≤ 0.25. For the Referent × Valence combinations of self-positive, self-negative, other-positive, and other-negative conditions, the mean corrected hit rates were .16 (*SD* = .16), .14 (*SD* = .16), .15 (*SD* = .15), and .16 (*SD* = .16), respectively.

Table 2

Mean proportion (standard deviation) of hits and false alarms for item recognition of nouns as a function of preceding Referent and Valence conditions.

	Positive		Negative	
	Self	Other	Self	Other
Hits	.49 (.17)	.48 (.15)	.48 (.17)	.49 (.18)
False Alarms	.33 (.16)			

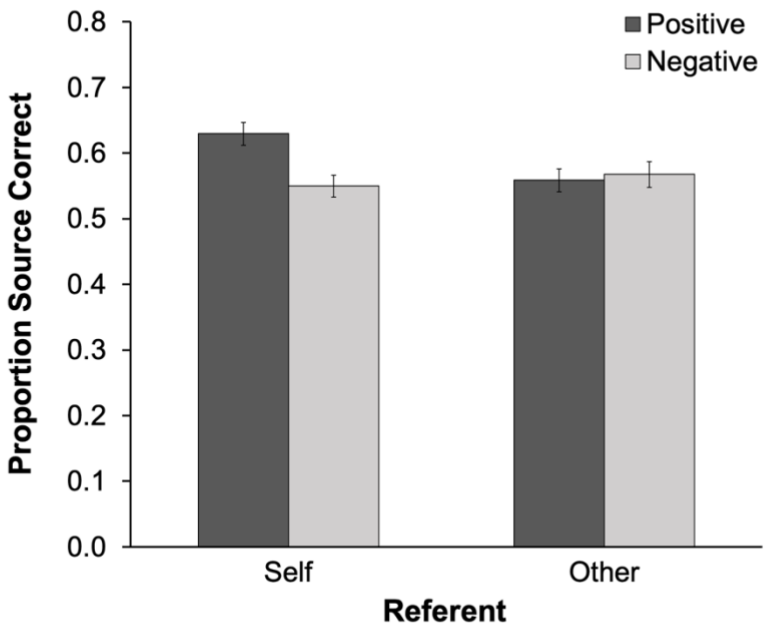
Note. There were no separate false-alarm rates per each referent or valence condition as there was a single pool of affectively neutral new nouns that did not belong to a condition.

Source memory accuracy was calculated as the mean proportion of correctly recognized nouns that were attributed to the correct source (i.e., the correct location on the screen) computed separately for those preceded by self- or other-referential processing of each valence.[3] A 2 (Referent) × 2 (Valence) repeated-measures ANOVA conducted on source memory accuracy revealed no significant main effect of Referent, $F(1, 103) = 2.39$, $p = .13$, $BF_{Inclusion} = 0.36$, but a significant main effect of Valence, $F(1, 103) = 4.12$, $p = .045$, $\eta_p^2 = .04$, $BF_{Inclusion} = 0.83$, with better source memory for nouns that were preceded by positive self/other-referential processing ($M = .59$, $SD = .18$) than for those preceded by negative self/other-referential processing ($M = .56$, $SD = .18$). Importantly, there was also a significant Referent × Valence interaction, $F(1, 103) = 6.09$, $p = .015$, $\eta_p^2 = .06$, $BF_{Inclusion} = 3.51$. As shown in Figure 2, simple effects analyses revealed that while source memory was better for nouns that were preceded by positive ($M = .63$, $SD = .18$) vs. negative ($M = .55$, $SD = .17$) self-referential processing, $t(103) = 3.32$ $p = .001$, $d = 0.33$, $BF_{10} = 18.07$, source memory did not significantly differ for those that were preceded by positive ($M = .56$, $SD = .17$) vs. negative ($M = .57$, $SD = .20$) other-referential processing, $t(103) = –0.34$, $p = .73$, $BF_{10} = 0.12$. In addition, source memory for nouns that were preceded by negative self-referential processing did not significantly differ from source memory for those that were preceded by positive or negative other-referential processing, all ts ≤ 0.65, all ps ≥ .52, all BF_{10}s ≤ 0.13.

[3] Source memory accuracy from all 2 (Referent) × 2 (Valence) combinations of the conditions were significantly above chance performance level (.50), all ts ≥ 3.00, all ps ≤ .003, all ds ≥ 0.29, all BF_{10}s ≥ 7.34.

Figure 2.

Source memory for nouns as a function of preceding Reference and Valence. Error bars represent standard error of the mean.



Discussion

The present study sought to investigate potential differences in cognitive resources required for processing positive vs. negative self-relevant information when encoding takes its natural course. To this end, using an intermixed referent design, we examined how preceding self/other-referential processing of positive/negative trait adjectives affects item and source memory for subsequently presented neutral nouns. Replicating the typical SRE, self-referenced trait adjectives were overall better recognized than other-referenced trait adjectives, but the magnitude of this self-referential memory advantage was not significantly affected by the emotional valence of the trait adjectives. Although item memory for subsequently presented nouns was not significantly affected by preceding self/other-referential processing of positive/negative trait adjectives, source memory for the nouns was significantly impaired following self-referential processing of negative compared to positive trait adjectives. In addition, source memory for nouns did not significantly differ following self-referential processing of negative trait adjectives vs. other-referential processing of either positive or negative trait adjectives.

Our finding that the magnitude of the SRE was not significantly modulated by the emotional valence of the trait adjectives is in disagreement with the results of Hudson et al. (2020, [Experiment 2]) that also employed an intermixed referent design. Our failure to replicate Hudson et al. thus suggests that factors other than task design may have also contributed to the previous mixed findings of the impact of emotional valence on the magnitude of the SRE. One such factor may be individual differences in trait and state self-esteem that are shown to modulate self-enhancement and self-protection motives (e.g., Blaine & Crocker, 1993; Tice, 1991; see also Jones & Brunell, 2014). Future studies may systematically examine the extent to which the size of the SRE varies depending on the emotional valence of incoming information across different task designs, comparison conditions (semantic or other-referential encoding) and individual differences factors to gain a more nuanced understanding of the relationship between self-reference and emotional valence.

Our novel finding is that source memory for subsequently presented nouns was significantly impaired following negative compared to positive self-referential processing. This finding, together with our finding that participants took significantly longer to respond to negative than to positive trait adjectives in the self-referent condition during encoding, suggests that negative self-referential processing requires relatively more cognitive resources than positive self-referential processing, thereby leaving relatively less cognitive resources to encode subsequently presented information. Why might negative self-referential processing be more cognitively taxing than positive self-referential processing? As suggested elsewhere (e.g., Fossati et al., 2003; Mu & Han, 2010), one possibility is that when processing negative stimuli in a self-referential manner, individuals may need to inhibit or suppress their emotional responses to the stimuli in order to maintain the positivity of their self-views and to protect themselves from the adverse effects of experiencing negative emotions. In line with this possibility is the finding that strategically suppressing the processing of negative self-relevant information can contribute to the maintenance of the generally positive self-views in healthy individuals under self-esteem threat (Dodgson & Wood, 1998; Hoefler et al., 2015). Given previous findings showing that inhibiting/suppressing emotions drains available cognitive resources thereby negatively impacting performance on subsequent tasks requiring cognitive control (Friese et al., 2013; Wang et al., 2014), future studies may interleave positive/negative self/other-referential processing with a cognitive task known to rely on cognitive control processes (e.g., Stroop task, flanker task) to more directly test the possibility that negative self-referential processing requires effortful inhibition/suppression of one's own emotional responses to negative self-relevant stimuli (see also Wagner et al., 2013).

It is worth noting that our finding of relatively impaired source memory for subsequently presented nouns following negative compared to positive self-referential processing diverges from the findings of a small body of existing research examining the effects of general affective states on source memory for emotionally neutral material. Specifically, the results of this small body of literature have shown that negative affective states led to enhanced memory for contextual details associated with neutral target items compared to positive or neutral affective states, when the affective states were induced prior to encoding through a mood induction procedure (Gingerish & Dodson, 2013; Storbeck, 2013; but see Subramaniam et al., 2016) or during encoding via a concurrent presentation of emotional materials with target items (Marci et al., 2018; Xie & Zhang, 2017). Although not directly comparable, the discrepancy between the source memory patterns found in the present study vs. previous studies could be in part attributed to differing degrees of self-relevancy of affective experiences. That is, while the positive or negative affective experiences elicited in the present study had a direct relevance to oneself in the context of self-evaluation/appraisal, those elicited in the previous studies appear unlikely to have directly implicated the self. Thus, one possibility is that positive and negative affective states may have differing effects on subsequent memory processes depending on whether or not the self directly serves as the source of those affective experiences. Some indirect support for this possibility comes from previous studies showing that individuals' trait self-esteem levels shown to modulate self-enhancement and self-protection motives predicted self-relevant emotional reactions (e.g., feeling proud or ashamed) but not general, non-self-relevant emotional reactions (e.g., feeling happy or unhappy) to success or failure (e.g., Brown & Dutton, 1995; Brown & Marshall, 2001). Future research could explore potential interactive effects of self-relevance and affective states on subsequent information processing by systemically varying the degree to which positive and negative affective experiences bear direct relevance to oneself.

Although we did not have a priori prediction regarding potential differences in cognitive resources required for self- vs. other-referential processing, our findings of significantly better source memory for nouns following positive self-referential processing compared to all other conditions, along with nonsignificant differences in source memory for nouns following negative self-referential processing vs. positive/negative other-referential processing suggest that the comparison of self- vs. other-referential processing in their requirements for cognitive resources should take into account the emotional valence of incoming information. In particular, our findings suggest that while positive self-referential processing is less cognitively effortful than other-referential processing of either positive or negative information, negative self-referential processing is unlikely to be more effortful than other-referential processing. Given the chronically favorable views most healthy individuals have on themselves (Kendall et al., 1989; Schwartz, 1986), positive self-referential processing may be less cognitively taxing than negative self-referential processing or other-referential processing because positive aspects of self-concept/knowledge are more readily accessible compared to both negative aspects of self-concept/knowledge or knowledge about other individuals. Indeed, it has been shown that incoming information that "fits" with individuals' current views of themselves (e.g., depressive personality traits to those with depression or negative self-views) is more efficiently processed relative to information that does not align with the self-views (e.g., non-depressive personality traits to those with depression or negative self-views) regardless of a concurrent cognitive load (e.g., McDonald & Kuiper, 1985). In addition, individuals may also be more motivated to incorporate positive than negative self-relevant information into their existing self-concept/knowledge (D'Argembeau & Van der Linden, 2008; Durbin et al., 2017; Sedikides & Green, 2000), which may in turn result in more efficient processing of positive self-relevant information relative to negative self-relevant information or other-relevant information

Unlike source memory for nouns, item memory for nouns was not significantly affected by the preceding self/other-referential processing of positive/negative trait adjectives in the present study. Although speculative, we offer two possible explanations for this null finding.

First, although item recognition performance was significantly above chance level (i.e., the corrected hit rate of 0) in all four referent × valence combinations of the conditions, the performance was overall quite low with a mean proportion corrected hit rate of .15. This tendency toward a floor effect might have obscured any potential effects of preceding self/other-referential processing of differing emotional valence. Second, to the extent that encoding/binding of item-context combinations requires more cognitive/attentional resources relative to encoding of item information alone (e.g., Reinitz et al., 1994; Troyer et al., 1999; Greene et al., 2021), source memory may have been more sensitive than item memory to the amount of cognitive resources left available following positive/negative self/other-referential processing. One way to uncover the reasons for the present null finding in item recognition could be to compare item and source memory for subsequently presented nouns using an item recognition test with lower difficulty (e.g., by using a smaller number of noun stimuli or an orienting task that promotes deeper-level, semantic encoding).

Overall, the present findings suggest that negative self-referential processing requires relatively more cognitive resources than positive self-referential processing and that the emotional valence of incoming information determines the relative cognitive resources required for self-referential vs. other-referential processing. One fruitful avenue for future research is to explore the boundary conditions for the present findings. For instance, given the observed lack of self-positivity bias and/or the presence of excessive negative bias in individuals with psychopathology, especially those with depression and anxiety (e.g., Derry & Kuiper, 1981; Thurston et al., 2017), it would be interesting to examine whether the present patterns of findings would be absent or even reversed among those with psychopathology. In addition, future studies may examine how individuals' self-esteem levels (J. Yang et al., 2014; Zhang et al., 2013) and/or their self-verification motive (Swann, 1997, 2011) affect the relative cognitive effort required for positive vs. negative self-referential processing.

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