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Source memory that encoding was self-referential: the influence of stimulus characteristics

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ABSTRACT

Decades of research suggest that encoding information with respect to the self improves memory (*self-reference effect, SRE*) for items (*item SRE*). The current study focused on how processing information in reference to the self affects source memory for whether an item was self-referentially processed (a *source SRE*). Participants self-referentially or non-self-referentially encoded words (Experiment 1) or pictures (Experiment 2) that varied in valence (positive, negative, neutral). Relative to non-self-referential processing, self-referential processing enhanced item recognition for all stimulus types (an *item SRE*), but it only enhanced source memory for positive words (a *source SRE*). In fact, source memory for negative and neutral pictures was worse for items processed self-referentially than non-self-referentially. Together, the results suggest that item SRE and source SRE (e.g., remembering an item was encoded self-referentially) are not necessarily the same across stimulus types (e.g., words, pictures; positive, negative). While an *item* SRE may depend on the overall likelihood the item generates any association, the enhancing effects of self-referential processing on source memory for self-referential encoding may depend on how embedded a stimulus becomes in one's self-schema, and that depends, in part, on the stimulus' valence and format. Self-relevance ratings during encoding provide converging evidence for this interpretation.

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A *self-reference effect* (SRE) in memory is said to occur when information that is processed with reference to the self (e.g., does this adjective describe you?) is remembered better than information processed in other ways (e.g., semantically [e.g., judging whether adjectives are commonly used in the English language]; Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997). Historically, the SRE has focused on item memory using recognition and recall tests, with far fewer studies investigating source memory for specific features of events (i.e., details such as encoding task, background scene, assigned ownership; Johnson, Hashtroudi, & Lindsay, 1993; Kahan & Johnson, 1992; Kim & Johnson, 2012; Leshikar & Duarte, 2012, 2014; Serbun, Shih, & Gutchess, 2011). One early source memory study examined memory for trait adjectives that had been exchanged in an experimental "social" situation (Kahan & Johnson, 1992). It found that under conditions of equal old/new item recognition, participants were better able to identify the self vs. another person as the *generator* of items than to identify the self vs. the other person as the *referent* of items (see related findings from the *destination memory* literature, e.g., Gopie & MacLeod, 2009). This result highlights that it is not always obvious how self-referential processing might affect memory for the different aspects of an event. Here we focus specifically on whether participants remember that an item was self-referentially processed (i.e., remember the encoding task). Given the most common theoretical interpretations of the SRE, this is a particularly interesting aspect of source memory.

Theoretical explanations for the SRE include the notion that self-referential processing, compared to other encoding tasks (e.g., making semantic judgements), encourages greater elaborative and/or organisational processing that taps into well-established networks (or schemas) of self-related knowledge and/or memories (e.g., Keenan, Golding, & Brown, 1992; Klein & Loftus, 1988; Klein, 2012; Klein & Nelson, 2014; Symons & Johnson, 1997). For example, a self-descriptive encoding task (e.g., judging whether a word describes you) and an autobiographical encoding task (e.g., thinking about a party you attended with friends) are speculated to recruit self-relevant information from semantic and episodic memory, respectively (Klein & Nelson, 2014). Thus, the association of an item with the self is presumably central to the item SRE.

Other research has suggested that the emotional valence of stimuli can influence how information is organised and incorporated into one's self-relevant network.

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Investigators interested in self-referential memory for emotional information (e.g., trait adjectives, autobiographical memories) have proposed that individuals may be more motivated to associate positive than negative information with the self, and hence better remember it, in order to protect themselves against potential threats to their positive self-image (D'Argembeau, Comblain, & Van der Linden, 2005; D'Argembeau & Van der Linden, 2008; Sedikides & Green, 2000). For example, individuals report a greater number of contextual details for memories of positive autobiographical events than negative events (D'Argembeau, Comblain, & Van der Linden, 2003). Thus, it is possible that the SRE might be more likely to occur for positive than negative stimuli, assuming positive self-knowledge is more easily and readily accessible for activation and individuals are more motivated and willing to incorporate positive information into their self-schema.

Several studies, using trait adjectives as stimuli, have examined the SRE with respect to emotional valence. The majority of these studies have shown that the size of the SRE does not vary depending on valence (D'Argembeau et al., 2005, Experiment 2; Fossati et al., 2004; Gutchess, Kensinger, Yoon, & Schacter, 2007 [Experiments 2, 3, but see Experiment 1]; Pauly, Finkelmeyer, Schneider, & Habel, 2013; Yang, Truong, Fuss, & Bislimovic, 2012; Yoshimura et al., 2009). One notable exception is a study by D'Argembeau and colleagues (2005, Experiment 1) that showed a bigger SRE for the recall of positive than negative trait adjectives. To our knowledge, only one study has explicitly investigated the SRE using positive and negative pictures (Hess, Popham, Dennis, & Emery, 2013, Experiment 2). In contrast to the pattern found in trait adjective studies, Hess et al. (2013) found that among social pictures (i.e., pictures that included people), self-referential encoding (i.e., imagining themselves, a close family member, or a friend in the situation depicted in the picture) significantly increased recall of positive pictures, but did not enhance recall of negative pictures; self-referential encoding did not enhance the recall of either positive or negative nonsocial pictures. It is unclear if Hess et al.'s (2013) findings for recall of pictures would generalise to other measures of item memory given that valence differences in the SRE for recognition of pictures has not been examined. In sum, there is some evidence to suggest that whether there is an impact of emotional valence on the size of the SRE for item recognition could depend on the stimulus format. More evidence would help clarify this issue.

In any event, findings regarding item recognition or recall do not constitute strong evidence that information has been organised with respect to the self because item memory alone does not indicate whether participants remember that the item in question was processed with respect to the self (Kahan & Johnson, 1992). *Source memory* refers to memory for features or details associated with an event that help distinguish it from other events (e.g., where did I meet this person, Johnson et al., 1993). Item recognition and source memory are sometimes dissociable (Johnson et al., 1993; see Cook, Hicks, & Marsh, 2007, for discussion); thus an *item* SRE is potentially dissociable from a *source* SRE (e.g., Serbun et al., 2011, Experiments 2, 3). For example, self-referential processing could increase attention to an item, engaging processes that increase item recognition, without necessarily connecting the item to the self, which would be necessary to enhance source memory for self-referential processing. Accurate source memory that processing was self-referential would be strong evidence that an item-self association was established.

There are a few studies that have focused on how self-referential processing affects various aspects of source memory (e.g., Hamami, Serbun, & Gutchess, 2011; Kim & Johnson, 2012; Leshikar & Duarte, 2012, 2014; Leshikar, Dulas, & Duarte, 2015; Serbun et al., 2011). For example, some studies have found that self-referential processing enhances specific memory (i.e., the ability to distinguish between same and similar items), which requires memory for specific, source features (e.g., colour, orientation, Hamami et al., 2011). But, not all source features and attributions are the same (e.g., Kahan & Johnson, 1992). Critically, few studies have assessed source memory for whether the self was the *referent* of the processing, which, as discussed above, would provide strong evidence that an item-self association was established. In one such study using trait adjectives as stimuli, participants were asked at encoding to judge, on different trials, if trait adjectives were self-descriptive, commonly encountered, or presented in uppercase letters (Serbun et al., 2011, Experiment 2, see also Experiment 3). On a later source memory test, participants had to identify which encoding condition the word had been presented in ("self", "common", "case") or whether the word was new. Participants showed better source identification for words encoded self-referentially relative to each of the other encoding conditions. This finding supports the idea that people have better source memory for the encoding task when words are processed self-referentially (e.g., deciding if a word is self-descriptive) than non-self-referentially.

Evidence of a *source* SRE for pictures is even more limited, but one study with a less direct manipulation of self-referential encoding offers some potentially relevant information (Leshikar & Duarte, 2012). In this study, participants were shown a series of objects overlaid onto background scenes and asked to judge whether they found the object-scene pairing pleasant. This manipulation was characterised as *self-referential* by the authors because it asked participants to evaluate their own thoughts and feelings about the object-scene pairing. They compared this judgement to a condition in which participants decided whether the background scene contained the dominant colour of the object picture (i.e., the *self-external* condition). At test, participants judged whether they had previously seen the object during encoding (i.e., old/new recognition) and if so, participants made two source judgements: (1)

whether the object was encoded in the self-referential or self-external condition, and (2) which background scene had been paired with the object. Results showed that there was a greater likelihood that *both* source judgements would be correct if the item had been encoded self-referentially. However, further analysis revealed that the probability of a correct source judgement for just the encoding task (regardless of whether or not the background scene was correctly identified) was greater for the self-external than the self-referential condition, suggesting that self-referential encoding did not necessarily enhance the association between objects and the self. Although it is possible that the different results in the Serbun et al. (2011) and Leshikar and Duarte (2012) studies resulted from the nature of the self-referential encoding task (i.e., self-descriptive vs. judging pleasantness), it is also possible that the effects of self-referential processing on source memory for having encoded information self-referentially vary depending on whether words or pictures are used as stimuli.

Although the self-referential studies that use pictures as stimuli have not examined source memory as a function of stimulus valence, a recent study using words as stimuli may provide possible clues as to how valence might affect *source* SRE. Leshikar, Dulas, et al. (2015) asked young and older adults to decide whether positive and negative adjectives were either self-descriptive ("self") or commonly used words ("common"). After deciding whether the word had been seen during encoding (i.e., remember/know/new recognition), participants made a source judgement about the encoding task (i.e., "self", "common", or "don't know"). When words had been encoded in the common condition, both age groups exhibited better source accuracy for negative words. In contrast, when words had been encoded self-referentially, older adults had better source memory for positive than negative words; the same pattern was observed in young adults, but was only marginally significant ($p = .06$). This pattern suggests that one might expect different *source* SREs for positive and negative stimuli. In this case, positive > negative for self-referentially encoded words (see also Leshikar, Park, & Gutchess, 2015, for a similar pattern using a different procedure), which is consistent with the idea that people are more likely to associate positive information with the self (D'Argembeau et al., 2005; D'Argembeau & Van der Linden, 2008; Sedikides & Green, 2000).

From a source monitoring perspective, encoding should improve source memory when the processes engaged during encoding encourage attention to, and binding of, the source specifying details that will be tested (e.g., Johnson et al., 1993; Johnson, Nolde, & De Leonardis, 1996). Variables do not necessarily affect item and source memory the same way. For example, emotion sometimes heightens attention to items but negatively affects the binding of source details to the item (e.g., Johnson et al., 1996; Mather et al., 2006; see Mather, 2007, for a review). Theoretical interpretations of the SRE imply that remembering that the self was the referent of processing should be related to how well items are associated with a network of self-related information (e.g., self-schemas, autobiographical memories; e.g., Keenan et al., 1992). Furthermore, some theorising postulates that connecting information to the self should be affected by motivational dynamics (e.g., protecting one's self-image; D'Argembeau et al., 2005; D'Argembeau & Van der Linden, 2008; Sedikides & Green, 2000) that are sensitive to the valence of information. The present study investigated these ideas. Given that individuals may be more motivated to activate positive self-knowledge and incorporate positive information into their self-schema (D'Argembeau & Van der Linden, 2008; Sedikides & Green, 2000), we asked whether the *source* SRE would be greater for positive than negative stimuli. In addition, based on previous evidence suggesting that the impact of emotion on the SRE may vary by stimulus format, we assessed memory of both words (Experiment 1) and pictures (Experiment 2). To gain leverage on the critical theoretical question of whether self-referential processing actually results in associating information with the self, we (a) obtained participants' ratings of the self-relevance of the information, and (b) assessed participants' source memory for whether the information had been processed self-referentially.

Experiment 1

Method

Participants

Twenty-four students (*M* age = 20.6 years, $SD = 3.2$; 12 females) participated. The sample size (target $n = 24$) was selected in advance based on that of similar studies (e.g., Leshikar, Dulas, & Duarte [2015, Experiment 1] n's = 24 young and 24 older adults; Serbun et al. [2011, Experiment 3] N = 24; Schmidt, Patnaik, & Kensinger [2011, Experiments 1 and 2] $N = 24$). Because memory for valenced stimuli can differ significantly between depressed and non-depressed individuals (e.g., Denny & Hunt, 1992; Hamilton & Gotlib, 2008; Sanz, 1996), we screened for depression using the Beck Depression Inventory (BDI; Beck, Steer, & Carbin, 1988; administered after the memory test). No participants were excluded for this, or any other, reason. All participants provided written informed consent in accordance with a protocol approved by Yale University's Human Subjects Committee.

Materials

Stimuli consisted of 432 words (144 each positive, negative, neutral), representing various parts of speech, taken from the Affective Norms for English Words database (Bradley & Lang, 1999; e.g., *wealthy*, *scream*, and *salad*, for positive, negative, and neutral words, respectively). The absolute valence differences between positive and neutral stimuli and between neutral and negative stimuli were equivalent.

Table 1. Mean (standard error) valence ratings for stimuli in experiment 1 (words) and experiment 2 (pictures).

	Words	Pictures
Positive	7.41 (.04)	7.07 (.04)
Negative	2.79 (.05)	2.90 (.04)
Neutral	5.10 (.04)	5.05 (.02)

Mean valence ratings are listed in Table 1. Positive and negative stimuli were equated for arousal (positive words: $M = 5.68$, $SD = 0.81$; negative words: $M = 5.70$, $SD = 0.86$; $p = .83$). By definition, positive and negative stimuli were significantly more arousing than neutral stimuli ($M = 3.84$, $SD = 0.43$; both $ps < .001$). Positive, negative, and neutral words were equated for word length, frequency, familiarity, and imageability based on scores provided by the Medical Research Council (MRC) Psycholinguistic Database (Coltheart, 1981; all $ps > .08$). Perhaps not surprisingly, neutral words were more concrete than positive or neutral words (both $ps < .001$), but importantly, concreteness did not differ between positive and negative words ($p > .20$). Means for these stimulus characteristics are available from the first author.

The words were divided into two sets to be used as studied and non-studied stimuli (i.e., lures during the memory test); the sets were equated along all stimulus dimensions (e.g., valence, word frequency, etc.) and counterbalanced across participants. Each set contained 72 words from each of the 3 valence categories (e.g., positive). Each study set was then further divided into 2 sets of 108 (36 of each valence) that were equated along all stimulus dimensions and used in each task condition (self-referential, non-self-referential) an equal number of times across participants.

Procedure

Participants were presented with 216 words (108 encoded self-referentially, 108 encoded non-self-referentially; 36 words within each encoding condition were positive, negative, neutral) in lowercase letters (Arial 48pt font) in the centre of the computer screen for 3000 ms followed by a 1000 ms interstimulus interval (ISI). For each word, participants were asked to make either a self-referential or non-self-referential judgement. Prompts were displayed simultaneously underneath each word to serve as a reminder of the type of judgement required for each rating. For words requiring a self-referential judgement ("Me?" prompt), participants were instructed to rate the degree of personal relevance for the concept that each word represented on a scale from 1 (low) to 4 (high). For example, during the practice instructions, participants were shown the word *coffin* and were instructed to rate the extent to which the word reminded them of "something that is personally relevant". For words requiring a non-self-referential judgement ("Story?" prompt), participants were asked to rate the likelihood that the word would appear in a current news story using the same 1–4 scale. Stimuli were blocked by encoding task (Me, Story), with 18 stimulus items per block. Within each block, valence was pseudorandomised so that no more than two of the same valence type occurred in succession. Blocks were pseudorandomly presented so that no more than two of the same type of encoding task occurred in a row.

As a distraction task after encoding, participants completed an abbreviated version of the vocabulary subscale of the Wechsler Adult Intelligence Scale (Wechsler, 1987) and a demographics questionnaire. After this 15-minute delay interval, participants were given a surprise memory test. All 216 words from encoding (i.e., targets) plus 216 new, non-studied words (i.e., lures) were pseudorandomly intermixed such that no more than three of the same valence type, encoding task judgement, or targets/lures occurred in succession. The same test was administered to all participants. Test stimuli were presented in 6 blocks of 72 words each. Words were presented for 3000 ms, in all uppercase letters (Arial 42pt font), followed by a 1000 ms ISI. Underneath each test stimulus were the cues "Me", "Story", and "New" (Arial 32pt font), and participants were asked to decide whether: (a) the word appeared during encoding and they had judged the self-relevance of the word, (b) the word appeared during encoding and they had made the non-self-referential judgement about how often the word would appear in a current news story, or (c) it was a new, non-studied word.

Results

Encoding ratings

The 1–4 response scale that participants used to make rating judgements during encoding was collapsed into two categories, low (ratings of 1 or 2) and high (ratings of 3 or 4). Table 2 shows the mean proportions of responses given a high rating (note that the proportion of low ratings is equal to 1 − the proportion of high ratings). A 2 (encoding task: self-referential, non-self-referential) × 3 (valence: positive, negative, neutral) repeated measures ANOVA on the mean proportion of high ratings of words showed no main effect of encoding task, $F(1, 23) < 1$, a significant effect of valence, $F(2, 46) = 36.47$, $p < .001$, $\eta_p^2 = .61$ (positive > negative > neutral; all $ps < .01$),

Table 2. Mean proportion (standard error) of items given a high rating in the self-referential and non-self-referential conditions in experiment 1 (words) and experiment 2 (pictures).

		Words	Pictures
Self-referential			
	Positive	.57 (.04)	.45 (.04)
	Negative	.30 (.03)	.17 (.03)
	Neutral	.34 (.03)	.43 (.05)
Non-self-referential			
	Positive	.42 (.03)	.35 (.05)
	Negative	.53 (.03)	.50 (.03)
	Neutral	.25 (.02)	.48 (.03)

Note. Ratings were binned into low (1, 2) and high (3, 4) categories; low ratings are equal to 1 minus high ratings.

and a significant interaction, $F(2, 46) = 58.78$, $p < .001$, $\eta_p^2 = .72$. This interaction arose because ratings for items in the self-referential condition were higher than ratings in the non-self-referential condition for positive and neutral items, but the reverse was true (non-self > self) for negative items (all *ps* < .03). Consistent with previous literature, as discussed in the Introduction, this finding suggests that positive and neutral words were more likely to be associated with the self than negative words.

Item recognition

We assessed item recognition, regardless of source accuracy (see Table 3, top). Corrected recognition scores were calculated as the proportion of hits (targets recognised as old) minus the proportion of false alarms (new items falsely recognised as old) and were analysed using a 2 (encoding task: self-referential, non-self-referential) × 3 (valence: positive, negative, neutral) repeated measures ANOVA.

There was a significant main effect of encoding task, $F(1, 23) = 28.15$, $p < .001$, $\eta_p^2 = .55$; words encoded self-referentially ($M = .71$) were recognised better than words encoded non-self-referentially ($M = .63$). There was also a main effect of valence, $F(2, 46) = 5.99$, $p < .01$, $\eta_p^2 = .21$. Pairwise comparisons showed that neutral words ($M = .72$) were recognised better than positive ($M = .66$; $p < .05$) and negative ($M = .65$, $p < .01$) words, which did not differ significantly from each other ($p > .10$).[1] The encoding task × valence interaction was not significant, $F(2, 46) = 0.03$, $p > .10$, $\eta_p^2 = .001$, meaning that the *item* SRE did not differ across valence types.

Table 3. Mean proportion (standard error) of hits, false alarms, and corrected recognition for experiment 1 (top) and experiment 2 (bottom).

Words	Positive	Negative	Neutral
Self-referential			
Hits	.83 (.03)	.87 (.02)	.84 (.03)
False alarms	.14 (.03)	.19 (.04)	.08 (.02)
Corrected recognition	**.70 (.05)**	**.68 (.05)**	**.76 (.04)**
Non-self-referential			
Hits	.76 (.03)	.80 (.02)	.76 (.03)
False alarms	.14 (.03)	.19 (.04)	.08 (.02)
Corrected recognition	**.62 (.05)**	**.61 (.05)**	**.68 (.04)**
Pictures	Positive	Negative	Neutral
Self-referential			
Hits	.80 (.03)	.79 (.03)	.86 (.03)
False alarms	.11 (.02)	.12 (.03)	.10 (.02)
Corrected recognition	**.70 (.04)**	**.67 (.04)**	**.76 (.04)**
Non-self-referential			
Hits	.67 (.03)	.75 (.03)	.76 (.03)
False alarms	.11 (.02)	.12 (.03)	.10 (.02)
Corrected recognition	**.56 (.04)**	**.63 (.04)**	**.66 (.04)**

Notes. Hits refer to judging a target item as old, regardless of source judgement; false alarms refer to judging a new item as old, regardless of source judgement. Given that lures are not processed self-referentially or non-self-referentially, the false alarm rate is the same in both conditions. Mean corrected recognition was calculated by subtracting each participant's mean proportion of false alarms from their mean proportion of hits, and the group means of these differences are indicated in the table. Hence, in some cells this mean is slightly different (.01) than if you simply subtract the group mean false alarms from the group mean hits (see, e.g., positive self-referential pictures).

Source memory

Of primary interest was participants' source memory for the encoding task. Correct source memory was calculated as the mean proportion of correctly recognised items that were attributed to the correct source (e.g., Foley, Johnson, & Raye, 1983). The means are shown in Figure 1. Data were analysed using a 2 (encoding task: self-referential, non-self-referential) × 3 (valence: positive, negative, neutral) repeated measures ANOVA. The main effects of encoding task and valence were not significant (both *ps* > .10); however, the encoding task × valence interaction was significant, $F(2, 46) = 4.34$, $p < .05$, $\eta_p^2 = .16$. Source memory was better for positive words that were encoded self-referentially compared to non-self-referentially, $t(23) = 2.60$, $p < .05$, but there was no difference in source accuracy between encoding tasks for negative or neutral words (both *ps* > .10).

These findings are discussed after we present the data for pictures.

Experiment 2

The methods for Experiment 2 were the same as Experiment 1, with the following exceptions.

Method

Participants

Twenty-four students (M age = 20.5 years, $SD = 2.4$; 12 females) from the same pool participated. None had participated in Experiment 1. Two additional students participated but were excluded from the analyses based on high scores on the BDI. No other participants were excluded.

Materials

Stimuli were 504 pictures (168 each positive, negative, neutral) taken from the International Affective Picture System database (IAPS; Lang, Bradley, & Cuthbert, 2008). Examples include pictures of a *beach*, *roaches*, and an

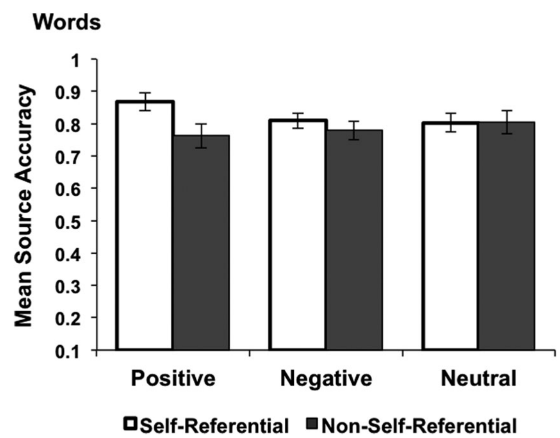

Figure 1. Correct source memory for encoding task in Experiment 1 (words). Error bars are standard error of that bar's mean.

umbrella, for positive, negative, and neutral stimuli, respectively. As in Experiment 1, valence was balanced (see Table 1) and arousal was equated (positive pictures: $M = 5.28$, $SD = 0.86$; negative pictures: $M = 5.34$, $SD = 0.84$; $p = .53$). Neutral pictures ($M = 3.36$, $SD = 0.58$) were less arousing than positive or negative pictures (both *p*s < .001). Visual complexity, brightness, and the number of pictures containing people did not significantly differ between positive and negative pictures (*p*s > .07).[2] However, due to the nature of neutral images within the IAPS database, the neutral pictures that were chosen to meet other constraints were brighter than negative pictures ($p < .01$), contained fewer people, and were less visually complex than positive and negative pictures (all *p*s < .001). The pictures were divided into sets that served as stimuli in each encoding task and as targets and lures on the source memory test, balanced on all dimensions, and counterbalanced across participants, as described in Experiment 1

Procedure

Participants encoded 252 pictures (126 encoded self-referentially, 126 encoded non-self-referentially; 42 within each encoding condition were positive, negative, neutral). Pictures (500 × 375 pixels; 1920 × 1080 screen resolution) were displayed in the centre of the computer screen for 3000 ms each followed by a 1000 ms ISI. The prompt for the self-referential judgement was “Me?” and participants were instructed to rate the degree of personal relevance for the concept that each picture represented on a scale from 1 (low) to 4 (high). For example, during the practice instructions, participants were shown a picture of a family and were instructed that even though this specific picture of a family may not look like their own family, they should rate the extent to which the concept depicted by the picture (i.e., “family”) is self-relevant. For pictures requiring a non-self-referential judgement, the prompt was “Quality?” and participants were asked to rate the overall perceptual quality of each picture by assessing the overall visual characteristics (e.g., composition, brightness, colour, clarity) using the same 1–4 scale. Participants were instructed that ratings of 4 (high) indicate that the picture could likely be featured in a high-quality magazine.

After the same distraction task used in Experiment 1, participants were tested on all 252 pictures that were presented during encoding plus 252 new pictures, pseudorandomly intermixed and presented in 6 blocks of 84 pictures each. All other details of the test were the same as Experiment 1, except that the source options were “Me”, “Quality”, and “New”.

Results

Encoding ratings

A 2 (encoding task: self-referential, non-self-referential) × 3 (valence: positive, negative, neutral) repeated measures ANOVA on the mean proportion of high ratings of pictures (see Table 2) showed that the main effect of encoding task just missed the traditional cut-off for significance, $F(1, 23) = 4.08$, $p = .055$, $\eta_p^2 = .15$ (non-self > self). There was a significant main effect of valence, $F(2, 46) = 11.28$, $p < .001$, $\eta_p^2 = .33$ (neutral > positive > negative; all *p*s < .05), and a significant interaction, $F(2, 46) = 33.85$, $p < .001$, $\eta_p^2 = .60$. This interaction arose because the ratings for items in the self-referential condition were significantly lower than in the non-self-referential condition for the negative items ($p < .001$), but there was no difference between encoding conditions in the ratings for positive or neutral items (both *p*s > .10). Thus, as with negative words in Experiment 1, it appears that negative pictures were less likely to be associated with the self than were the positive or neutral pictures.

Item recognition

Corrected recognition scores (see Table 3, bottom) were analysed as in Experiment 1. There was a main effect of encoding task, $F(1, 23) = 22.96$, $p < .001$, $\eta_p^2 = .50$; pictures encoded self-referentially ($M = .71$) were recognised better than pictures encoded non-self-referentially ($M = .62$). A significant main effect of valence was also observed, $F(2, 46) = 12.25$, $p < .001$, $\eta_p^2 = .35$. Pairwise comparisons showed that there was better recognition of neutral pictures ($M = .71$) than positive ($M = .63$; $p < .001$) or negative ($M = .65$; $p < .01$) pictures, which did not differ significantly from each other ($p > .10$).[1] The encoding task × valence interaction was also significant, $F(2, 46) = 7.89$, $p = .001$, $\eta_p^2 = .26$; there was a significant item SRE for positive, $t(23) = 5.25$, $p < .001$, and neutral pictures, $t(23) = 4.65$, $p < .001$, but the SRE was only marginal for negative pictures, $t(23) = 1.81$, $p = .08$.

Source memory

Correct source memory for the encoding task using pictures (see Figure 2) was analysed as in Experiment 1. There was a main effect of encoding task, $F(1, 23) = 9.51$, $p < .01$, $\eta_p^2 = .29$, with better source memory for pictures encoded non-self-referentially ($M = .82$) than self-referentially ($M = .70$). There also was a main effect of valence, $F(2, 46) = 9.78$, $p < .001$, $\eta_p^2 = .30$, with better source memory for both positive pictures ($M = .77$, $p = .01$) and neutral pictures ($M = .80$, $p < .001$) than negative pictures ($M = .72$). The difference between source memory of positive and neutral pictures was marginally significant ($p = .09$). The encoding task × valence interaction was significant, $F(2, 46) = 4.60$, $p < .05$, $\eta_p^2 = .17$; source memory was better for both negative and neutral pictures encoded non-self-referentially than self-referentially, $t(23) = 2.42$, $p < .05$, $t(23) = 4.87$, $p < .001$, for negative and neutral, respectively, and source accuracy did not differ between encoding tasks for positive pictures ($p > .10$).

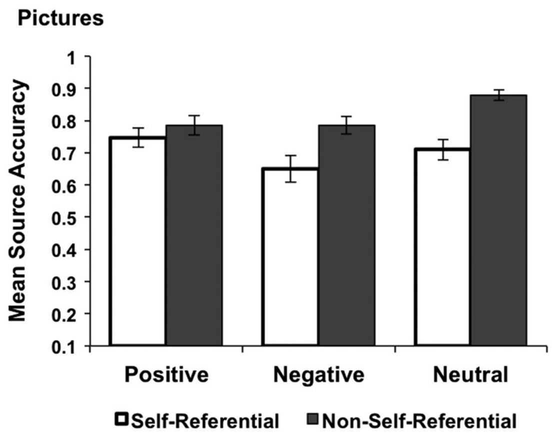

Figure 2. Correct source memory for encoding task in Experiment 2 (pictures). Error bars are standard error of that bar's mean.

Discussion

The current study explored the consequences of self-referential processing on item recognition and source memory. In particular, we were interested in whether people's memory for the encoding task (i.e., processing information self-referentially) depended on the valence and/or format of the item. Importantly, participants' evaluative ratings of self-relevance during encoding provided a converging index of how self-relevant the items were for each participant.

With respect to the question of whether participants recognised an item as old, regardless of whether they remembered whether it was processed self-referentially (i.e., old/new recognition), we found that for words, the magnitude of the *item* SRE was similar for all valence types, replicating previous findings (e.g., Fossati et al., 2004; Yang et al., 2012). For pictures, self-referential processing increased old/new recognition of positive and neutral pictures, but only marginally for negative pictures. This pattern for pictures is consistent with the results of Hess et al. (2013, Experiment 2) showing enhanced recall after self-referential encoding of positive, but not negative, social pictures. Taken together, these results are generally consistent with previous findings of an *item* SRE under various conditions.

As noted in the Introduction, an *item* SRE (e.g., for old/new recognition) alone does not speak to the issue of whether self-referential processing results in a persisting item-self association. Our source memory task (i.e., was this item processed with respect to yourself vs. in the story/perceptual quality task) was directed at this issue. Prior research has found that self-referential encoding of words can enhance source identification for the encoding task relative to other encoding conditions (e.g., Serbun et al., 2011); however, that study did not speak to the issue of whether source accuracy depends on the valence of the words. In our study, for words, source memory was better for positive items processed self-referentially than those processed non-self-referentially, but this was not true for negative or neutral items. Thus, the advantage in *item* recognition for self-referentially processed words, regardless of valence, cannot simply be attributed to associations between items and the self. For pictures, we found no benefit in source memory for items that were processed self-referentially in any of the valence categories. In fact, we actually found the opposite for neutral and negative pictures – better source memory for the non-self-referential task. As for words, this pattern suggests that the item SRE for pictures cannot be attributed primarily to an association established at encoding between the self and the pictures. In short, the findings from Experiments 1 and 2 clearly suggest that a *source* SRE depends on the valence and format of the items being processed, but that the *item* SRE is less sensitive to these factors and, importantly, an *item* SRE does not necessarily imply an item-self association.

According to the Source Monitoring Framework (Johnson et al., 1993), self-referential encoding should be beneficial for source memory when the processes engaged during encoding bind features to items such that they later can serve as diagnostic cues for correct source identification. For example, if during encoding, a specific self-relevant association is generated (e.g., I am usually *kind*; that *dog* reminds me of one I had as a child), it might later be activated during remembering and serve as evidence that the item was processed self-referentially. Our findings suggest that binding the self as a contextual feature, which can then be used as a cue for a later source judgement, is more likely to occur for positive than negative words, and unlikely to occur for the types of negative pictures that were used in the present study. This would be consistent with the idea that positive stimuli (in this case, especially words) garner processing priority (Mather & Sutherland, 2011) in a top-down fashion when motivationally relevant (e.g., self-protection; D'Argembeau & Van der Linden, 2008; Sedikides & Green, 2000).

The greater likelihood of associating positive than negative or neutral words with the self is consistent with the idea that positive aspects of the self are more easily activated than negative aspects of the self and/or that individuals are motivated to process information in a way that preserves a positive self-concept (e.g., D'Argembeau et al., 2005; D'Argembeau & Van der Linden, 2008; Sedikides & Green, 2000). The finding that negative pictures yielded especially poor source memory for the items that were processed with respect to the self is consistent with the lower self-relevance ratings for those items and supports the general idea that people do not easily incorporate negative information into their self-schema. The reverse *source* SRE for pictures, but not for words, suggests that negative pictures are especially unlikely to elicit self-referential associations. Why might that be the case?

Compared to individual words, pictures like those used in the present study are quite specific. Words are relatively open to interpretation depending on context (e.g., Bransford & Johnson, 1973), which might make them good cues for activating self-relevant information from episodic memory or one's self-schema, making it easier to (or more likely one will) create an item-self association. In contrast, pictures often depict more specific situations that might be less likely than words to initially or quickly cue a self-relevant association. For example, the word "death" might cue any number of self-relevant thoughts or memories, such as the recent death of a family member or pet; one's fears of illness, death, or a terrorist attack; or the excitement of successfully making the sudden death kick in a soccer match. On the other hand, viewing a picture of a dying person in a hospital may prime individuals to think about death specifically in the context of a hospital, which might, for many people, limit the type of self-relevant information activated, possibly making it less likely to find a self-relevant association. Although the pictures were balanced across valence categories on several features (see Method section), it could be the case that the positive (e.g., cake, money) and neutral (e.g., luggage, towel) pictures we used depicted more generic or familiar situations than the negative pictures (e.g., gun, graveyard) for our sample of students. Although the patterns of self-relevant ratings and source memory performance suggest there is not a perfect association, negative pictures were by far the least likely to be given high self-relevance ratings during our encoding task (see Table 2), which provides evidence consistent with the idea that negative pictures may be relatively unlikely to produce self-referential associations. It should be noted that although we equated the words and pictures reasonably well on stimulus intensity, we did not equate the content of the items in the two studies (e.g., the word *coffin* and a picture of a coffin). Hence, discussion of similarities and differences in the pattern of findings for the two experiments is speculative. Future research would benefit from equating the content of the items across stimulus modalities.

The nature of self-referential tasks and the control conditions used in studies examining the SRE vary widely across the literature. We thought it was important to use manipulations similar to those in some of the studies we were comparing to in developing the rationale for our study (e.g., Serbun et al., 2011: words with self-descriptive vs. commonly encountered tasks; Leshikar & Duarte, 2012: pictures with pleasantness vs. dominant colour tasks). The net result was that there were differences between the control tasks that were used in the two experiments presented here. Whereas the control condition in Experiment 1 asked participants how likely it was that the word would appear in a news story, in Experiment 2 participants were asked to decide how likely it was that the picture would appear in a high-quality magazine. The first instruction probably encouraged semantic processing and the second instruction probably encouraged perceptual processing. Such processing differences may be characteristic of how people process words and pictures, and hence may play an important role in producing differences in the source SRE between words and pictures. It is indeed challenging to determine the appropriate control condition that would be an equally natural way to process both pictures and words. However, it should be noted that these materials and procedures yielded generally similar old/new recognition for words and pictures (see Table 3); thus, differences in old/new recognition are unlikely to explain the differences between the two experiments in the source SRE. Furthermore, there was no difference in the response times for participants to make their ratings in the self-referential and non-self-referential tasks for positive words in Experiment 1 ($p = .39$) or positive pictures in Experiment 2 ($p = .58$). This suggests that participants spent a comparable amount of time processing and evaluating the stimuli in the self and non-self encoding conditions in the two experiments, but there was a significant source SRE in Experiment 1 but not Experiment 2 for positive stimuli. In addition, whereas participants took longer to make their self than non-self encoding ratings for negative words in Experiment 1 ($p < .001$), there was no difference in source memory; there was no difference in rating response times between the self and non-self task for negative pictures in Experiment 2 ($p = .19$), yet source memory was better in the non-self than self condition. This complex pattern of response times suggests that differences in "time on task" due to differences in the nature of the self and non-self tasks is not a plausible explanation for differences in the SRE between experiments. Nevertheless, to better compare the source SRE between stimulus formats, future studies would benefit from incorporating words and pictures within a single study and including a non-self-referential encoding task that could apply to both stimulus types (e.g., relevance for a close other or famous other).

In summary, we had two measures of people's likelihood of associating an item with the self – their initial ratings of self-relevance during the encoding phase and their subsequent source memory judgement that an item had been processed with respect to the self. Together, this information provides information about the mechanisms underlying SREs. An *item* SRE may be supported by associations of any type (including, but not limited to, item-self associations) arising from the greater attention typically given items to be processed self-referentially compared to typical non-self-referential tasks. Regardless of stimulus characteristics such as valence and format, associations sufficient for supporting item recognition are likely to be created. The pattern of the *source* SRE, on the other hand, is consistent with the idea that people are likely to form item-self associations for positive words and unlikely to form item-self associations for negative pictures. The self-relevance ratings provide further evidence supporting this idea. We have proposed that this difference is driven in part by the openness of words to interpretation vs. the specificity of pictures, which in turn may make it more likely that positive words will become associated with semantic or autobiographical aspects of our self than negative pictures. Of course, context is likely to shift such a pattern. Systematically investigating the similarities and differences in these and other factors that dissociate *item* and *source* SREs should further clarify, or generate interesting hypotheses about, the mechanisms that support SREs. Furthermore, given that individuals use their own self-schema to process information self-referentially, it would be interesting for future research to determine whether individual differences on various measures, such as self-esteem or life satisfaction, moderate these findings.

Notes

1. Although item recognition for emotional, especially negative, items is often higher than neutral items; this is not always the case. In particular, corrected recognition, such as reported here, is sometimes worse for emotional items. This is especially true for negative items, which typically show modestly better hit rates accompanied by substantially inflated false alarm rates relative to neutral items (e.g., Cook et al., 2007; Maratos, Allan, & Rugg, 2000). Given that better memory for neutral stimuli occurred in both the self- and non-self-referential conditions, it seems unlikely to be due to our specific encoding tasks, rather it seems more likely to us that it was driven by stimulus characteristics. For example, despite the fact that words were equated on imageability, neutral words were more concrete than emotional words, which may have enhanced memory for neutral words relative to the emotional words. Likewise, in Experiment 2, neutral pictures were less complex (e.g., more likely to be pictures of single objects, such as an umbrella or tissues) and it might have been easier to make recognition judgments about these less complex object-based pictures than more complex scenes (e.g., war images). In any event, the difference in item memory between the neutral and emotional items is not the main focus of this paper, and we see no easy way that it could account for the key differences in source SRE for positive and negative items.
2. In general, samples of positive, negative, and neutral IAPS pictures are likely to vary on a number of dimensions. In addition to identifying the pictures that included people and measuring the brightness of images, we had five people, who did not participate in this study, rate the visual complexity of pictures. Pictures were selected to minimise differences in these characteristics across valences. Other dimensions may vary as well. However, such variation is not problematic for the present purposes, because we are primarily interested in the interaction between valence and the type of processing during encoding (self-referential vs. non-self-referential) and the items appeared equally often in each encoding condition.

Disclosure statement

No potential conflict of interest was reported by the authors.

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