

SURVIVAL OF THE SELF: EXAMINATIONS OF THE ROLE OF SELF-REFERENCE IN
ADAPTIVE MEMORY

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Tayler Eaton

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ABSTRACT

The survival encoding effect, or “adaptive memory”, shows a memory advantage to information processed in the context of one’s own survival. The self-reference effect, which also confers a memory advantage but to information processed in reference to the self, does not grant an advantage to memory recall as great as the survival encoding effect. The present study examines how each of these effects operates across stimuli type, and whether the survival encoding effect operates functionally as a distinct encoding process or as an augmented form of self-reference. Survival encoding and self-referential paradigms were adapted to examine the same concrete noun words in Study 1 (n = 60) and the same abstract trait words in Study 2 (n = 61), parsing out words related to self and other for each encoding process. A within-subjects design was used across five encoding conditions: survival-self, survival-other, self-reference, other-reference, and pleasantness (acting as a deep encoding comparison). In Study 1, significant main effects were found for person (self vs. other) and strategy (survival-relevance vs. self-relevance). In Study 2, a significant main effect was found for person but not strategy. Across both studies, the self-other memory distinction was abolished in the survival condition. These results provide evidence that “adaptive memory” provides a unique and stimuli-specific memory advantage and cannot be understood as an enhanced self-reference effect. Implications for the role of each encoding condition in maladaptive memory are discussed.

BIOGRAPHICAL SKETCH

Taylor Eaton is currently working towards her Ph.D. in Developmental Psychology in the Human Development department at Cornell University. She received an Honours Bachelor of Science degree in Psychology Research and an English Minor from the University of Toronto. Taylor was employed as a research assistant in Epidemiology and Public Health at University College London and a business support specialist at UCL Advances (now UCL Innovation & Enterprise) before beginning her doctoral degree at Cornell.

I dedicate this thesis to my Auntie Jennie, who was never an aunt but always a mother.

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Introduction

Human memory is one of the most compelling areas of research in the fields of psychology and neuroscience. Our memories serve to create identities for ourselves and to help us navigate the broader world. They are what we use to differentiate ourselves as human, rather than organic machines which simply react to proximal stimuli in our environment – but memory itself is a product of both our internal and external environments.

The context of and method by which an event is processed influences the nature of both the memory itself and our ability to recall that memory. Our limited attentional resources, for example, result in the memory formation only for the information to which we choose to direct our attention (Shapiro, et al, 1997). Our emotional state is also known to have a significant impact on memory. Emotionally-arousing events are often remembered to a greater degree than neutral events (Kensinger & Corkin, 2003; Sharot, Martorella, Delgado, & Phelps, 2007) and come with an altered subjective quality, such as enhanced perceived vividness (Todd, et al., 2013). This is an adaptive memory process – if an event is significant enough to trigger emotional arousal, it is worth encoding, consolidating and remembering, as your life may depend on it (Eaton & Anderson, 2018); arousal, however, can also render memory maladaptive following trauma, resulting in intrusive recall (Bryant, et al., 2013; Todd, et al., 2014; Fridman, et al., 2012). In addition to arousal – which has a pronounced effect on post-encoding processes (Anderson, et al., 2006; Cahill & Alkire, 2003) – are the appraisals during encoding that influence later memory, which are often less appreciated in emotional memory. One way of processing an event in the context of one’s own life is the survival encoding effect, also known as “adaptive memory” (Nairne, Thompson & Pandeirada, 2007), which posits that fitness-related stimuli are preferentially encoded and remembered. Such survival encoding has been

consistently replicated (see Nairne, 2014 for a review) across different stimuli. Thus, even under low emotional salience and arousal, the appraisal of an object with regard to survival has substantial memory enhancing benefits. Here we examined how different emotionally-relevant appraisals at encoding influence memory for low emotional salience materials, including neutral concrete nouns in Study 1 and abstract personal traits in Study 2. Examining survival (i.e., survival-relevant or not), self-relevance (me or not), and valence (pleasant or not) encoding in conjunction can reveal whether such appraisals represent common or distinct contributions to adaptive memory, independently of intrinsic emotional significance. Determining the influence of emotion-independent encoding strategies on memory can provide necessary insight into the individual differences involved in the development of maladaptive memory.

Adaptive memory examinations typically involve asking participants to rate common nouns based on their relevance to the participant's survival in an evolutionary hunter-gatherer environment, later testing for free recall. Survival memory shows greater recall for common nouns processed in relation to a survival context than to other schema-evoking contexts (e.g., moving to a new residence), as well as other deep encoding strategies – that is, strategies which use abstract, semantic, or associative processing for greater recall (Craik & Lockhart, 1972; Craik & Tulving, 1975). However, inherent in the processing of one's own survival is self-reference. The self-reference effect demonstrates that information processed in relation to the self is associated with greater recall and recognition memory (Rogers, et al, 1977; see Cunningham & Turk, 2017 for a review). Given the importance of the role of altered sense-of-self and perceived threat to survival in extreme emotional reactions in peritraumatic processing (Ehlers & Clark, 2000), it is important to determining the specific role self-referential processing has in the survival encoding effect. This will allow for a deeper understanding of the effect of

specific cognitive appraisals on emotional and trauma-related memory. The purpose of the current study is to determine whether survival encoding and self-reference are distinct or common influences on memory recall and how they compare to basic judgements of valence.

Survival encoding results in greater recall than judgments of how easily a word brings to mind an important personal experience (Nairne et al 2007). Other efforts have been made to address the role of self-reference in survival encoding with mixed results, manipulating self-reference by orienting participants toward the survival value of objects for themselves or others (Weinstein, et al. 2008; Kang, et al., 2008; Klein, 2012; Cunningham et al. 2013; Dewhurst et al, 2017). Cunningham, et al. (2013) suggested that between-subjects designs allow for the participant to project the self onto the ‘other’ persona in the paradigm and are therefore insufficient in separating self and other in examining survival encoding. In a repeated measures self/other comparison the self-survival condition had a recall boost over the other survival condition. However, while survival encoding is more powerful than self-reference, and survival processing of the self is more powerful than survival processing of non-self entities, the precise role of self-reference in survival encoding is unknown (Klein, 2012). Specifically, does survival encoding function as an augmented version of self-reference, or is it a unique and distinct encoding process?

Dewhurst and colleagues (2017) questioned the style of self-reference paradigms used in extant survival encoding literature – in particular, the use of episodic self-relevant vignettes. The most robust self-reference effect emerges when one rates the relevance of trait words to oneself (e.g. Maki & McCaul, 1985). When examining both self-reference and survival encoding processes using traits, (e.g., are you honest, is honesty needed for survival) self-referential processing outperforms survival encoding – a result opposite to the typical survival encoding

recall advantage. They also did not find an advantage for survival encoding relative to valence encoding. These findings question the specific nature of survival encoding processing, its relation to self-reference and valence encoding, as well as their specific role in enhancing memory for specific stimuli.

Establishing the survival encoding effect as distinct from self-referential encoding would suggest that the processing of information in the context of life-or-death, irrespective of emotional arousal and of self-relevance, is an appraisal that lends a unique advantage to emotional memories. The current paper aims to further clarify the nature of survival encoding and the role of self-reference in survival encoding across paradigms. We utilise a within-subjects design using a self-other distinction across two studies. In Study 1 we examine the processing effects using concrete nouns; in Study 2 we apply the same paradigm using abstract traits. In Study 1, we hypothesize there will be a recall advantage for survival conditions over reference conditions, and for self-referent conditions over other-referent conditions. If they originate from independent appraisals, then we expect survival and reference encoding effects to be additive. Survival encoding is thought to display adaptive memory as it reflects some evolutionary orientation of assessing survival needs, which concerns the utility of objects in the environment and not personal characteristics needed for survival. As such, we expect material specificity for survival encoding, and thus, in Study 2, memory for personal traits will not be subject to a survival encoding advantage.

Study 1

Rationale

The current study sets out to extend the basic survival encoding findings for use with a within-subjects design and to parse out the roles of self and other appraisals within each of the Survival Encoding and Self-Reference effects. When the Survival Encoding paradigm has been adapted to examine self-other differences previously (Weinstein, et al., 2008; Cunningham, et al., 2013), the stimuli used were the concrete nouns typical of survival encoding literature. When directly comparing the two separate encoding effects, each condition used a separate set of stimuli. The current design therefore attempts to effectively clarify the role of self-reference by controlling for differences in presented stimuli.

Methods

Participants. Sixty (60) undergraduate Cornell students participated in exchange for course extra credit. Running a power analysis in G*Power on a repeated measures ANOVA with two measurements with an alpha level of 0.05 and a medium effect size ($f = .25$) (Faul et al., 2013), the required sample size is 54. All procedures were approved by the Cornell University Institutional Review Board and all participants provided their informed consent.

Materials and design. Five word lists of 32 words (160 words total) were developed from the updated Battig and Montigue norms (Van Overschelde, Rawson, & Dunlosky, 2004) and the updated Clark and Paivio norms (Paivio, Yuille, & Madigan, 1968), which were balanced on valence, word frequency, semantic category, and word length. Meryl Streep was selected as the ‘Other’ figure as 96% of 303 sampled undergraduate Cornell students could identify her and she had the highest pleasantness rating of all sampled celebrities (84%).

Procedure. Upon arrival, participants were brought through the informed consent process and asked to complete the three individual differences questionnaires. Participants were given instructions and taken through a practice rating task. For each condition, the following instructions were presented and each word was rated on a 5 point Likert scale which ranged from “Not relevant at all” to “Extremely relevant” for the survival encoding conditions, “Not well at all” to “Extremely well” for the self-reference conditions, and “Not pleasant at all” to “Extremely pleasant” for the pleasantness condition. Each participant rated words in all five conditions.

Self-Survival. In this task we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you will need to find steady supplies of food and water and protect yourself from predators. You will be presented with a list of words, and we would like you to rate how relevant each word would be for you to have in this survival situation. Some of the words may be relevant and others may not—it is up to you to decide.

Other-Survival. In this task we would like you to imagine that Meryl Streep is stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, she will need to find steady supplies of food and water and protect herself from predators. You will be presented with a list of words, and we would like you to rate how relevant each word would be for Meryl Streep to have in this survival situation. Some of the words may be relevant and others may not—it is up to you to decide.

Self-Referential. In the following set of trials, you will be presented with a list of words and be asked to judge how well each word relates to you. Some will relate to you and others will not – it is up to you to decide.

Other-Referential. In the following set of trials, you will be presented with a list of words and be asked to judge how well each word relates to Meryl Streep. Some will relate to her and others will not – it is up to you to decide.

Pleasantness. In the following set of trials, you will be presented with a list of words and be asked to judge how pleasant or unpleasant you find the word. Some will be pleasant and others will not – it is up to you to decide.

The study controlled and randomized the order of the words presented, as well as counterbalanced the use of each word list across the five conditions using Latin Squares. In addition, each condition was split into word lists of five to six words, and the presentation of each condition in the experiment was counterbalanced using Latin Squares.

Following the word rating paradigm, participants completed a short distractor task involving remembering and recalling a series of digits (as described in Nairne, Thompson & Pandeirada, 2007). They next completed a surprise free recall task which was timed for 10 minutes. Proportion of words recalled was calculated for each condition (the number of words correctly recalled over the number of words presented for each condition).

Results

A two-by-two repeated measures ANOVA was run comparing person (self vs. other) to encoding strategy (survival vs. reference). Self conditions were found to have an advantage over other conditions, with a significant main effect found for person ($F(1,59) = 21.77, p < .001$).

Survival conditions were found to have an advantage over reference conditions, with a significant main effect for strategy ($F(1,59) = 60.41, p < .001$). A significant interaction effect between person and strategy was also found ($F(1,59) = 10.31, p < .01$; see Figure 1). Pairwise comparisons of the interaction revealed that recall for survival self and survival other were both significantly higher than for self-reference ($p < .01; p < .05$) but survival self was not significantly different from survival other ($p = 0.29$). Difference in reaction time and subjective word ratings were found to be nonsignificant across conditions. Order of word presentation did not affect recall ($p = 0.51$). Cohen's d was 0.39.

To assess the above effects relative to valence encoding, we conducted an additional one-way repeated ANOVA with 5-levels representing the distinct encoding strategy conditions. Follow up contrasts on the significant effect of strategy ($F(1,59) = 13.70, p < .001$) revealed that valence encoding had a robust effect on recall, with even self-survival not significantly differing than valence encoding ($p = 0.11$).

Study 1 Discussion

Both survival and self-reference encoding gave a clear recall advantage, with self-survival resulting in numerically the greatest recall. Survival other was more accurate than *both* the self-reference and other-reference conditions, suggesting an additional boost for survival encoding over self-reference. However, the interaction between encoding conditions, revealed a partial lack of independence of these encoding strategies, with a subadditive effect of survival self-encoding. The self-reference effect (self greater than other) was largely abolished within the survival strategy condition. That there was no significant difference in recall between the survival self and survival other conditions may indicate a suppression of the self-reference effect by the survival encoding effect. We can conclude that survival encoding provides a memory

advantage *greater* than that of self-reference, and due to its effect on other-focused processing, operates differently than would be expected of an augmented self-reference effect.

Study 2

Rationale

Although survival encoding was shown to be more robust than self-reference, in Study 1 the stimuli were drawn from databases used throughout the survival encoding literature, consisting of concrete nouns. Self-reference is classically demonstrated using *trait* words – adjectives which may or may not describe a trait one sees in oneself. Study 1 demonstrated that self-reference did extend to enhanced memory for concrete nouns but this may underestimate the robustness of the self-reference effect from semantically distinct trait categories typical of survival encoding studies. That self-reference did not significantly augment the recall advantage of survival encoding may also be material specific. Thinking about the personality traits one may need for survival may reveal an additive effect of these two appraisal strategies, counter to the self-survival suppression effect we found in Study 1. By contrast, survival encoding may represent a specific adaptation for the utility of objects in the environment for our survival needs and thus would be unrelated to reflection upon our internal virtues and failings.

In Study 2, we set out to determine whether (a) the survival encoding effect generalises to other types of stimuli, (b) we see a stronger self-other difference within each of our strategy conditions using stimuli that are known to show a robust self-reference effect, and (c) we still see a difference between the survival encoding and self-reference effects given different stimuli.

Methods

Participants. Sixty-one (61) undergraduate Cornell students participated in exchange for course extra credit. Running a power analysis in G*Power on a repeated measures ANOVA with two measurements with an alpha level of 0.05 and a medium effect size ($f = .25$) (Faul et al., 2013), the required sample size is 54. All procedures were approved by the Cornell University Institutional Review Board and all participants provided their informed consent.

Materials and design. Five word lists of 32 words (a total of 160 words) were developed from Anderson's (1968) personality trait words, which were balanced on valence, word frequency, semantic category and word length. The procedure was as described for Study 1.

Results

A two-by-two repeated measures ANOVA was run comparing person (self vs. other) to encoding strategy (survival vs. reference). Self conditions were found to have an advantage over other conditions, with a significant main effect found for person ($F(1,60) = 17.29, p < .001$); a significant interaction effect between person and strategy was also found ($F(1,60) = 29.63, p < .001$; see Figure 2). By contrast with self-reference encoding, there was little evidence for a survival encoding effect on traits. The interaction revealed that survival encoding appears to again largely diminish the self-reference effect. Pairwise comparisons revealed that recall for self-reference was higher than other-reference ($p < .001$) as well as higher than survival self ($p < .001$). Survival self again did not differ from survival other ($p = 0.32$). However, survival other was higher than other-reference ($p = .07$), indicating a small effect of survival encoding on traits. Difference in reaction time and subjective word ratings were found to be nonsignificant across conditions. Order of word presentation did not affect recall ($p = 0.24$). Cohen's d was 0.36.

To assess the above effects relative to the valence encoding, we conducted an additional one-way repeated ANOVA with 5-levels representing the distinct encoding strategy conditions. Follow up contrasts on the significant effect of strategy ($F(1,60) = 7.52, p < .001$), revealed that valence encoding had a robust effect on recall, with even self-survival not significantly differing than valence encoding ($p = 0.3$).

Study 2 Discussion

The survival encoding effect did not generalise to trait stimuli. A greater self-other difference was seen within the reference condition compared to Study 1. This was expected given that the stimuli in this paradigm were selected to demonstrate a self-reference effect. Both the self-other difference within the survival encoding effect and the difference between survival other and reference other were abolished. As in Study 1, the self-reference effect appeared to operate differently from the survival encoding effect consistent with its expression being highly material specific.

Discussion

When examining concrete words, the survival encoding effect shows a clear recall advantage over self-reference. This is evident both from the recall advantage itself and from the fact that the survival other condition maintains a recall advantage over self-reference, and survival processing provides a recall advantage to other-oriented processing which is otherwise associated with low recall.

Additionally, the examination of both the self-reference and survival encoding effects using trait words, although failing to show a recall advantage for survival encoding, demonstrates that self-reference and survival encoding *operate differently*, and, regardless of

presented stimuli, the survival encoding effect overpowers the self-other distinction in memory processing. Across both studies, no significant differences were found between survival self and survival other conditions. Survival-related processing thus abolishes the self-other differences consistently observed in self-referential processing. The self-reference aspect of the survival encoding effect is overridden by the survival processing effect.

Much like Dewhurst et al (2017), the self-reference condition in Study 2 gives a recall advantage over self-survival – but, as with Study 1, the self-other distinction expected within the survival condition is absent. Any self-referential processing that may be inherent in survival encoding either does not differentiate between self and other or provides a memory advantage to other-focused processing that is not present in purely self-referential processing.

If the mere processing of information with reference to the self were driving the survival encoding effect, the type of presented stimuli would have comparable effects on both types of conditions. However, the self-survival and self-reference conditions operate in distinct and different ways when trait words are used as stimuli. Survival encoding is strongest when processing concrete nouns – physical objects which have an immediate impact on present survival – and abstract concepts such as traits are less accessible in survival-relevant scenarios. These data demonstrate that a type of appraisal at work during self-reference is largely distinct from survival encoding.

Our sense of self is essential to our survival; our ability to successfully interact with the world is dependent on not only identifying threats in the environment. An awareness of our own personal abilities and weaknesses is necessary to effectively navigate our environment and stay alive, and our ability to accurately engage self-referential encoding underlies this. However,

determining a threat in the environment and how to engage with that threat is more immediate and important than determining whether the threat is to you or to someone else, and thus the power of self-referential processing in a survival scenario is diminished.

Processing information as survival-relevant even when it is neutral provides a unique memory advantage and cannot be characterized as a greater self-reference effect. The interaction between survival and reference conditions suggests an interdependency despite acting as distinct encoding processes. Strategies that people utilise at encoding can affect later retrieval (Craik & Lockhart, 1972); of note is the fact that these encoding strategies do not always provide an adaptive advantage (Dunmore, et al, 1999). Rather, we see in trauma literature that particular encoding strategies – or cognitive appraisals of the event – can make individuals vulnerable to psychopathology (Ehlers & Clark, 2000). Two individuals can experience the same objective trauma, but the encoding strategy utilised can determine whether one recovers from the trauma or suffers a chronic, maladaptive reaction. Specifically, if one interprets a traumatic event as catastrophic or threatening to their life or self (see Elwood, et al, 2009 for a review), that individual is at risk for developing a maladaptive trauma response such as posttraumatic stress disorder (PTSD), a disorder particularly characterized by intrusive memory recall. PTSD in turn alters the brain structurally and functionally (see Nutt & Malizia, 2004 for a review). This overlap between the lasting physiological effects of self-processing and survival-processing during traumatic experiences supports the present results.

In order to meet diagnostic criteria for PTSD, an individual must experience an event perceived to be either a severe threat to their own life or safety, *or* to the life or safety of another (DSM-5, 2013). Only 17.7% of trauma-exposed individuals develop chronic PTSD (Santiago, et al., 2013); high emotional arousal at the time of encoding is inherent to that event being

classified as a trauma, and thus emotional arousal is insufficient in explaining the development of PTSD. Rather, the cognitive appraisals engaged at encoding of the trauma determine the trajectory of the disease (Ehlers & Clark, 2000). A single encoding event of peritraumatic self-referential catastrophizing can lead to PTSD; similarly, encoding an event as being threatening to one's survival can have the same effect. Self-referential processing alone is insufficient in triggering maladaptive memory, but its conjunction with life-or-death processing may contribute.

Processing an event as threatening to the survival of oneself is only one mechanism for the development of PTSD; witnessing a separate individual experience a trauma can have the same result (Patki, et al, 2015). Additionally, the long-term cognitive and physiological outcomes of engaging in life-or-death processing of a traumatic event are the same whether you are processing information related to *your own* survival or *someone else's* survival. The present results demonstrate on a behavioural level that self-other processing distinctions are overpowered by the impact of survival processing.

The way in which someone interprets and processes an event on a cognitive level, irrespective of level of emotional arousal, can affect their memory recall and have significant, lasting changes to their brain and body. The concept of “adaptive memory” may be used to elucidate the role of threat-to-life processing in later memory outside the context of emotional or physiological arousal. Interestingly, the survival encoding effect is strongest when participants are primed with an evolutionary hunter-gatherer survival scenario, even when compared to other self-survival conditions (Wilson, 2016); consequently, this memory effect is believed to reflect an evolutionary adaptation which aids in seeking physical objects for our survival.

Further directions include a deeper exploration of this cognitive strategy and its interaction with self-reference; in particular, determining whether the abolishing of the self-other distinction in survival encoding is universal or situational. Survival encoding is most robust when processing concrete objects, but it is unknown whether threats specific to oneself compared to threats specific to another, such as idiosyncratic life-threatening allergies, alter the encoding strategies utilised. Additionally, a topic of exploration is the power of survival encoding versus self-reference in social ostracization versus concrete fear-inducing threats, given that social ostracization triggers survival-related fear (Eisenberger & Lieberman, 2004).

Deeper examinations of survival encoding and its neural correlates could contribute to a new understanding of the nature of life-or-death processing and of traumatic memory and its variance among individuals. Determining the neural correlates of the unique survival encoding strategy and its relation to event processing in traumatic memory could have important implications for the interactive nature of emotion, memory, trauma, and arousal. The present study has contributed to steps taken in understanding this strategy, but further examinations can solidify the specific underlying mechanisms and thereby identify an intervention target for people who utilise maladaptive encoding processes.

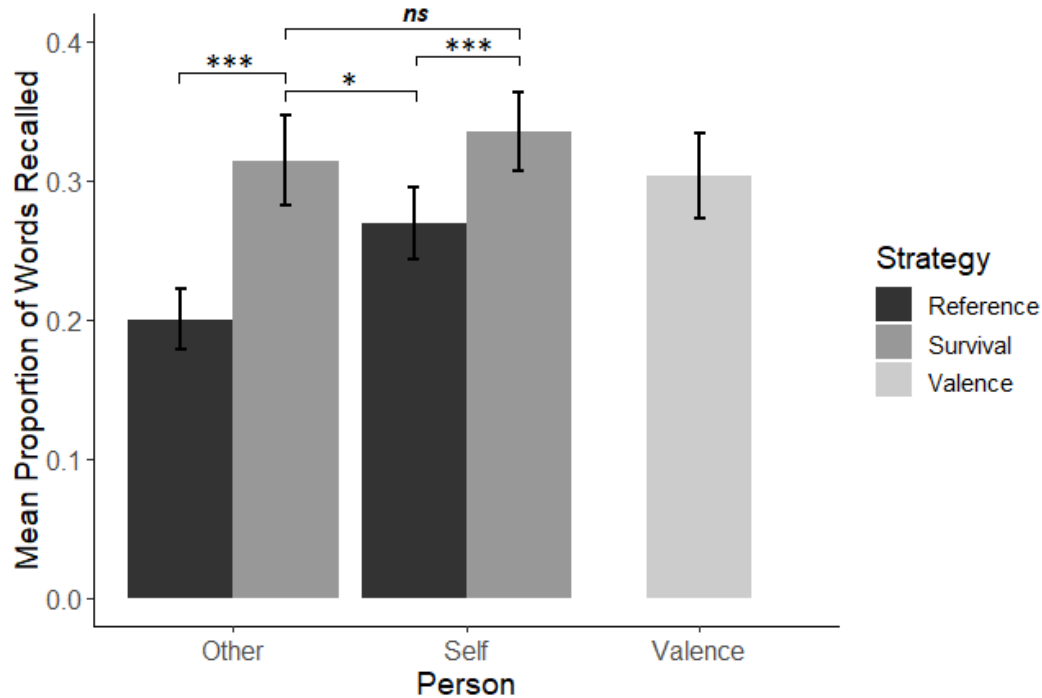


Figure 1. Recall Memory by Encoding Strategy in Study 1 Utilising Concrete Nouns. Survival and self-reference both give a recall advantage. Survival encoding results in the greatest recall advantage and abolishes self-other memory distinctions.

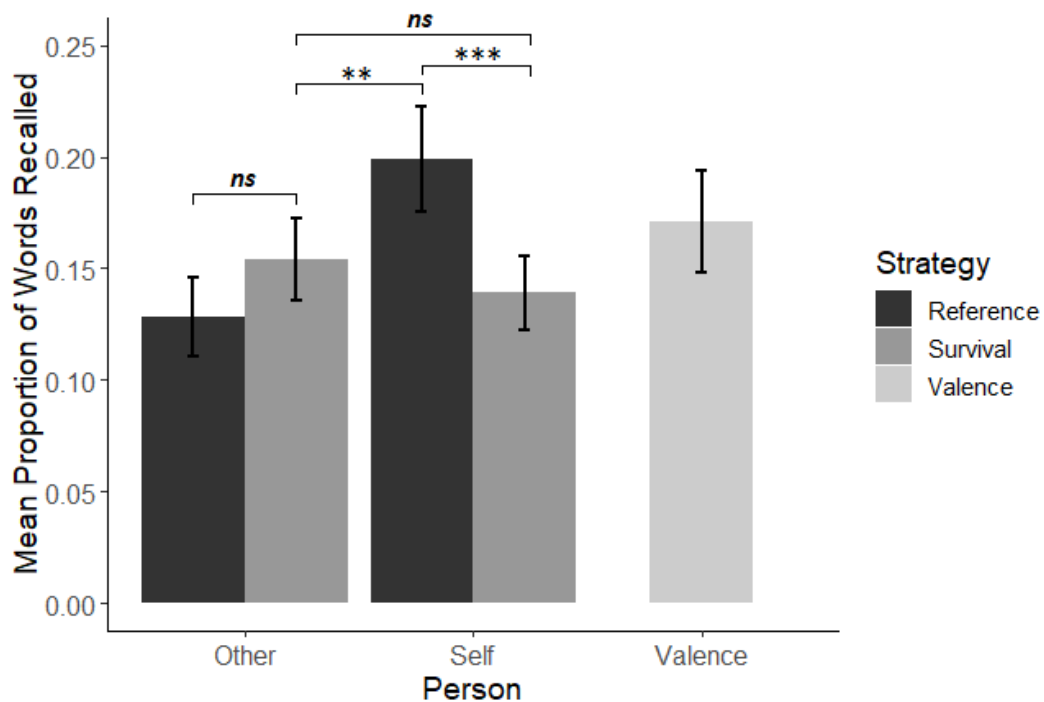


Figure 2. Recall Memory by Encoding Strategy in Study 2 Utilising Abstract Traits. Self-reference gives a recall advantage over survival encoding. Survival encoding abolishes self-other memory distinctions.

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