The Self-Reference Effect in the Visual and Auditory Modalities: Effects of Referent and Valence on Memory Performance

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

People tend to better remember information that has been encoded in reference to the self than information that pertains to someone else, a phenomenon termed the self-reference effect (SRE). It is also believed that this bias for self-relevant information is selective, such that healthy adults prioritize the encoding of self-positive relative to self-negative information (a self-positivity bias). Depressed individuals, on the other hand, are believed to display a self-negativity bias, whereby they remember more negative than positive information about themselves. Previous studies have assessed these two biases using the Self-Referential Encoding Task (SRET). In this task, participants first endorse, using a yes/no judgement, visually presented positive and negative trait adjectives, as either accurately representing themselves or another known character (e.g., Harry Potter). This task is then followed by surprise memory tasks for these adjectives. After the task, when depression is a variable of interest, participants complete a self-report measure of depression. In our study, depression was assessed in a non-clinical sample using the CES-D self-report measure. Participants classified as "depressed" were those who reported levels of depressive symptoms superior to 16, based on the measure's established cutoff. To our knowledge, no research using the SRET has examined whether these two biases also exist when the information is presented through the auditory modality. Given that self-relevant information is often encountered through spoken language in daily life, it is important to explore how these biases operate in the auditory modality. In the present study, participants were assigned to complete the SRET in either the visual (n=176) or auditory (n=176) modality. Results confirmed a significant SRE in both modalities and did not reveal an interaction between SRE and modality. Contrary to expectations, there was no evidence of a self-positivity bias, nor were there any differences in the pattern of results for depressed (n=186) vs. non-depressed (n=166) participants in the recognition task, although a significant decrease in positivity bias was found for depressed individuals during the endorsement task. Overall, these findings suggest that the SRE is consistent across modalities. However, the absence of both a self-positivity bias in healthy individuals and a self-negativity bias in depressed individuals diverges from previous research. Given the large in-person sample size and highly controlled stimuli in this study, these null effects warrant further investigation into the valence-related memory biases previously reported.

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Chapter 1
Introduction

The ability to encode and retrieve information is essential for successful functioning in everyday life. Memory enables us to learn from past experiences, anticipate future events, and sustain a continuous sense of identity over time (Conway & Pleydell-Pearce, 2000; Schacter & Addis, 2007). However, memory is not a passive recording of events. Rather, it is a selective process, with certain types of information prioritized over others (Conway & Loveday, 2015). In particular, self-relevant information has been shown to be more effectively encoded and readily retrieved than information that lacks personal relevance (Symons & Johnson, 1997). This phenomenon, first described by Rogers, Kuiper, and Kirker in 1977, has been termed the Self-Reference Effect (SRE). For example, individuals are more likely to recall an adjective when asked to evaluate whether it applies to themselves, compared to when they are asked to consider whether it applies to another person. Since its discovery, the SRE has been studied extensively. This mnemonic advantage for self-referential information has been found across different types of stimuli, such as written adjectives and photographs (Hamami, Serbun & Gutchess, 2011).

1.1 Potential Mechanisms Underlying the Self-Reference Effect

The SRE appears to be the result of multiple cognitive and neural factors. The leading explanation is that it is due to more elaborative encoding of autobiographical information in long-term memory (Symons & Johnson, 1997). Elaborative encoding occurs when new information forms connections with related existing material in memory (Klein & Kihlstrom, 1986). For example, if someone is asked if they are a kind person, they often will reflect on past behaviours and their self-concept before responding. Creating these associations will then strengthen the memory traces and result in elaborative encoding of the adjective "kind" (Symons & Johnson, 1997). Furthermore, self-relevant information is often emotionally arousing, which can further enhance memory consolidation (Yoshimura et al., 2009). Emotional memories are known to engage the amygdala, a key subcortical brain structure involved in emotion processing, particularly during encoding and retrieval (Cahill & McGaugh, 1998). Emotional autobiographical memories - recollections of personally experienced events - similarly activate the amygdala and rely on interactions between the amygdala and hippocampus (a key brain area involved in memory) to support the reconstruction of vivid, contextrich experiences (Svoboda et al., 2006; Malin & McGaugh, 2006). In contrast, non-emotional autobiographical memories tend to rely more heavily on the neocortex and do not benefit from the same consolidation enhancements associated with emotional arousal (D'Argembeau et al., 2013; Malin & McGaugh, 2006). With respect to the SRE specifically, the recognition of self-reference (vs. Other-referenced) words appear to more strongly activate the ventromedial prefrontal cortex, posterior cingulate cortex and bilateral angular gyrus (Yaoi et al., 2015). This heightened activation is thought to result from the formation of stronger memory traces, facilitating superior recognition performance.

1.2 The Role of the SRE in Self-Concept Development

Recent developmental research suggests that the SRE plays an important role in the emergence and growth of self-concept during early childhood. Studies have shown that even very young children exhibit this memory bias, indicating that sensitivity to self-relevant information is present early in life and may support the formation of self-knowledge. In one study, 18-month-old infants were presented with objects that were either assigned to them (paired with a mirror to view themselves) or assigned to another person (paired with an image of someone else) (Wiesmann et al., 2025). In the recognition task, infants were shown images of the previously assigned objects alongside similar but unfamiliar items, and memory was assessed via eye-tracking. Results showed that infants who recognized themselves in the mirror demonstrated better memory for the self-assigned objects compared to those assigned to others. In contrast, infants who did not recognize themselves in the mirror showed no memory advantage. A second study found that toddlers aged 20–40 months (all of whom demonstrated mirror self-recognition) showed better memory for self-assigned objects. Based on these findings, Wiesmann et al. (2025) argue that the sense of self begins to emerge around 18 months of age and that as children grow older, the SRE becomes stronger. Supporting this, in a study of children aged 6 to 11, researchers found that the magnitude of the SRE increases between the age of 8 and adulthood (Hutchison et al., 2021). Furthermore, Henderson et al. (2009) examined the SRE in children aged 8 to 16 with and without high-functioning autism and found that the strength of the SRE was inversely related to social skills and scores on the Autism Spectrum Screening Questionnaire (ASSQ), suggesting that the SRE may be a key factor in social development. Consistent with the aforementioned findings, they also observed that the SRE increases with age. These findings imply that the SRE may play a key role not only in maintaining a stable identity in adulthood but also in the initial development of self-awareness and self-knowledge during childhood. Due to limitations in current testing paradigms, assessing self-referential processing in younger, pre-literate children remains challenging. Incorporating auditory components into existing SRE paradigms could offer novel approaches for studying self-referential processing in early development. The limited body of work on the development of the SRE highlights the need for further investigation in younger populations.

The self-reference effect may also be linked to our ability to understand others. Theory of Mind (ToM) refers to the ability to recognize the mental states of oneself and others (Premack & Woodruff, 1978). In a study of 396 university students aged 18-37, Dinulescu et al. (2021) found that recognition accuracy for self-referential information was positively correlated with ToM abilities, supporting the role of the SRE in social cognition. In contrast, a study of 97 participants aged 11–35 years found that while both the SRE and the ability to take on others' perspective increased with age, the two measures were not significantly correlated (Scheuplein et al., 2023). This suggests that although the two abilities develop in parallel, they may rely on distinct underlying mechanisms. Further research is needed to determine whether these abilities are independent or related (and if they are related, what the underlying mechanisms are). The potential connection between SRE and ToM highlights the broader significance of self-referential processing and its foundational role in social cognition.

1.3 Valence Biases in Self-Referential Memory

Valence biases – preferences for remembering positive or negative information – are often discussed in relation to the SRE. A central question is whether individuals show greater memory enhancement for self-relevant information that is positively or negatively valenced. Research on the SRE predominantly indicates that individuals with good mental health are more likely to remember positive over negative self-relevant information (Liu & Tan, 2024). This effect indicates an interaction between valence and self-referential processing, as the positivity bias typically emerges only in the self-condition and not in the other-referential condition (Liu & Tan, 2024). In addition, individuals also tend to evaluate themselves more positively than they evaluate others (Fields & Kuperberg, 2015). According to the SRE literature, maintaining a positively biased self-view is essential for psychological well-being, helping to sustain self-esteem, motivation, and a resilient self-concept (Fields & Kuperberg, 2015). In contrast, the absence or decrease of the positivity bias has been associated with mood and anxiety disorders (Fields & Kuperberg, 2015). Research has demonstrated that the severity of depressive symptoms is correlated with the strength of a negativity bias (Duyser et al., 2025). The more severe the depression, the more pronounced the tendency to focus on and remember negative self-referent information rather than that which is self-positive (Duyser et al., 2025). A study of clinically depressed patients found that, compared to non-depressed individuals, depressed individuals showcased either a reduced self-positivity bias in memory or a self-negativity bias in memory (Zupan et al., 2017). These findings suggest that depression significantly disrupts the self-positivity bias, either diminishing it or reversing it entirely. This reduction in positivity, coined a “positive blockade”, in depression (Beck, 1967) requires further investigation.

While the conclusion that self-positive information is most efficiently encoded (at least among psychologically healthy individuals) has been dominant for decades in the SRE literature, recent findings by Garcia-Arch et al. (2024) challenge this perspective. While they did not test memory effects, García-Arch et al. investigated how individuals process and incorporate information that either aligns with or contradicts their existing self-concept. The study consisted of two sessions. In the first session, participants recorded a verbal description of their personality and then rated how well a list of trait adjectives described them. In the second session, participants underwent electroencephalography (EEG) while completing a three-block task. In blocks 1 and 3, they were shown the same adjectives they had endorsed in the first session and asked to rate again how much each trait applied to them (“You think you are [adjective]”). Before block 2, participants received feedback in the form of a list of trait adjectives, supposedly provided by three evaluators who had listened to their personality recording. In Block 2, participants were then asked to indicate, with a yes or no response, whether they believed others would describe them using each adjective (“Do others think you are [adjective]?”). The findings showed that self-congruent and self-incongruent feedback elicited distinct electrophysiological responses, suggesting that the brain processes affirming and contradictory feedback differently. Congruent feedback produced earlier and lower-amplitude ERP responses, suggesting that self-consistent information is more readily assimilated. In contrast, incongruent feedback elicited stronger neural responses, indicating that the brain registered this information as more disruptive. The authors suggested that the rapid detection of self-incongruent feedback may serve a protective function, helping maintain stable self-representations by filtering out information perceived as inconsistent with the self. Importantly, these patterns were observed regardless of the valence of the adjectives. This research suggests that the alignment of feedback with pre-existing self-views might play a more critical role than valence (positive or negative) in how individuals incorporate new information into their self-concept. One interpretation is that individuals prioritize maintaining a stable and coherent self-concept, even if it means overlooking positive information. Thus, biases for self-relevant information may be more complex than a simple bias for self-positive information which may help explain why some studies fail to observe a self-positivity bias.

In contrast to what has been reported for self-referential memory, it has been well established that memory for information not related to the self is negatively biased. That is, individuals tend to pay more attention to and better remember negative stimuli compared to neutral or positive ones (Baumeister et al., 2001). From an evolutionary perspective, this finding has been interpreted as an adaptive mechanism, such that there is a greater advantage in survival to remembering and avoiding a harmful stimulus than pursuing a helpful one (Norris, 2019). Supporting this view, even infants as young as three months learn more quickly from negative stimuli than positive stimuli (Norris, 2019). In adulthood, this negative bias has been shown to be more prominent in young adults, with a gradual shift toward a positivity bias observed in older adults. This age-related change, often referred to as the "age-related positivity effect," may reflect either a reduction in the negativity bias or a growing preference for positive information (Reed et al., 2014; Fields et al., 2021). Altogether, these findings suggest that self-referent information and non-referent information exhibit distinct memory valence biases. While non-self memory favours negatively valenced information, self-referential memory is more complex and might either be biased towards self-positive information or favour information that aligns with an individual's self-perception.

1.4 The Self-Referential Encoding Task (SRET)

The SRE has been predominantly studied with the Self-Referential Encoding Task (SRET; Rogers & Kirker, 1977). The standard version of this task involves three components: endorsement, recall, and recognition. In the endorsement task, participants endorse, by clicking yes or no, visually presented positive and negative trait adjectives, as either representing the self (e.g., "Does this word describe you?") or another known character (e.g., "Does this word describe Harry Potter?"). Participants are then asked to complete a distractor task, for example, counting back from 50 or completing simple math problems. This is followed by a surprise free recall task whereby participants must recall as many adjectives as they can from the endorsement task. In a subsequent recognition task, participants are presented with a list of adjectives from the endorsement task mixed with novel adjectives and are asked to indicate, often through circling them, which words they recognize from the endorsement task. Using this design, the SRE is demonstrated by a larger number of recalled and recognized self-related adjectives compared to other-related adjectives (Rogers et al., 1977). The SRET tests both memory for self-referential vs. other-referential information and valence biases, by incorporating negative and positive adjectives (Hudson et al., 2021).

To our knowledge, Symons and Johnson (1997) conducted the only meta-analysis specifically assessing the SRE using the SRET. Their meta-analysis included 130 studies with an average sample size of 39 participants per study. They reported robust evidence for the SRE. However, findings have been more mixed when examining biases related to emotional valence. For example, D'Argembeau et al. (2005) investigated how retrieval conditions influence valence effects and the SRE. Participants in their study completed the standard SRET (with both a free recall and a recognition task). Evidence of a self-positivity bias emerged only during the free recall task. In contrast, the recognition task did not reveal a self-positivity bias. The authors theorized that this occurred because free recall requires participants to generate their own internal retrieval cues. They proposed that people are more likely to generate cues for positive words because they are motivated to maintain a positive self-image, either by avoiding negative information or by focusing on positive traits. In recognition tasks, however, the re-presentation of the words serves as an external cue which can trigger memory for items that were not strongly encoded. This can dampen the valence effects observed in recall tasks, where only the most strongly encoded adjectives are likely to be retrieved. Interestingly, several studies using the SRET have found no valence bias in memory when participants were asked to make judgments about a fictional character or a well-known public figure (e.g., a celebrity; Hudson et al., 2020). This finding is somewhat unexpected given that non-self memory research suggests a negativity bias (Vaish et al., 2013). Negative stimuli are thought to carry greater informational value than positive ones, thereby attracting more attention and requiring more cognitive processing (Peeters & Czapinski, 1990). Baumeister et al. (2001) reviewed a broad collection of research findings across domains (i.e., psychology and social behaviour) and observed a consistent pattern whereby negative experiences tend to be more impactful than positive ones. In this context, a lack of negative bias in the SRE literature for information about the non-self character is surprising. However, this may be attributable to the fact that the fictional characters used in these studies often possess known positive traits. For example, Harry Potter, a commonly selected "other" character, is the heroic protagonist of the popular children's book series Harry Potter and might be perceived overall as positive.

Regarding the stimuli used in previous SRET studies, many do not explicitly report if or how the valence of their stimuli was measured, nor do they describe any other lexical characteristics of their stimuli that may impact results (e.g., Danier-Best et al., 2018; Ahmed et al., 2024; Vella et al., 2025). Control of stimuli is critical, as differences in lexical factors between positive and negatively valenced stimuli may lead to memory effects that are attributable to those factors rather than to a true valence bias (D’Argembeau et al., 2005). For example, if the positive words are more arousing than the negative words, this could lead to an apparent positivity bias that is in fact due to arousal (Kensinger, 2009). In their meta-analysis, Symons and Johnson (1997) identified this lack of control as a limitation of many studies, which may contribute to variability in findings. They also noted that the use of highly related stimuli can produce memory benefits unrelated to self-referential processing. For example, in some studies, there are stimuli that share the same root word (e.g., pretty and prettiest). The study by D’Argembeau et al. (2005) carefully matched their stimuli in terms of valence, frequency, and word length and did not find a self-positivity bias in the recognition task. Therefore, it is critical for future studies to implement stricter control in stimulus selection to more accurately evaluate the SRE and associated valence biases. In the present study, stimuli were controlled along multiple dimensions known to influence lexical processing and memorability: arousal (the extent to which a stimulus is calming or exciting), valence (the extent to which a stimulus is negative or positive), frequency (how often words are experienced), age of acquisition (the age at which people, on average, learn the meaning of a word), concreteness (the degree to which a word refers to a perceptible entity), length in letters, length in phonemes, and phonotactic probability (the frequency with which segments and sequences of segments occur in syllables and words) (Brysbaert, Warriner, & Kuperman, 2014; Brysbaert, Mandera, & Keuleers, 2018; Elsherif, Preece, & Catling, 2023; Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012; Vitevitch et al., 2012).

1.5 The Visual vs. the Auditory Modality

Past studies have assessed the self-relevance and valence biases utilizing visual versions of the SRET. As far as we know, no study using the SRET has been conducted in the auditory modality. In the current study, we aimed to determine whether similar cognitive biases in favour of self-referential and positive information also exist in the untested auditory modality. This question is particularly important given that humans routinely process information through both auditory and visual channels. Investigating the SRE across modalities is therefore essential for a comprehensive understanding of self-referential processing. Additionally, exploring the auditory modality opens new possibilities for studying populations who may not easily engage with visual tasks, such as individuals with visual impairments or limited reading proficiency. Our goal was to lay the foundation for incorporating auditory components into SRET studies in order to expand the accessibility of testing methods. In the current study, we tested both auditory and visual modalities in adults, for the first time, using an identical paradigm, which allowed for a direct comparison of self-referential and valence-related memory biases across these two sensory domains.

In general, the literature suggests that, in terms of long-term memory, a visual memory advantage is often observed when compared to auditory memory (Cohen et al., 2009). Cohen et al. (2009) conducted four experiments comparing recognition memory in the auditory and visual modalities. Their stimuli included complex auditory scenes, spoken language, written scene descriptions, images, and music. In every experiment, auditory recognition was systematically inferior to visual recognition. A similar advantage for visual memory has been reported by others. Gleode & Gregg (2019) conducted two within-subject experiments investigating recognition memory in both the auditory and visual modalities. They presented participants with images of objects (visual), and environmental sounds (auditory). Participants were then tested on their recognition of the stimuli at 2 time points, immediately following the task (experiment 1) and again after a delay of 2-7 days (experiment 2). In both recognition tests, participants were presented with target stimuli, unrelated novel stimuli, and lures, items that were similar but not identical to the original stimuli. The inclusion of lures allowed researchers to examine memory coarseness. Coarse, 'gist-based' memories are more likely to be confusable with original stimuli due to their lack of detail. Results from experiment 1 (no delay) showed that visual memory supported the storage of more items and preserved finer detail compared to auditory memory. However, following the delay in experiment 2, the precision of visual memory declined. In contrast, auditory memory was less detailed immediately after the task and remained stable in representation after the delay. Over time, memory representations from both modalities became equal in coarseness resulting in similar levels of recognition accuracy. Of most relevance to the present study, Otten et al. (2010) conducted a within-subject experiment where participants were presented with 120 auditory words and 120 visual words and, after a 45-minute delay, were tested on their recognition. Similar to Gleode & Gregg (2019)'s experiment 2, with the inclusion of a delay, they found no significant differences in recognition accuracy between modalities. Considering these results, we anticipated similar recognition abilities in the two modalities, especially since our design incorporated a delay in the form of a distractor task between the endorsement and the recognition task.

To date, no studies have directly compared recognition accuracy for self- versus other-referential information in the auditory and visual modalities. However, Northoff et al. (2006) conducted an fMRI experiment examining the neural basis of the SRE using both auditory and visual stimuli. Participants were presented with auditory stimuli (e.g., their own name vs. unknown names) and visual stimuli (trait adjectives from a visual SRET task, as well as images of their own face, their partner's face, and an unfamiliar face). The study found that self-referential processing activated the medial prefrontal cortex regardless of modality, suggesting that self-processing is modality independent. Drawing on these findings, we predicted that the magnitude of the SRE would be similar in the auditory and visual modalities.

1.6 The Present Study

The present study aimed to address existing gaps in the literature by testing the SRE in a modality that has not been previously examined in the SRET paradigm. This study employs the classic SRET to compare the self-reference and valence biases across modalities (visual vs. auditory). In addition, to examine the effects of depressive symptoms on valence-related biases in a non-clinical sample, participants completed the Center for Epidemiologic Studies Depression Scale (CES-D) after the SRET. We made a few improvements compared to other SRET studies in the literature. First, we used positive and negative stimuli that were balanced across nine linguistic variables that are known to influence processing and memory. Second, we tested a sample size ($n = 352$) that is nine times greater than the average study ($n = 39$) as reviewed by Symons and Johnson (1997). We also removed the free recall component of the SRET, as previous studies have reported low recall performance likely due to a high number of trials (Hudson et al., 2020). Thus, recognition performance was used as the sole memory measure.

To the best of our knowledge, no study has directly compared the SRE across auditory and visual modalities. This comparison is critical for determining whether the SRE can be reliably studied using auditory stimuli. If supported, this would enable more thorough investigations of the SRE in populations for whom visual language tasks pose challenges, such as young children. It also has important implications for understanding how self-relevant information is encoded across sensory modalities. In real-world settings, individuals routinely encounter self-relevant information through both auditory (e.g., conversations, feedback) and visual (e.g., written text, facial expressions) channels. Investigating the SRE in both modalities is therefore essential for understanding how self-related processing operates in ecologically valid contexts. We predicted that any self-referent biases observed in the visual modality would also be present to the same magnitude in the auditory modality, which would suggest that the SRE reflects a modality-independent phenomenon. Additionally, we expected an interaction between reference (Self vs. Other) and valence (Positive vs. Negative), such that positive self-referential words would be better remembered than words in the other conditions

(Liu & Tan, 2024). Furthermore, we hypothesized that individuals with elevated depressive symptoms would exhibit either a negativity bias or a reduced positivity bias (Zupan et al., 2017). However, it is important to note that our study examined a nonclinical sample identified using a measure of depressive symptoms, whereas clinically diagnosed individuals would likely present with more pronounced symptomatology and, potentially, a stronger negativity bias. In support of this possibility, a previous study that also used the CES-D in a self-referent encoding task with a nonclinical sample found that recall performance was not associated with depression severity (Dainer-Best et al., 2018).

Chapter 2
Experiment

2.1 Participants

Three hundred and sixty-nine (369) University of Waterloo students between the ages of 16-28 participated in the experiment. Participants were recruited from the University of Waterloo's SONA website and received course credit for their participation. Participants were required to have normal or corrected-to-normal hearing, have watched at least one Harry Potter film or read one of the Harry Potter novels, and have learned English before the age of 8. The age of English exposure was specified because people who have acquired a second language after the age of 7 may exhibit reduced responses to emotional words in that language compared to those who acquire it earlier (Harris, Gleason, & Ayçiçeği, 2006). Participants were randomly assigned to either the visual modality condition or the auditory modality condition. The data from 17 participants (4.6%) were then excluded: 1 for having a diagnosed speech disorder, 11 for lost data, 1 for lack of English proficiency, and 4 for improperly completing the task. The remaining 352 participants (n=176 participants in each modality) had a mean age of 20 years (SD = 2.85) and included 288 females, 54 males, and 10 non-binary individuals. Their racial identification was as follows: 146 White (41.5%), 69 East Asian (19.6%), 68 South Asian (19.3%), 27 South East Asian (7.7%), 17 Mixed Race (7.7%), 10 Middle Eastern (2.8%), 8 Black (2.3%), 4 Latin American (1.1%), 2 Indo-Caribbean (0.6%), and 1 Indigenous (0.3%). Participants were remunerated with 1 SONA credit for 45 minutes of participation.

2.2 Stimuli

2.2.1 Adjectives

A total of 120 adjectives were selected, 60 positive and 60 negative. The positive and negative word sets were balanced in lexical measures of frequency, age of acquisition, concreteness, length in letters, length in phonemes, arousal, and phonotactic probability. Critically, the two types of words differed only in valence and dominance, with positive words having significantly higher values of both. Descriptive statistics for the positive and negative adjectives are reported in Table 1.

Adjectives	**Positive (Mean (SD))**	**Negative (Mean (SD))**
Frequency	3.01 (0.57)	2.58 (0.71)
Age of Acquisition	6.07 (1.37)	6.23 (1.28)
Concreteness Rating	2.30 (0.61)	2.39 (0.59)
Length	6.32 (1.62)	5.37 (1.79)
Phonemes	5.35 (1.63)	4.90 (1.54)
Valence	7.44 (0.38)	2.92 (0.70)
Arousal	4.65 (1.03)	4.83 (0.84)
Dominance	6.86 (0.50)	4.40 (0.71)
Phonotactic Probability	0.24 (0.09)	0.22 (0.09)

Table 1

Descriptive statistics for the adjectives used in the experiment. Brysbaert & New (2009) provided the frequency, which is reported in log frequency (Lg10CD); age of acquisition is taken from Kuperman et al. (2012); concreteness is taken from Brysbaert et al. (2013); length is reported in number of characters; phonemes are reported in number of phonemes; valence, arousal, and dominance reflect the normative ratings taken from Warriner et al. (2013); phonotactic probability is taken from Vitevitch & Luce (2004).

From the 60 positive and 60 negative adjectives, four experimental lists were created that were balanced across the nine lexical dimensions. Each list consisted of 30 adjectives (15 positive, 15 negative). For each participant, 30 words (15 positive, 15 negative) were assigned to the Self block, 30 (15 positive, 15 negative) to the Harry Potter (Other) block, and the remaining 60 (30 positive, 30 negative) served as novel lures in the recognition task. The four word lists were counterbalanced across participants, such that each word appeared equally often in each block across the full sample. Additionally, we ensured that all 120 adjectives had different root words (e.g., cute & cutie would not be included).

For the auditory condition, recordings of the 120 adjectives were sourced from a professional female Canadian voice actor and edited using the software Praat version 6.2.13. We requested three recorded versions of each word spoken in neutral prosody and selected the most neutral version of the three to be included in the experiment. The files were edited utilizing Praat to begin 50 ms before the sound onset.

2.2.2 CES-D Self-report

Depressive symptoms were quantified using the Centre for Epidemiologic Studies Depression Scale (CES-D). The CES-D is a 20-item measure created by Radloff in 1977 for research purposes in the general population. According to Radloff, a high score is considered any value between 16-60. Thus, for this experiment, participants who scored 16 and above are considered to have high depressive symptoms, and those who scored less than 16 are considered to have low depressive symptoms. Of the 352 participants, 186 (~52.8%) fell within the high depression score range (hereafter the Depressed group for conciseness) and 166 (~47.2%) participants scored within the low depression score range (hereafter the Non-Depressed group). Within our Depressed group scores ranged from 16-54 on the CES-D measure. The descriptive statistics for these groups are included in table 2.

Modality	**Gender**	**Non-Depressed (n)**	**Depressed (n)**
	Female	67	74
Auditory	Male	18	12
	Non-Binary	1	4
Total		86	90
	Female	62	74
Visual	Male	17	16
	Non-Binary	1	6
Total		80	96

Table 2

Participant distribution by modality and depression status.

2.3 Procedure

Upon arrival at the lab, participants were reminded of the inclusion criteria for the experiment. Once eligibility was confirmed, they reviewed and signed an informed consent form. They could then proceed to complete the Self-Referential Encoding Task (SRET) task. The SRET was created using the experimental software PsychoPy, version 2022.2.5.

The SRET included three components: an endorsement task, a distractor task, and a surprise recognition task (detailed below). In the endorsement task, participants responded to adjectives in reference to themselves (Self) and Harry Potter (Other). Following this task, they completed a distractor task and then a surprise recognition task. In the visual condition, words were presented centrally on the screen in Open Sans font, with a letter height of 0.1 (in PsychoPy units). PsychoPy uses a visual angle-based measurement system, where a height of 1.0 corresponds to the full height of the display window; thus, a height of 0.1 represents approximately 10% of the screen's height. In the auditory condition, the adjectives were played through noise cancelling Bose Quiet Comfort 45 over-ear headphones at a comfortable speaking volume.

Following the experiment, participants completed the CES-D questionnaire on a Microsoft Excel form.

2.3.1 Endorsement Task

The computer screen displayed the instructions for the endorsement task, which consisted of two blocks: a Harry Potter block and a Self-block (see Figure 1). The order of the blocks was counterbalanced across participants such that half of the participants were presented with the Self block first and the other half were presented with the Harry Potter block first. Before each block, participants completed a practice block containing five adjectives (different from the experiment adjectives and only physical descriptors, e.g. tan, blonde). The practice trials were designed to ensure participants understood the task and primed them to think in terms of themselves or Harry Potter. In the Harry Potter block, the instructions read, "Consider each adjective in reference to Harry Potter – Does each word describe Harry Potter?" In the Self block, the instructions were, "Consider each adjective in reference to yourself – Does each word describe you?"

Participants were instructed to respond using the 'n' and 'm' keys on the keyboard, which represented 'no' and 'yes'. Key assignments were counterbalanced across participants. Participants were asked to use the index and middle fingers of their dominant hand for key presses. To help participants remember the key assignments, they were displayed at the bottom of the screen throughout the experiment.

In each block, thirty adjectives were presented in random order. In the auditory modality, the adjectives were played through headphones while a fixation cross was displayed at the center of the screen. Each adjective was played once, and participants were required to respond 'yes' or 'no' before the next trial began. The audio stimuli ranged from 90 to 1000 milliseconds. In the visual modality, the adjectives were displayed in the center of the screen and remained there until the participant responded 'yes' or 'no.' Once a response was made, the next trial began.

In both the visual and auditory conditions, each trial began with the presentation of a fixation cross for 1 second. Following the fixation cross, the adjective either appeared and remained on screen in the visual modality, or was played once while a cross was presented on the screen in the auditory modality, until the participant responded "yes" or "no." After the participant's response, the fixation cross reappeared for 0.5 seconds before the onset of the next trial. Thus, there was a fixed 1.5-second interval between adjective presentations.

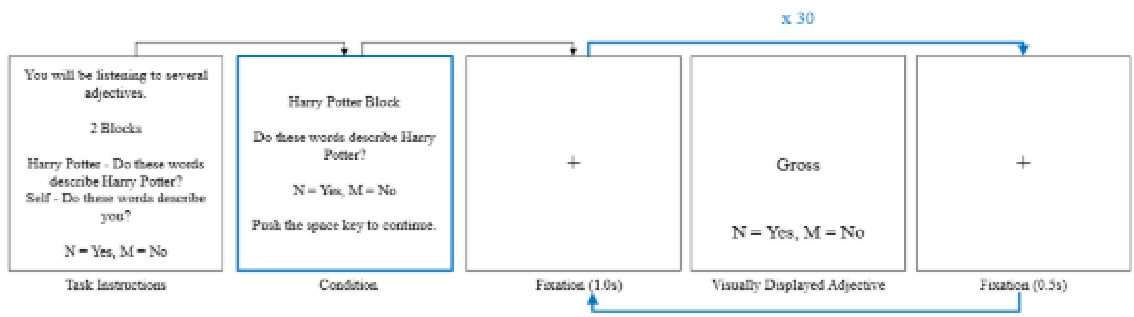

Figure 1.

Visual modality endorsement task example demonstrating a negative trait adjective in the Harry Potter block. Participants completed two blocks (Self, Harry Potter) with a practice block prior to each official block. Each block included 30 adjectives (15 positive, 15 negative). The block order was counterbalanced across participants.

2.3.2 Distractor Task

Following the SRET endorsement task, participants were asked to verbally count back from 50 (distractor task).

2.3.3 Surprise Recognition Task

Following the distractor task, participants completed a surprise recognition task (see Figure 2). They were first presented with the recognition task instructions, in which they were told that they should indicate which words they recognized from the endorsement task. If they recognized a word, they were to click yes. Once ready to begin, the 60 adjectives presented in the endorsement task and an additional 60 new distractor adjectives (half positive, half negative) were presented in a randomized order. Participants used the same keys, 'n' and 'm', to respond 'yes' or 'no'. The key assignment in this task was congruent with the key assignment in the endorsement task (i.e., if 'm' was assigned 'yes' in the endorsement task, then 'm' would also be assigned 'yes' in the recognition task for that participant). This consistency prevented response errors due to key confusion. In the visual modality, words were presented on the monitor (Fig.2); in the auditory modality, they were played through earphones (the same modality was used as in the endorsement task).

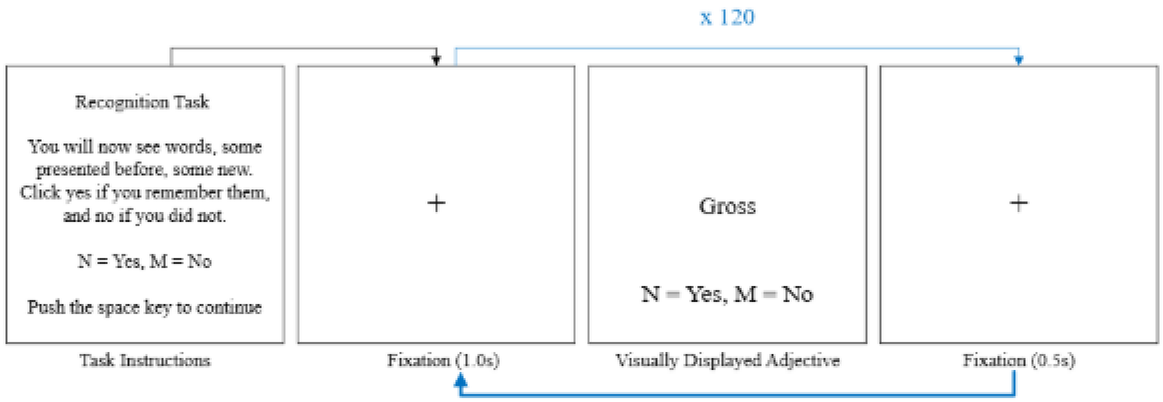

Figure 2.

Visual modality recognition task example. Participants were presented with the 60 adjectives from the endorsement task (30 positive, 30 negative) alongside 60 new adjectives (30 positive, 30 negative).

2.3.4 Centre for Epidemiologic Studies Depression Scale (CES-D)

After the SRET was completed, participants were asked to complete the Centre for Epidemiologic Studies Depression Scale (CES-D) to quantify their depressive symptoms. Once done, participants were debriefed and assigned a course credit.

The CES-D is a 20-item self-report questionnaire that assesses participants' experience of low mood – as reflected in feelings of sadness, anhedonia, and guilt – over the past two weeks. Participants responded on a 4-point Likert scale ranging from "*Not at all or less than one day*" (0) to "*Nearly every day for 2 weeks*" (3) and items were summed to create a total score. Scores above 16 represent moderate to severe depressive symptomology (Eaton et al., 2004).

2.4 Data Analysis

2.4.1 Adjective Endorsement

JASP 0.19.2 was used to conduct the endorsement analyses. Endorsement scores were calculated as the number of "yes" responses for each word type (Self-Positive, Self-Negative, Other-Positive, Other-Negative).

For the modality analyses, a mixed model 2 (Reference: Self, Other) × 2 (Valence: Positive, Negative) × 2 (Modality: Auditory, Visual) ANOVA was conducted. Reference and valence were within-subject factors, and modality was a between-subjects factor.

As modality did not affect the results, we assessed the effect of depression on endorsement across the modalities using a second mixed model 2 (Reference: Self, Other) × 2 (Valence: Positive, Negative) × 2 (Depression: Depressed, Non-Depressed) ANOVA. Reference and valence were within-subject factors, and depression was a between-subjects factor.

2.4.2 Recognition Accuracy

Recognition accuracy was measured using the sensitivity metric *d'*, which is calculated by subtracting the false alarm rate from the hit rate for each participant within each adjective category (self-positive, self-negative, other-positive, other-negative). The hit rate represents the standardized probability of correctly recognizing a previously presented adjective (i.e. the number of correct responses divided by the total number of adjectives for that category, 15), while the false alarm rate reflects the standardized probability of incorrectly identifying a new adjective as previously presented (i.e. the number of incorrect new responses divided by the total number of adjectives for that valence, 30). This *d'* computation takes false alarms into account, yielding a more precise measure of recognition performance.

To assess modality differences in recognition accuracy, a mixed model 2 (Reference: Self, Other) × 2 (Valence: Positive, Negative) × 2 (Modality: Auditory, Visual) ANOVA was conducted in JASP. Reference and valence were within-subject factors, and modality was a between-subjects factor.

For the depression analyses, as above, modality was not included as a factor given the results of the modality ANOVA. Using JASP, we investigated the effect of depressive symptoms (CES-D score) on recognition accuracy using a mixed model 2 (Reference: Self, Other) × 2 (Valence: Positive, Negative) × 2 (Depression: Depressed, Non-Depressed) ANOVA, grouping visual and auditory modalities. In this analysis, depression was treated as a between-subject variable. To further examine the effect of depressive symptoms as a continuous variable, a multivariate analysis of variance (MANOVA) was conducted using R (version 4.3.1).

An alpha level of .05 was used for all statistical tests.

2.5 Results

2.5.1 Adjective Endorsement

2.5.1.1 Endorsement Results across Modalities

No effect of Modality, $F(1,265) = 2.988$, MSE = 19.804, $p = .085$, $\eta_p^2 = .011$ or interactions between Modality and any other factor were found (all p's > .212). There was a significant main effect of Reference, $F(1,265) = 21.685$, MSE = 88.019, $p < .001$, $\eta_p^2 = .076$, due to participants endorsing more Harry Potter than Self words. The main effect of Valence was also significant, $F(1,265) = 1968.892$, MSE = 15651.036, $p < .001$, $\eta_p^2 = .881$, due to participants endorsing more positive than negative adjectives. The Reference by Valence interaction was also significant, $F(1,265) = 56.694$, MSE = 349.705, $p < .001$, $\eta_p^2 = .176$.

To understand this interaction better, we conducted two post-hoc ANOVAs, one for each Valence. A 2 Modality x 2 Reference ANOVA performed for positive adjective endorsement revealed that participants endorsed fewer positive adjectives in the Self block than in the Harry Potter block, $F(1,350) = 64.723$, MSE = 420.364, $p < .001$, $\eta_p^2 = .156$, consistent with the main effect of reference. The post-hoc ANOVA investigating solely negative adjectives, however, found an effect of Reference in the opposite direction, with participants endorsing more negative adjectives in the Self block than in the Harry Potter Block, $F(1,350) = 12.110$, MSE = 43.418, $p < .001$, $\eta_p^2 = .044$, Fig.3. Overall, participants endorsed fewer positive words and more negative words in the Self block than in the Harry Potter block.

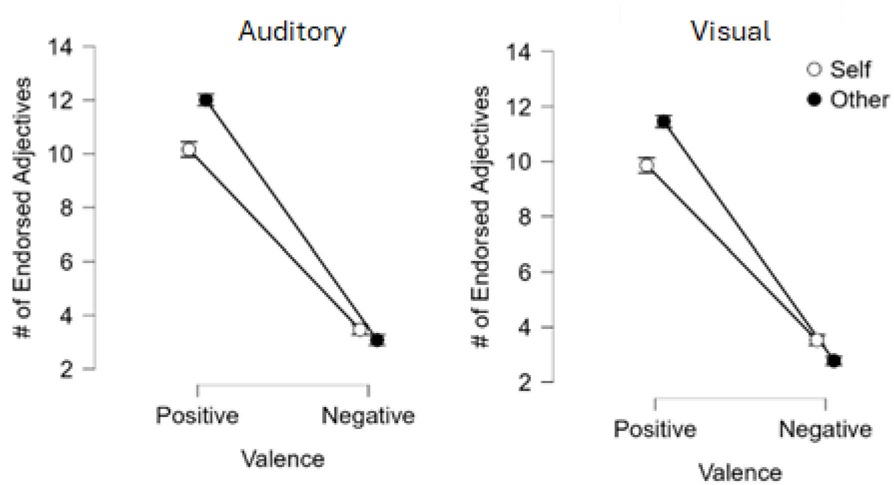

Figure 3.

Participants' endorsement by valence and reference condition, for each modality. The error bars represent the standard error.

2.5.1.2 Endorsement Results for Depressed Vs. Non-Depressed Participants

In a mixed ANOVA (2 Reference x 2 Valence x 2 Depression), there was no main effect of Depression, $F(1,265) = 2.643$, MSE = 17.539, $p = .105$, $\eta_p^2 = .010$ and no interaction of Depression and Reference, $F(1,265) = 6.431$, MSE = 25.637, $p = .012$, $\eta_p^2 = .024$. As before, the main effect of Reference, $F(1,265) = 18.172$, MSE = 72.434, $p < .001$, ηp2 = .064, the main effect of Valence, $F(1,265) = 2129.319$, MSE = 15770.727, $p < .001$, $\eta_p^2 = .889$, and the interaction between Reference and Valence, $F(1,265) = 50.900$, MSE = 296.020, $p < .001$, $\eta_p^2 = .161$, were all significant. In addition, there were significant interactions between Valence and Depression, $F(1,265) = 20.264$, MSE = 150.086, $p < .001$, $\eta_p^2 = .071$, and between Reference, Valence and Depression, $F(1,265) = 16.101$, MSE = 93.642, $p < .001$, $\eta_p^2 = .057$.

To better understand these complex interactions with Depression, we conducted two follow-up ANOVAs (2 Reference x 2 Valence), separately for the Depressed and Non-Depressed groups. The main effect of valence was significant in both groups (Depressed: $F(1,151) = 907.645$, MSE = 7455.002, $p < .001$, $\eta_p^2 = .857$; Non-Depressed: $F(1,114) = 1316.434$, MSE = 8342.785, $p < .001$, $\eta_p^2 = .920$), with more endorsement for positive than negative adjectives. The effect of Reference, however, differed by group. For Depressed participants, the main effect of Reference, $F(1,151) = 27.925$, MSE = 106.949, $p < .001$, $\eta_p^2 = .156$, was qualified by an interaction between Valence and

Reference, $F(1,151) = 61.266$, MSE = 419.449, $p < .001$, $\eta_p^2 = .289$. Depressed participants endorsed significantly fewer positive adjectives in the Self block than in the Harry Potter block, $t(151) = -8.406$, $p < .001$, Fig.4. They also endorsed significantly more negative adjectives in the Self block than in the Harry Potter block, $t(151) = 3.605$, $p = .003$. In contrast, for the Non-Depressed participants, no effect of Reference was found, $F(1,114) = 1.245$, MSE = 5.220, $p = .267$, $\eta_p^2 = .011$, indicating that Non-Depressed participants did not differ in their endorsement between the Harry Potter and Self blocks. That is, they endorsed more positive adjectives regardless of who the adjectives were referring to. The difference in negative adjective endorsement between the Self and Harry Potter blocks was also not statistically significant for the Non-Depressed groups, $t(114) = 1.096$, $p = 1.000$.

Finally, to even further understand these interactions, four independent t-tests were conducted to compare Depressed and Non-Depressed participants across the following conditions: Self-Positive, Potter-Positive, Self-Negative, and Potter-Negative. For the Self block, Depressed participants (M = 9.376, SD = 3.246) endorsed fewer positive adjectives than Non-Depressed participants (M = 11.114, SD = 2.863), $t(350) = -5.299$, $p < .001$, Cohen's $d = .111$. In contrast, for the Harry Potter block, the Depressed participants (M = 11.672, SD = 2.448) and Non-Depressed Participants (M = 11.819, SD = 2.592) endorsed a similar number of positive adjectives, $t(350) = -0.548$, $p = .584$, Cohen's $d = -0.058$. For negative adjectives, Depressed participants endorsed more negative adjectives in the Self block (M = 3.747, SD = 2.211) than Non-Depressed participants (M = 3.062, SD = 1.816), $t(298) = 2.871$, $p < .004$, Cohen's $d = .118$. Finally, in the Harry Potter block, the Depressed participants (M = 2.957, SD = 2.065) and Non-Depressed Participants (M = 2.627, SD = 1.732) endorsed a similar number of negative adjectives, $t(302) = 1.498$, $p = .135$, Cohen's $d = .172$. The mean endorsement values are displayed in both Figure 4 and Table 2.

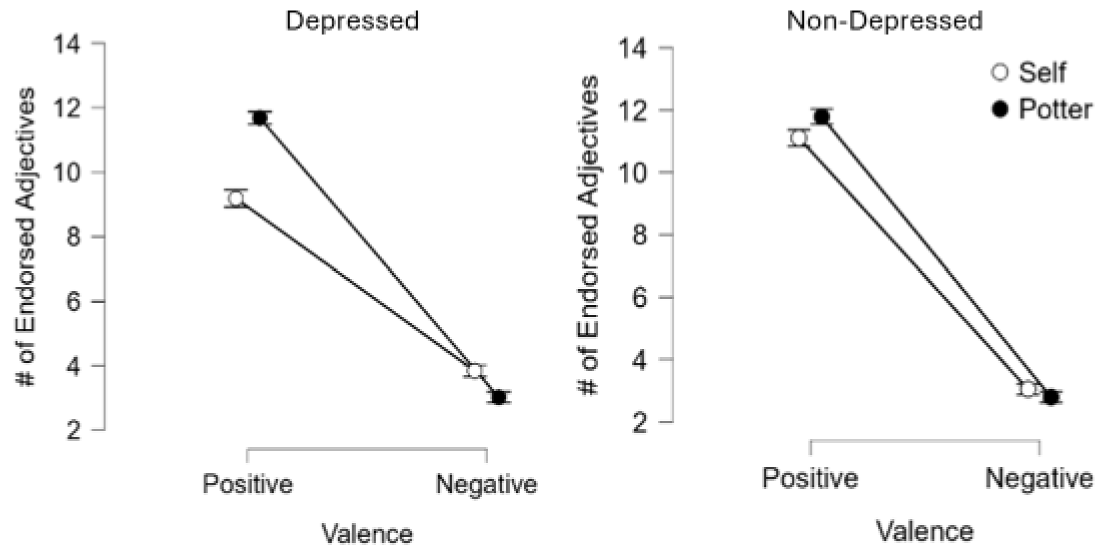

Figure 4.

Endorsement results by valence and reference condition, for depressed and non-depressed participants. The error bars represent the standard error.

			Self		Other	
			Mean	SD	Mean	SD
Modality	Auditory Modality	Positive	10.26	3.18	11.85	2.51
		Negative	3.42	2.04	2.97	2.09
	Visual Modality	Positive	10.14	3.20	11.63	2.52
		Negative	3.48	2.11	2.64	1.73
Depression	Depressed	Positive	9.38	3.25	11.67	2.45
		Negative	3.75	2.21	2.96	2.07
	Non-Depressed	Positive	11.11	2.86	11.82	2.59
		Negative	3.06	1.82	2.63	1.73

Table 3.

Means and standard deviations for endorsement scores across conditions and groups. Values are rounded to 2 decimal places.

2.5.2 Recognition Accuracy

2.5.2.1 Recognition results across Modalities

The main effect of Modality was not significant, $F(1,350) = .308$, MSE = .038, $p = .579$, $\eta_p^2 = 8.806x10^{-4}$ and no significant interactions between Modality and any other factor were found (all p's > .185). In addition, there was no significant effect of Valence, indicating that participants did not display a memory bias for positive or negative words, $F(1,350) = 0.406$, MSE = .008, $p = .525$, $\eta_p^2 = .001$.

There was a main effect of Reference, $F(1,350) = 105.429$, MSE = 2.411, $p < .001$, $\eta_p^2 = .231$, due to participants remembering more self-referenced words than Harry Potter words. There was also a small significant interaction between Reference and Valence, $F(1,350) = 4.178$, MSE = .047, $p = .042$, $\eta_p^2 = .012$. We conducted 2 post hoc ANOVAs (2 Modality x 2 Valence) to assess Valence accuracy separately for the Self block and the Harry Potter block. We did not find an effect of Valence in the Self block, $F(1,350) = .545$, MSE = .008, $p = .461$, $\eta_p^2 = .002$, or for the Harry Potter block, $F(1,350) = 2.796$, MSE = .047, $p = .095$, $\eta_p^2 .= .008$. Thus, the interaction between Reference and Valence was not reflective of true differences. Recognition accuracy values are displayed in Figure 5 and Table 3.

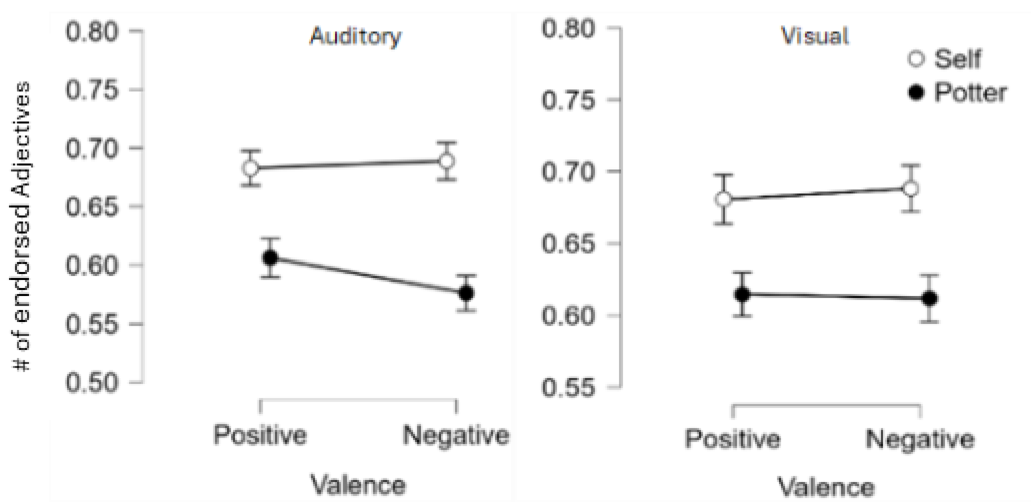

Figure 5.

Recognition accuracy for the Harry Potter and Self blocks, for each modality. The error bars represent the standard error.

			Self		Other	
			Mean	SD	Mean	SD
Modality	Auditory Modality	Positive	0.68	0.20	0.61	0.21
		Negative	0.69	0.21	0.58	0.20
	Visual Modality	Positive	0.68	0.22	0.61	0.20
		Negative	0.69	0.21	0.61	0.22
Depression	Depressed	Positive	0.67	0.23	0.61	0.21
		Negative	0.69	0.22	0.60	0.22
	Non-Depressed	Positive	0.69	0.19	0.61	0.20
		Negative	0.68	0.21	0.59	0.20

Table 4.

Means and standard deviations for recognition accuracy (d') across conditions and groups. Values are rounded to 2 decimal places.

2.5.2.2 Recognition Results for Depressed Vs. Non-Depressed Participants

The 2x2x2 ANOVA in which Depression was a between-subject factor (Depressed vs. Non-Depressed) revealed no significant effect of Depression, F (1,350) = 0.002, MSE = 2.319×10^{-4}, p = .965, $\eta_p^2 = 5.445 \times 10^{-6}$, and no interactions between Depression and any other factor (all *p's* > .154). As before, there was also no effect of Valence, F (1,350) = 0.516, MSE = 0.010, p = .473, η_p^2 = .001, but the main effect of Reference was significant, F (1,350) = 105.344, MSE = 2.421, p < .001, η_p^2 = .231, as participants recognized more self-words than Harry Potter words. As before, there was a small interaction found between Valence and Reference, F(1,350) = 4.076, MSE = .046, p = .044, η_p^2 = .012 but the follow-up post-hoc tests for each reference condition were not significant, suggesting a lack of true differences. Average recognition accuracy values for Depressed and Non-Depressed participants are displayed in Figure 6 and Table 3.

We also considered CES-D as a continuous measure and conducted a MANOVA, including the same factors as above (Reference, Valence, and Modality) but using CES-D scores as a regressor. This analysis confirmed that the degree of depressive symptoms did not relate to recognition accuracy, F (1,350) = 0.9892, p = .4134.

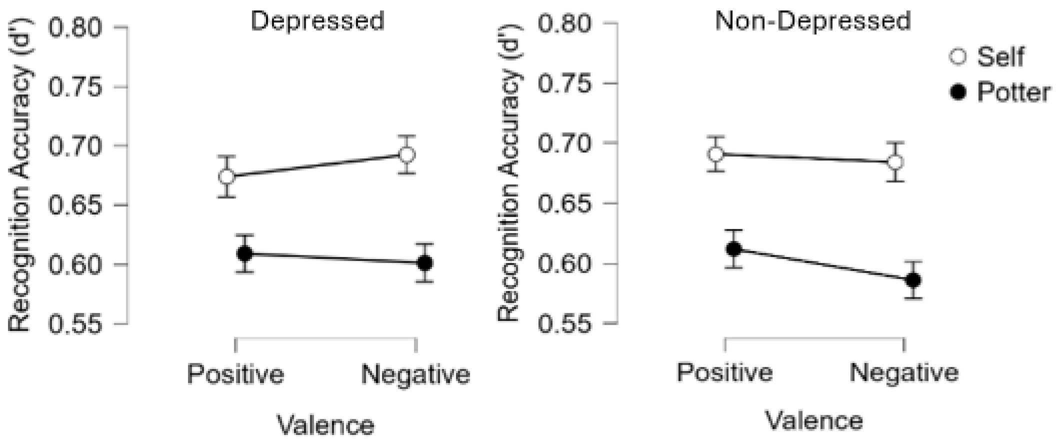

Figure 6.

Recognition accuracy by valence and reference for depressed and non-depressed participants. The error bars represent the standard error.

Chapter 3
Discussion

The aim of this study was to investigate the SRE, to establish whether it exists in the auditory modality, and if so, whether it is comparable in magnitude in the auditory modality and the visual modality. A secondary objective was to examine whether word valence - positive or negative - impacts recognition memory for words. Finally, I sought to explore whether depressive symptoms influence valence-related memory biases. To our knowledge, this is the first study using the SRET to assess these effects in the auditory modality. Based on the literature, we predicted that if the auditory SRE functions similarly to that in the visual domain, both a self-reference effect and a self-positivity bias would be expected at the behavioural level (Hudson et al., 2020). Prior research on memory has suggested that recognition performance is generally comparable across auditory and visual presentations when a time delay is incorporated; thus, no modality differences were expected in the number of items recognized overall (Otten et al., 2010). We also predicted a comparable SRE magnitude in both modalities, reflecting an amodal process. Regarding the effect of depressive symptoms on valence-related memory biases, we expected to see a diminished positivity bias or a negativity bias for self-relevant information in more depressed individuals (Zupan et al., 2017). The results of the current study revealed a memory advantage for self-relevant information in both modalities, with no differences in recognition performance between the modalities, consistent with our predictions. Contrary to expectations, however, we did not observe a self-positivity bias in endorsement or any significant valence-related memory biases. Additionally, there were no significant differences in memory performance between participants with elevated depressive symptoms and those without. Below, I will discuss the potential implications of our findings and the limitations of the study.

3.1 Methodological considerations

Expanding on previous study designs, we aimed to investigate the self-referential memory effect (SRE) with increased statistical power. Our study included a sample of 352 participants, a stark contrast to most studies employing the SRET task, which typically report an average sample size of 39 participants (Symons & Johnson, 1997). To further enhance the precision of our task, we carefully controlled our stimuli along nine lexical dimensions that are known to influence word processing and memory (Brysbaert, Warriner, & Kuperman, 2014; Cortese et al, 2020; Brysbaert, Mandera, &

Keuleers, 2018; Elsherif, Preece, & Catling, 2023; Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012; Vitevitch et al., 2012). Of primary importance, we matched our positive and negative stimuli for frequency, age of acquisition, and concreteness, all of which have strong effects on processing. This type of stimulus control has rarely been implemented in the SRE literature but is crucial for accurately capturing both the SRE and valence-related biases (D'Argembeau et al., 2010). Furthermore, it is important to note that we used a paradigm consistent with the majority of SRE studies, suggesting that our procedure is unlikely to account for discrepancies between our original hypotheses and our results. Given the large sample size, careful stimulus control, and paradigmatic consistency, we believe this study represents one of the most methodologically stringent investigations of the SRE to date.

3.2 Lack of modality differences

Our study achieved its primary objective by demonstrating the presence of the self-reference effect (SRE) in the auditory modality and showing that its magnitude does not differ between the auditory and visual modalities. These findings align with previous research suggesting that self-referential processing engages similar neural structures across modalities, such as the medial prefrontal cortex (mPFC) (Northoff et al., 2006), and that auditory and visual memory performance are comparable when a delay is incorporated into the study design (Otten et al., 2010; Northoff et al., 2006). However, since no other study, to our knowledge, has tested the SRE using auditory stimuli and directly compared its magnitude to the visual modality, we made our predictions tentatively. Based on our findings, future studies can now reliably incorporate the auditory modality into their SRE testing paradigms.

3.3 Lack of self-positivity bias

The absence of any valence effects in recognition memory was unexpected, diverging from much of the existing SRE literature. For example, Hudson et al. (2020) reported a self-positivity bias in the recognition task of their experiment 1 (n = 38) and in both the recognition and free recall tasks of their experiment 2 (n = 44). Our findings, however, align more closely with those of D'Argembeau et al. (2010) (n =36), who, after carefully controlling their stimuli, also found no valence-related SRE in recognition. Interestingly, D'Argembeau et al. did observe a self-positivity bias in free recall, and they proposed that this bias may emerge more readily during free recall due to the different cognitive demands it entails. Specifically, free recall requires individuals to generate their own retrieval cues, allowing self-related processes to influence memory reconstruction. In contrast, recognition tasks present external cues, limiting the need for self-generated elaboration and thus reducing the influence of self-related biases on performance (D'Argembeau et al., 2010). This interpretation is further supported by Carson et al. (2018) (n = 50), who assessed memory performance using solely a recognition task. Similar to our study, they only observed an SRE but no self-positivity bias. In contrast, Daniel-Best et al. (2018), using a SRET that involved only free recall and included a large sample of 1,273 participants, observed both an SRE and a self-positivity bias. These findings support the possibility that our lack of a self-positivity bias may be attributed to the exclusion of a free recall task. However, given that some researchers have successfully captured valence effects in recognition tasks, we propose that our complete absence of valence effects in recognition may also be a result of our control of lexical variables (in addition to a large sample size).

It is also possible that the absence of a self-positivity bias on recognition memory may also reflect specific characteristics of our participant pool, which was composed primarily of university students. Student populations often exhibit elevated levels of anxiety compared to broader community samples, which could interfere with the expression of a self-positivity bias. Anxiety has been shown to reduce the self-positivity bias in memory (Kalenzaga & Jouhaud, 2018). Using the SRET with 135 first-semester university students, Tracy et al. (2021) found that negative self-referential processing was associated with higher General Anxiety Disorder (GAD-7) scores during the students' first month of university. Scores on the GAD-7 range from 0 to 21, with greater values corresponding to higher levels of anxiety (Spitzer et al., 2006). As Garcia et al. (2024) noted, individuals tend to prioritize maintaining a stable and coherent self-concept, even if it means disregarding positive self-relevant information. To draw more definitive conclusions about the self-positivity bias, future research should screen for anxiety symptoms along with depressive symptoms.

3.4 Effects of depression on memory biases

We initially predicted that participants with depressive symptoms would exhibit a negativity bias in memory, consistent with well-documented features of depression (Duyser et al., 2025). The reason for the absence of this effect in the recognition task among participants with depressive symptoms remains unclear. However, we did find another experiment with similar results to ours. Supporting our findings, Dainer-Best et al. (2018) conducted the SRET in a large non-clinical sample (n = 1,273), using the CES-D to assess depressive symptoms. They found no association between free recall performance and depression severity and concluded that recall data from the SRET may not be useful as a predictor of depression. The authors did not elaborate on potential explanations for this lack of effect. In contrast, Duyser et al. (2025) conducted a SRET study with 956 clinical participants, divided into three groups: individuals with current depression, those with remitted depression, and a control group with no history of depression or other psychiatric diagnoses. Using a free recall task, they found that the negative memory bias was most strongly associated with depressive symptom severity and advocated for the clinical application of the SRET. While their findings support this association, we suggest that the SRET should be used with caution, particularly when applied as a screening or tracking tool in undiagnosed, non-clinical populations. Our study assessed depressive symptoms as a continuous variable in a non-clinical sample and found no relationship between depression scores and memory biases. This result is particularly striking given our large sample size, standardized paradigm, and carefully controlled stimuli. Given the absence of any valence effects in our study, we urge caution in using the SRET as a diagnostic or severity-tracking tool for depression.

3.5 Importance of endorsement in the SRET

Although our study is primarily focused on memory, assessed through a recognition task, we also uncovered interesting findings regarding the endorsement of self-referent and other-referent adjectives. While endorsement rates are often omitted in SRET studies, which tend to focus solely on recognition or recall, our data suggest endorsement may provide additional insights. In contrast to existing findings (e.g. Hudson et al., 2020), participants in our study endorsed more adjectives overall for Harry Potter than for themselves. More specifically, participants endorsed more positive adjectives for Harry Potter than for themselves, and more negative adjectives for themselves than for Harry Potter. This diverges from the findings of Hudson et al. (2020), who reported no referent-by-valence interaction in Experiment 1 and a self-positive interaction in Experiment 2 for endorsement. Indeed, when we analyzed endorsement data separately for depressed and non-depressed participants, we found that non-depressed participants displayed equally positive and negative endorsement patterns for both Harry Potter and the self. In contrast, depressed participants (who represented 52.8% of our sample) displayed a reduced positivity bias as well as an increased negativity bias in the Self block compared to the Harry Potter block. The two groups only differed in their endorsement of the self, not in their endorsement of Harry Potter. Importantly, these differences in endorsement patterns did not translate into differences in recognition performance. These findings on depression align with the depression endorsement literature, in that depression symptoms result in decreased positive word endorsement (Disner et al., 2016). In a non-clinical sample of 57 participants completing a SRET task, Disner et al. (2016) found that for every additional positive adjective endorsed, CES-D scores decreased by approximately 0.5 points, whereas for every additional negative adjective endorsed, CES-D scores increased by 0.5 points. Their findings support the use of the SRET *endorsement* task as a predictor of depressive symptom severity, with more depressed individuals endorsing fewer positive adjectives and more negative adjectives, as also found here.

3.6 Limitations

Although the present study contributes to advancing our understanding of the SRE and valence-related memory biases, there are a few limitations for future researchers to be cautious of. Our "other" condition featured the character Harry Potter, a generally positively valenced figure due to his role as the heroic protagonist in a beloved book series and movie franchise. We selected him as our “other” referent because the SRET requires a familiar “other” to meaningfully compare memory performance to the self condition, and he has been frequently used in prior SRET studies for this purpose. However, Harry Potter’s predominantly positive traits may have increased the likelihood that he would be associated with positive adjectives, perhaps even more so than the self (as demonstrated in the endorsement results). However, again, this did not translate as valence differences in the recognition task. In future research, this variable should be more carefully controlled. For instance, studies could incorporate multiple "other" referents across different experimental conditions to examine the SRE and positivity bias beyond a single character. Additionally, participants varied in their familiarity with Harry Potter, potentially resulting in inconsistent perceptions of the "other" condition across individuals. Participants who were more familiar with Harry Potter may have engaged in more elaborative encoding compared to those with limited knowledge of him, thereby introducing variability in the depth of processing. As our primary interest was in the self-referential condition, these limitations did not directly impact our main research goals. However, future studies could benefit from measuring familiarity with the "other" or ensuring a more uniformly familiar “other” referent.

3.7 Conclusion

This study extends the self-reference effect (SRE) literature into the auditory modality using a large and statistically powerful sample (n = 352). The use of a large sample, standardized paradigm, and highly controlled stimuli enhances our confidence in these results. Our findings suggest that the SRE is modality-independent, supporting its robustness across sensory channels. This provides a strong foundation for researchers to reliably employ auditory stimuli in SRET paradigms. Significantly, using auditory tasks removes the constraint of reading ability, enabling the investigation of self-referential memory in younger, pre-literate populations. This methodological advancement may allow for additional insight into children's development of the sense of self and self-referential memory biases. With regard to valence-related memory biases, our findings did not support the presence of a self-positivity bias, contrary to what is commonly reported in the literature. This discrepancy may suggest that the self-positivity bias is less robust than previously assumed—possibly inflated by small sample sizes or the use of uncontrolled stimuli in earlier studies. Alternatively, it is possible that the recognition task used in our study is less sensitive to valence effects than free recall task. These findings contribute to a more nuanced understanding of self-referential memory and have potential implications for developmental and clinical applications.

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