Negative Mood Reduces Self-Referential Memory Effects in an Online Object Ownership Simulation

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Acknowledgements

This dissertation would not have been possible without Dr Progress Njomboro, my supervisor. His mentorship and willingness to respond at any time of day were deeply appreciated. This project would not be as pleasant to read as it is today without his brilliant edits and feedback.

My sincere thanks to Mr Tadious Boswell for his assistance with the technical aspects of this study and his willingness to modify the online materials. Developing our wonderful website was a challenge, from which we all learned a lot, but it was certainly worth it in the end.

I am immensely grateful for the financial support I received from the UCT postgraduate funding office, particularly from the Vice-Chancellor's Scholarship who funded my degree, without whom this paper would not have been possible. A special thanks is also owed to Dr Kevin Thomas and Kerewin Parfitt for their assistance in securing my completion grant.

I would also like to extend my gratitude to my colleagues, friends, and family who assisted me to no end during the turbulent COVID-19 period of this study and stood by me while my research plans appeared to burst into flames. Their words of encouragement, cups of tea, and shoulders to cry on meant the world. A special thanks to my fellow Neuropsychology interns whose shoulders were probably cried on the most. I thank my partner Ben for supporting me at my most frantic, and my cat Kenny for reminding me that there is more to life than working. Most of all, I must thank my mother, whose encouragement, support, and generosity carried me all the way through both my undergraduate and postgraduate degrees.

Abstract

The Self-Reference Effect (SRE) is a cognitive bias in which self-relevant stimuli are prioritised for processing. This bias allocates more attentional and encoding resources to self-relevant objects making their memory traces more robust and easily retrievable. Research has repeatedly shown that self-owned and self-proximal objects benefit from this bias. However, little is known about the factors that impact the SRE. Emerging research suggests that emotion may attenuate the SRE. For instance, studies show that the salience of a self-related stimulus reduces when the stimulus is associated with negative self-referential information. However, there is limited research on how the SRE may be modulated by transient mood states. The major aim of the present study is to determine whether the SRE may be modulated by transient mood states. We investigated whether an induced negative mood state alters memory for self-related objects using an online emotion induction and shopping task. This task was selected because although SRE effects are robust in laboratory conditions, most studies rely on tasks with low external validity. All participants completed an online mood induction protocol (either negative or neutral mood induction). Thereafter, participants completed an online self-referencing object ownership task involving encoding (and subsequent recall) of self-owned, familiar other-owned, or unfamiliar other-owned everyday household shopping items. The group induced into a negative mood showed reduced memory recognition accuracy compared to the neutral mood group, with reduced memory for self-owned items. Further analyses revealed that negative mood interacted with both depression scores and object ownership to influence self-referential processing. Our results add to current SRE evidence and offer insights into how this bias can be influenced by both transient mood states and affective symptoms.

Keywords: Self-reference, Object Ownership, Mood, Negative Emotion, Online.

The Self-Reference Effect (SRE) is a cognitive bias in which self-relevant stimuli are prioritised for processing. This prioritisation enhances attentional and encoding capacities, thus enabling the formation and storage of more robust memory traces. Consequently, the retrieval of these self-relevant memory traces is better relative to non-self-relevant traces (Rogers et al., 1977; Symons & Johnson, 1997). In attention studies, a similar attentional Self Prioritisation Effect (SRP) (Sui et al., 2012) has also been repeatedly demonstrated, in which judgments on self-related material are elicited faster and more accurately than judgments about other-related material. These effects have been shown to enhance the processing of self-relevant information across different cognitive domains (Mattavelli et al., 2017).

An emerging body of research suggests that self-related biases are prone to the influence of affect and emotion. Studies have reported an attenuated SRE following emotional priming (Fan et al., 2016), and that the SRP is altered by emotional stimuli (Sui et al., 2016). Specifically, in healthy participants the SRE is usually enhanced by positive self-referential emotional stimuli (Durbin et al., 2017) and both the SRE and SRP are weakened by negative emotional stimuli (Sui et al., 2016; Zhang et al., 2018). Most of this research has been conducted with stimuli that are inherently emotionally coded, such as negative self-descriptive trait adjectives. However, the relationship between more transient mood states and self-related biases remains unclear. In addition, most studies have relied on laboratory-based tasks that test memory or attention to objects with little semblance to real-life cognitive processing. There is limited research on how the SRE applies to other more ecologically valid stimuli such as real-life objects. At least one study has shown that the processing of self-owned objects benefits from self-referential cognitive biases (Rosa & Gutchess, 2011). Furthermore, little is known about how self-owned object biases are impacted by other important variables, such as emotional states or affect.

In the following review, we discuss the factors that influence self-related memory biases in cognitive performance. We focus on the relationships between the processing of self-related object ownership and mood. This area of research has been receiving increased attention over recent years as the SRE offers a method to investigate the mechanisms involved in self-bias. For instance, some research focuses on attenuated self-related cognitive biases in affective disorders, especially those in major depressive disorder (MDD). Some therapeutic interventions, such as mindfulness meditation techniques, target negative emotional self-referential thought (Lin et al., 2018). Investigating the relationship between mood and the SRE for self-owned objects may shed light on how everyday changes in mood or more enduring affective states can alter self-bias.

The Self-Reference Effect

The cognitive system is biased towards processing self-relevant stimuli. This bias is involved in the memory advantages demonstrated in the SRE. In healthy participants, this SRE-related memory benefit is thought to be relatively stable across the lifespan (Cunningham et al., 2011; Gutchess et al., 2007; Leshikar et al., 2015), although some studies suggest it gradually becomes less effective in healthy ageing (Eustache et al., 2015; Gutchess et al., 2015). Robust self-referential encoding memory performance benefits have been shown to surpass episodic and semantic encoding strategies (Symons & Johnson, 1997). In addition, the SRE operates on a wide range of stimuli, including memory for objects (Cunningham et al., 2011), contextual features (Serbun et al., 2011), actions (Manzi & Nigro, 2008) and most commonly on memory for trait adjectives (Rogers et al., 1977; Stendardi et al., 2021). For example, participants recall self-descriptive trait adjectives more accurately than those deemed to describe familiar others such as friends (Turk et al., 2008). Apart from SRE memory benefits, similar self-related biases have been demonstrated in studies of attention (Sui et al., 2014), visual perception (Sui & Humphreys, 2015), and other cognitive domains. The SRE is therefore a useful paradigm to investigate the extent to which self-related information is prioritised over other stimuli for cognitive processing (Kalenzaga & Clarys, 2013).

One criticism of SRE research is that familiarity with the chosen stimuli may influence recall (Klein, 2012). The majority of SRE research has been based on elaborative encoding strategies which depend on prior knowledge; often autobiographical information (e.g., 'recall a place where…') or self-descriptive trait adjectives (e.g., 'to what extent does 'funny' describe you?'). Other studies have employed elaborative encoding of visual objects, such as responses to one's own face compared to a famous face (Fan et al., 2016). These methods have been critiqued for potentially inducing over-learned responses to more familiar stimuli (Klein, 2012). Furthermore, studies using differing elaborative encoding methodologies have been shown to produce seemingly contradictory results (Klein, 2012). For instance, varying conceptions of other-familiarity have been utilised. Han et al. (2010) defined the familiar other as the former Chinese premier and showed a typical SRE pattern for the judgement of self-descriptive traits. In contrast, Wu et al. (2010) defined the familiar other as ‘mother’ in another study and found no SRE for participants completing the same task. There are some possible explanations for this discrepancy. For instance, there are variations across cultures in the extent to which the distance between the ‘self’ and ‘other’ identities are conceptualised and also in how these identities are integrated into the self-concept (Xiao-Bing et al., 2020). ‘Mother’ may be more self-related than the Chinese premier and thus would be more robustly integrated into one’s self-conception than a political figure. These results suggest that the robustness of the SRE may also vary across cultures, as specific identities may be incorporated into the self-concept to differing extents.

A few studies have controlled for some of the methodological factors mentioned above. For example, Sui et al. (2012) developed a perceptual matching methodology with associative learning to bypass the need for semantic judgement of over-familiar stimuli. In this task, participants were requested to associate geometrical shapes (e.g., a square, triangle, and diamond) with a label applied to the self (you), a familiar other (friend), or an unfamiliar other (stranger). Findings revealed that participants were fastest and most accurate when matching the self-shape label pair and were slowest and least accurate with the unfamiliar other-shape label. Sui and colleagues (2012) concluded that new knowledge (an arbitrary shape-label pairing) is subject to prioritisation by its degree of self-relatedness, without the confound of prior familiarity. Extending these findings, Sui and Humphreys (2015) also demonstrated the attentional SRP, whereby judgments about self-related material are elicited faster and more accurately than judgments about other-related material. This effect has been supported in subsequent studies (e.g., Lee et al., 2021; Schäfer & Frings, 2019; Woźniak & Knoblich, 2019). This finding has also been replicated at various stages of processing, such as during perception (Janczyk et al., 2019), in working memory (Yin et al., 2019), and during higher-order decision-making (Sui & Humphreys, 2015). It is plausible that self-referential processing acts as the ‘glue’, binding episodic memory information with perceptual information (Sui & Humphreys, 2015). Thus, self-relevant stimuli are robust attentional cues and can operate independently of awareness (Sui & Humphreys, 2017). One outstanding question in SRE research is whether such findings are universal or cross-cultural.

Cultural context influences the development of one’s self-concept, as the self is experienced in relation to others (see Huff et al., 2015 for a review). However, the SRE has been demonstrated in predominantly western cultures. A few international studies have shown that cultural factors seem to modify the SRE. For instance, research suggests that some communities such as those in parts of South and East Asia define the self in relational terms through interconnectedness with others, with an emphasis on family closeness (Markus & Kitayama, 1991). Western cultures on the other hand seem to value the self as a unique entity, and this bias is thought to underpin the self-prioritisation evidenced by the SRE (Huff et al., 2015). Several studies have demonstrated that participants from East Asian cultural backgrounds, such as participants from China, assimilate their mothers into their self-concept to a greater extent than Western participants do (Huff et al., 2015; Wang et al., 2012). Such differences have been linked to some observed cross-cultural differences in the quality of the SRE. For instance, Chinese participants showed significantly faster response times to mother-related stimuli than western participants (Sui et al., 2012), and enhanced memory for both self-owned and mother-owned objects (Sparks et al., 2016). Research from other cultures is scant. To the best of our knowledge, there has not been research on the SRE in Africa. Taken together, these findings demonstrate that self-related stimuli operate on a range of processing systems, at various stages and offer a useful paradigm with which to explore self-prioritisation in memory.

The Self-Reference Effect and Object Ownership

Most research on the SRE has been conducted using laboratory-based tasks using trait adjectives and other word-list stimuli. These lab tasks have poor ecological validity (Verga & Kotz, 2019), and tend to be biased by item familiarity. For example, one is always more familiar with one’s own name or face in comparison to others’ (Woźniak & Knoblich, 2019). Whilst trait adjective tasks are designed to assess explicit influences of the self on processing, implicit self-referential processes may be involved in being the owner of an object and other real-world self-referential processes (Golubickis et al., 2018; Li et al., 2022). Recognition of words and objects is neurologically and functionally dissociable and utilises separate memory stores. This is well demonstrated in cases of stimulus-specific agnosias (Rumiati & Humphreys, 1997). Research suggests that self-related biases influence object processing.

Studies of object attributions and categorisation have consistently demonstrated a cognitive bias towards self-owned objects. For instance, in an early study participants reported that objects assigned to the self had more positive attributes and were more valuable than equivalent objects assigned to others (Beggan, 1992). This was termed the ‘mere ownership’ effect. Object ownership SRE studies can have better control of stimulus over-familiarity by assigning object ownership within the experiments themselves (Truong et al., 2013). Cunningham et al. (2008) were the first to show that participant ownership of an object enhanced memory for that object over those assigned to others. This showed that the SRE extends to self-owned items. Several studies have supported this finding (Golubickis et al., 2018; Sparks et al., 2016; Truong et al., 2013; Turk, van Bussel, Brebner, et al., 2011). Several SRE studies have utilised objects that participants would encounter in daily life. For instance, Rosa and Gutchess (2011) developed a task in which participants are asked to simulate packing items into either a picnic basket or a suitcase, alongside two other people. The two other people are a close friend brought by the participant and an unknown confederate. This creates three levels of relational distance: Self, familiar other, and unfamiliar other. At the end of this task, the participants were asked to recall who put each item into the basket (the self, other, or unfamiliar other). Their results demonstrated the SRE among young healthy participants for object ownership. In addition, reward and attentional networks show enhanced activation when presented with self-owned objects (Truong et al., 2013; Turk, van Bussel, Brebner, et al., 2011; Turk, van Bussel, Waiter, et al., 2011). The SRE has also been manipulated to indicate the extent to which episodic memory for self-owned objects is prioritised over semantic information about the same object (Kalenzaga et al., 2013). More recently, a study in which participants determined the temporal order of presented object images showed that self-owned objects were reliably prioritised by attentional mechanisms, suggesting a top-down attentional bias for self-relevant information (Constable et al., 2019). The object ownership SRE has also been shown to extend to group ownership. For instance, participants are more likely to remember items owned by family members following arbitrary ownership assignments (Li et al., 2022).

Investigations that have aimed to establish the origins of this effect have demonstrated that a response bias appears to facilitate self-ownership effects (Golubickis et al., 2018). This bias operates at the point of the initial encounter with the object, as all objects are assumed to be self-owned at exposure (Firestone & Scholl, 2015). The automaticity of this assumption allows for faster and more accurate categorisation of self-owned objects in matching tasks because self-objects require less verification (Golubickis, et al., 2018). Egocentrism is thought to facilitate this enhancement, as it may underpin the inherently rewarding nature of self-related material (Northoff & Hayes, 2011). However, a competing view is that self-referential stimuli attract separate processing mechanisms from rewarding and emotional material (Sui et al., 2016). Although these arguments are beyond the scope of this work they do highlight the poorly understood underlying mechanisms of the object ownership SRE.

Performance on self-referential word list tasks may differ in important ways from memory performance in object ownership tasks, such as through the response biases mentioned above. No studies have examined the SRE ownership paradigm in an online, virtual setting. For this reason, it is not clear whether this bias operates on other stimuli, such as images of objects used in daily life. Our study was undertaken during the COVID-19 era lockdown when there was a need for online materials to investigate psychological phenomena remotely (O'Connor et al., 2020). The object-ownership paradigm we used bypasses the item-familiarity confound within SRE research. This paradigm potentially offers greater ecological validity, as object ownership occurs in real-life and online settings (Cunningham et al., 2011). Thus, there is a gap in the literature for investigating how the SRE interacts with object ownership in an online setting. This is necessary to investigate due to the large contribution that the virtual realm makes to current living, particularly in the present pandemic. Another relatively unexplored aspect of SRE research is how emotional processes and affective states influence the ownership SRE and other self-referential biases.

Self-Related Processing and Emotion

SRE research raises the question of whether self-biases are distinct processes, or if they are part of a generalised biasing network, alongside other well-established biases, such as for emotional stimuli. The preferential processing of emotionally coded stimuli is well-documented. For instance, the landmark classical conditioning experiments by LeDoux (1994) demonstrated the enhanced processing of frightening stimuli via activation of subconscious recognition networks, allowing for rapid, automatic bodily responses. Emotional stimuli have been shown to automatically summon attention and therefore influence behaviour (Lang, 1995; Schupp et al., 2007; Taylor & Fragopanagos, 2005). Emotions and affect also influence a variety of cognitive processes such as those involving the encoding, storage and retrieval of memories (Blaney, 1986; Elliott et al., 2002). Emotions are argued to be highly self-relevant as they are uniquely experienced by the subjective self (Herbert et al., 2011). Therefore, emotions share an important link with self-referential processing.

The link between emotional and self-referential processing has been supported by neuroimaging research. With regards to neural self-representation, a network of cortical midline structures has been shown to mediate self-referential processing across spatial, emotional, verbal, and emotional domains (Northoff et al., 2006). Activation in both the medial prefrontal cortex (mPFC) and the posterior cingulate cortex has been shown to discern self-representations from familiar and unfamiliar others, suggestive of localisation of self-representation (Feng et al., 2018; Northoff et al., 2006). Subcortical brain regions including the amygdala, brain stem, and periaqueductal grey matter are largely responsible for emotional processing (LeDoux, 1994, 2012; Panksepp, 1998), together with some cortical areas, such as the insula (Saarimäki et al., 2016; Uddin et al., 2017). Activation of particular cortical midline structures, such as the mPFC, anterior cingulate cortex, and dorsomedial prefrontal cortex (dmPFC) has been demonstrated during both emotional processing (Etkin et al., 2011; Phan et al., 2002; Riedel et al., 2018) and self-referential processing (De Pisapia et al., 2019; Feng et al., 2018; Leshikar & Duarte, 2014; Wong et al., 2017). This may be due to the intrinsic self-referential nature of emotional processing, rather than direct emotional processes, as emotions are experienced by the subjective self (Northoff et al., 2006). Event-Related Potential (ERP) evidence shows that during combined self-related and emotional processing, self-relevant material appears to guide processing at an earlier stage than the emotional material (Zhou et al., 2017). This suggests that the self is involved in early stages of emotional modulation and integration. Thus, although emotional and self-referential neurological processes appear largely distinct, they overlap and appear to interact under particular conditions.

There is a well-established link between self-referential processes and emotional difficulties. Negative mood (most commonly in major depressive disorders) has been shown to lead to greater self-focus (Green et al., 2003; Mor & Winquist, 2002; Salovey, 1992) and to reduce attention towards rewarding stimuli (Sui et al., 2016). Research demonstrates that depressed participants' negative self-perception causes increased self-fixation (Fossati, 2018; Ingram, 1990). Auerbach et al. (2015) showed that depressed adolescents show reduced recognition of positive self-referential material. Furthermore, participants with generalised anxiety disorder (GAD) symptoms have been shown to recall a greater degree of negative self-referential information (Tracy et al., 2021). One mechanism through which emotional material is thought to influence the SRE is through an individual's self-concept and the emotional valence (either positive or negative) of one's self-perception. Some research of more subtle SRE effects has demonstrated a greater degree of subjective memory for the encoding context of self-related trait adjectives. In such studies, self-related trait adjectives are encoded when the adjectives are selected by the participant as definitive of the self. In contrast, other-related trait adjectives are those selected as definitive of another identity, such as a celebrity. This pattern of performance is thought to illustrate an association between experiencing a high degree of self-relevance during encoding and autonoetic consciousness (Conway et al., 2001). Autonoetic consciousness is an increased ability to mentally “re-live” the encoding scenario (Tulving, 2005). The emotional valance of the stimulus (either positive or negative) corresponded with participants’ self-concept valences.

Common mood disorders such as MDD are associated with negative self-concept valance due to reductions in self-esteem for instance (Dobson & Stam, 1999). It follows therefore that mood symptoms may alter self-referential biases in crucial ways (Romero et al., 2016). In studies on autobiographical self-referential memory, it has been demonstrated that although participants do not seem to remember more emotional compared to non-emotional events, it does appear that emotional stimuli enhance the amount of detail recalled about each encoding scenario (Kensinger, 2007). This effect is stronger for negative than for positive and neutral memories, possibly due to the evolutionary advantage that would come from learning to avoid aversive environmental stimuli. Thus, a person’s emotional conception of themselves appears to impact self-referential recall in subtle ways, beyond merely altering memory recall. Changes to self-referential processes are argued to underpin certain mental health interventions, such as mindfulness meditation (Lin et al., 2018). Participants who regularly practiced mindfulness meditation showed a reduced SRE and relatively enhanced recall for ‘other’-related material (Shi & He, 2020). This suggests that such interventions can produce increased awareness of others and reduced self-focus. Findings such as these demonstrate that emotional stimuli and the SRE interact in ways which may impact real-world functioning and clinical conditions. Thus, there is a need for a more thorough understanding of the mechanisms involved.

Relationships between self-referential biases and processing of various emotional stimuli have been established. A positivity bias for emotional stimuli emerges in self-referential tasks requiring choices, recognition, or categorisation (Stolte et al., 2017). There is evidence from word lists studies that positive trait adjectives are more rapidly encoded and recognised (Herbert et al., 2008; Kuperman et al., 2014; Orooji et al., 2012). Emotive facial expressions are awarded a robust positivity bias, whereby participants show faster reaction times and more accurate categorisation of positive facial expressions (Calvo & Beltrán, 2013; Leppänen et al., 2003). In addition, positive facial expressions have been associated with a higher likelihood that participants will indicate that a face’s gaze was fixated on them (Lobmaier & Perrett, 2010). In contrast, negative emotional stimuli receive processing advantages on other tasks such as visual search tasks (Stolte et al., 2017). For example, angry faces are identified most rapidly and accurately within crowds of real faces (Pinkham et al., 2010). This visual search bias potentially reflects the lack of categorisation involved in such tasks, as they tend to demonstrate speed of attentional capture (Fox et al., 2000). Increased attentional allocation towards emotional stimuli, such as that paid to one's negative mood, appears to reduce self-referential bias (Pourtois et al., 2006). For instance, Event-related potential (ERP) evidence has shown that when presented with negative emotional pictures followed by self-referential names, participants in a negative mood demonstrated difficulty judging the colour of the names (Fan et al., 2016). Furthermore, negative stimuli have been shown to capture attention and require more time during cognitive analysis, and therefore may take longer to categorise (Fox et al., 2000; Stolte et al., 2017). As success during recognition tasks calls for detailed processing of the emotional stimulus, the rapid attention capture by emotional stimuli renders detailed processing, and therefore accurate recognition, less likely (Stolte et al., 2017). Results such as these suggest that the emotionally arousing quality of a stimulus may influence the way that self-referential stimuli are attended to, encoded, or both. A question that arises is how these biases interact with self-referential processing in real-life settings. This relationship between memory and emotion, particularly negative emotion, has recently been investigated using the SRE within mood research.

The Self-Reference Effect and Mood

There are fewer studies investigating the influence of emotional material on the SRE. These studies mostly rely on explicit, trait adjective tasks in which participants interact with stimuli which are both self-related and emotional. However, there is limited research investigating how exposure to emotional material, such as emotionally arousing imagery, influences subsequent self-referential processing. The question arises of how exposure to emotional media may impact self-referential processing in everyday functioning, such as through heightened arousal or changes in mood states. Although research has demonstrated that positive emotional material can enhance source memory in healthy participants (Sharot et al., 2004), it is not yet clear what the self, and possibly the SRE, might contribute to this process. Like other forms of emotional processing, moods are intrinsically self-related as they are experienced by the subjective self. Mood induction studies have usually demonstrated mood-congruent recall of emotional stimuli in healthy participants. For instance, fewer positive life events are recalled from episodic memory once participants are induced into a negative mood (Mathews & Bradle, 1983; Natale & Hantas, 1982). An early study of participants induced into positive mood states such as elation demonstrated increased recall of self-referential positive personal information compared to positive other-referential information (Nasby, 1998). In contrast, recall of negative information did not benefit from mood-congruent recall effects and was only improved by self-referential encoding. Most research on the SRE and mood demonstrates that mood disorders such as MDD influence self-referential biases through mood-congruency. Whilst non-depressed participants show a bias for recalling positive self-referential material, participants with MDD typically show enhanced mood-congruent recall, particularly for negative self-referent information (Derry & Kuiper, 1981; Gaddy & Ingram, 2014). Clasen et al., (2013) showed that negative mood inductions are maintained for longer periods in participants with MDD, whereby MDD symptom severity was positively associated with mood recovery difficulties, which may boost mood-congruency effects. In addition, a meta-analysis by Everaert et al., (2017) found that depressed participants showed greater emotional interpretation biases towards self-referential stimuli, such as by interpreting ambiguous self-referential stimuli in a negative manner. Negative mood is also associated with greater internal focus on the resting state or homeostasis compared with greater external reward-oriented approaches for neutral and positive mood states (Mor & Winquist, 2002; Paulus, 2007). An ERP study by Herbert et al. (2011) showed that depression scores were correlated with enhanced recall of negative nouns with personal pronouns. The authors argue that following rapid attentional allocation to emotional aspects, self-reference filters emotional stimuli to receive more in-depth processing. Thus, it is clear that emotional mood states influence self-related processing.

Sui et al. (2016) investigated whether the negative mood reduces attention paid to external information and therefore reduces self-referential attentional bias. They note that following a negative mood induction through either music or Velten negative statements, self-referential biases were reduced. The negative mood state was associated with lower accuracy and decreased reaction time when matching self-referential shapes in response to their associated labels (self or stranger). Their findings showed that the degree of self-prioritisation was reduced, as the neutral mood induction group showed no change in response the unfamiliar other (stranger). Research has yet to investigate how mood might impact the SRE self-proximal effects, such as through processing of self-relevant others (e.g., a friend). The authors suggest that attentionally and perceptually salient properties of self-referential stimuli are not produced in negative mood states due to increased attention on internal self-focus. The authors raise an alternative explanation whereby negative mood alleviates the commonly found positivity advantage for self-referential stimuli (e.g., Hu et al., 2020). This would imply that negative mood removes the positivity advantage which indirectly reduces self-referential bias. In a follow-up study Hu et al. (2020) had participants pair arbitrary shapes with “good self” and “bad self” labels. They found that the positive labels were prioritised, suggesting a positive self-bias in healthy participants. Furthermore, Qian, et al. (2020) argued that emotional arousal underpins the SRE reductions in response to emotional stimuli. Their study showed that highly arousing moods produced greater self-prioritisation whereas emotional valence did not produce reliable differences. In sum, whilst mood-congruent recall and self-referential prioritisation appear to be distinct processes, a small number of studies suggest that they interact to alter self-referential encoding in various ways. However, more research is needed to determine how this interaction impacts memory functioning in daily life.

Understanding self-referential biases and their relationship to transient and enduring mood states has important clinical implications. A key feature of several mood disorders such as MDD constitutes altered self-biases (Watkins, 2004). Several therapeutic interventions which target self-referential thought patterns have shown promising results. For instance, those who regularly practice mindfulness meditation show a reduced SRE and relatively enhanced recall for material about the ‘other’ (Shi & He, 2020). This suggests that an increased awareness on others and reduced self-focus can be targeted in such interventions. However, given the small number of studies investigating the nature of the SRE in everyday life, more research is needed. A better understanding of the interaction between the SRE and negative mood states in particular is needed due to the possibility that negative mood states may be directly targeted in therapeutic interventions. Furthermore, as demonstrated by Sui et al. (2016), negative mood states appear to reduce self-referential biases. More research is needed to explore these findings.

From this review, it is important to note that emotion, memory, and the self are interrelated in complex ways, but the extent to which these systems interact remains unclear. Whilst the SRE has been demonstrated to be a promising tool for investigating these relationships, the body of research on the SRE and emotion in healthy participants is lacking, particularly on how it relates to object ownership. An investigation into whether emotion, specifically negative mood, influences the SRE is necessary .

Rationale, Specific Aims, and Hypotheses

In this study, we first aimed to investigate the object-ownership SRE in the form of enhanced memory recall accuracy using a multiple-choice memory test. To do so, we used an online shopping simulation task using images of everyday objects. This new tool provides a convenient method to remotely assign item ownership and therefore elicit the SRE using more ecologically valid stimuli than arbitrary shapes, without necessitating familiarity with task stimuli (Truong et al., 2013). The representations of the 'self', 'other', and 'unfamiliar other' identities were also allocated within the task. As this study was conducted online, on-screen representations of these ownership conditions were displayed. Each identity was assigned a colour-coded rectangle to bypass over-familiarity confounds with self-related stimuli (Sui et al., 2012). Objects were owned by either the self (labelled 'my item'), a familiar other (labelled 'friend's item') or an unfamiliar other (labelled 'stranger's item'). Thus, we aimed to investigate memory for self-referentially encoded everyday objects and their assigned ownership conditions. A related aim was to establish how robust SRE is in the South African context since some elements of culture, such as the extent of individualism, have been shown to alter the SRE (Sparks et al., 2016; Xiao-Bing et al., 2020). South Africa has a culturally diverse population, and thus establishing a baseline SRE provides a starting point for future, more culturally-focused studies.

Secondly, to the best of our knowledge, this is the first study to examine the link between self-referential object stimuli and transient mood states. A negative mood induction protocol was utilised to achieve this aim. Negative mood has been theorised to reduce the advantages of self-referential memory traces (Sui et al., 2016). In general, negative moods are also more reliably induced than positive moods, particularly in online settings (Fernández-Aguilar et al., 2019; Göritz & Moser, 2006; Joseph et al., 2020). A film clip mood induction protocol was selected as a recent meta-analysis showed that these are the most effective mood induction protocols (Joseph et al., 2020) and they are conveniently applicable to an online setting. Furthermore, online film clips have been shown to induce negative moods more effectively than other common methods, such as autobiographical recall (Devilly & O'Donohue, 2021). Our study is the first to investigate self-referential ownership processing within transient mood states, as opposed to stimuli that are inherently associated with emotion, such as affective trait adjectives.

In summary, we aimed to investigate: 1) The presence of the SRE using an online test assessing self-referential memory for object ownership, 2) The potential weakening of the

SRE in the form of reduced recall accuracy following negative mood induction on a test assessing self-referential memory for object ownership. A secondary aim of our investigation was to produce a novel online ownership task to remotely elicit the SRE and to assess whether reaction times to self-referential material would be altered by self-referential material. Furthermore, we aimed to examine the extent of SRE self-prioritisation in a sample of South African participants. Based on the results from previous studies our main hypotheses are as follows:

H1: Mean recognition accuracy scores within each ownership condition will be highest when responding to self-related (my item) stimuli, second-highest for the familiar other (friend) and lowest for the unfamiliar other (stranger) related stimuli overall. In other words, participants will recall significantly more objects from their own baskets, less from their friend's basket, and the least from the stranger's basket.

H2: Mean recognition accuracy scores will be lower across all ownership stimuli following a negative mood induction protocol than for the control group exposed to a neutral film clip. That is, we expect participants induced into a negative mood to recall fewer objects overall compared to those exposed to an emotionally neutral clip, regardless of the owner of these items.

We also propose the following secondary hypotheses:

H3: The greatest mean difference in recognition accuracy scores will occur between the neutral and negative conditions when responding to self-related stimuli, with those exposed to a neutral film clip recalling a greater proportion of items. To rephrase, the extent of memory self-prioritisation will be greatest in the neutral control group.

H4: There will be no mean difference in recognition accuracy between the negative and neutral conditions for the familiar other (friend) and or the unfamiliar other (stranger) related stimuli. That is, there will be no memory prioritisation of the friend's items over the stranger's items following negative mood induction.

Methods

Design and Setting

We designed a mock online shopping task in which participants sorted their own, their friend's, or a stranger's grocery items into separate baskets after exposure to a negative or neutral mood protocol. We aimed to assess their recognition accuracy in recalling which items belonged to the self, a friend, or a stranger in a subsequent memory test. To do so we adopted a 2X3 mixed design wherein the within-subject independent variable was object (grocery items) ownership. This variable was pegged at three levels of self-relatedness: 1) self-owned (items owned by the participant), 2) familiar other-owned (items owned by the participant's friend), and 3) unfamiliar other-owned (items owned by a stranger). The between-subjects variable was mood manipulation (mood induction condition). In one condition participants were exposed to a negative mood induction film clip and in the other condition, they were exposed to an emotionally neutral clip, which formed the control group. We investigated the effect of self-relational distance (self vs familiar other vs unfamiliar other) on recognition accuracy in the incidental memory task as the dependent variable. Participants were randomly allocated to either the negative mood induction condition or the neutral control group.

Participants

Participants were recruited through convenient sampling using the University of Cape Town (UCT) Student Research Participation Programme (SRPP) for undergraduate psychology students. The students received course credits for their participation. Using G*Power version 3.1.9.4, we computed a minimum sample size of 44 participants. Predicting a large effect size of .40, this number of participants was intended to provide the experiment with a power of .95, with a two-tailed test. To be conservative, the correlation among repeated measures was set at 0 and the alpha level was set at 0.05. In a related in-person study by Sui et al. (2016), an effect size of .52 was suitable. We recruited a convenient sample of 169 undergraduates (Females = 143; Males = 23; Non-Binary = 1) between the ages of 18 and 30 (M = 22.62; SD = 4.95). This age range was intended to control for the declines in self-referential encoding typically seen in older adults (Leshikar et al., 2015; Zhang et al., 2019). We recruited a larger sample than in previous studies as the remote data collection procedure requires greater statistical power (Del Popolo Cristaldi et al., 2022).

All participants provided consent (Appendix A) and completed a demographic questionnaire (Appendix B) before participation. All participants had normal or corrected-to-normal vision and were evaluated on depressive and anxiety symptoms using the Beck Depression Inventory (BDI; Beck et al., 1996; Appendix C) and the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983; Appendix D) respectively. This was to account for possible mood disorder effects on self-referential processing (Gaddy & Ingram, 2014; Tracy et al., 2021). This was of particular interest given the prevailing COVID-19 pandemic conditions when this study was conducted. These conditions have been associated with negative mental health outcomes among students in general (Debowska et al., 2020) and in South Africa (Lewis et al., 2021; Visser & Law-Van Wyk, 2021). The experiment was carried out over the university vacation period to ensure that participants had minimal university pressure. Table 1 shows the sample characteristics.

Table 1

Sample Characteristics

Variable	Sample (*n* = 167)
Mean age (years)	22.62 (4.95)
Gender: female *n*, (%)	
Non-binary	1 (0.60)
Female	143 (85.63)
Male	23 (13.77)
Nationality *n,* (%)	
South African	147 (88.02)
Zimbabwean	12 (7.19)
Other	8 (4.79)
Mood induction Film *n*, (%)	
Neutral	85 (51.83)
Negative	79 (48.17)
BDI-II Depression Screening *n*, (%)	
Minimal; 0-13	96 (57.49)
Mild; 14-19	39 (23.35)
Moderate; 20-28	23 (13.77)
Severe; 29-63	9 (5.39)
STAI Anxiety Screening *n*, (%)	
Low state anxiety; 20-37	51 (30.54)
Moderate state anxiety; 38-44	23 (13.77)
High state anxiety, 45-80	93 (55.69)
Low trait anxiety; 20-37	42 (25.15)
Moderate trait anxiety; 38-44	21 (12.57)
High state anxiety, 45-80	104 (62.28)

Note. Standard deviations are in parenthesis.

Materials

The experiment was conducted online through a website created for the study using JavaScript, ReactJS, and NodeJS. All tasks took place on a white background with the Arial font style.

Consent and Screening

Participants completed electronic informed consent forms before participation (Appendix A). This form stated that participation was voluntary and that participants could withdraw at any time with no repercussions. Participants were informed that both their choice to participate and the collected data would remain confidential, as their names would not be mentioned in the research paper and their data would only be analysed by the researcher and their supervisor. The data were not recorded in association with the participants' names or any other personal information. All data were kept and analysed on a password-protected personal computer belonging to the researcher.

The BDI (Appendix C) and STAI (Appendix D) self-report questionnaires were included to account for the effects of depressive symptoms on mood and the impact of generalised anxiety on the SRE (Gaddy & Ingram, 2014; Tracy et al., 2021). The BDI consists of 21 Likert-type scale prompts concerning depressive symptoms experienced within the past two weeks. Each item presents a four-point scale ranging from no depressive symptoms to severe symptoms. For example, one prompt ranges from "I do not feel like a failure" to "I feel I am a complete failure as a person". When scored, each response is assigned a value between zero and three. All scores are combined to produce a total depression score for each participant. We adopted commonly used depression cut-off scores (Auerbach et al., 2015); with minimal (0-13; n = 88), mild to moderate (14-28; n = 59), and severe (29-63; n = 8) categories to interpret these scores.

The STAI is divided into the state and trait subscales. State anxiety refers to present and presumably transient anxiousness, whereas trait anxiety captures stable, pervading anxiety symptoms (Cattell & Scheier, 1958; Spielberger, 1966). Each section consists of 20 anxiety symptom prompts (40 total), for example, "I feel nervous and restless". Each item has a four-item Likert-type response scale (not at all, somewhat, moderately so, very much so) to provide one's level of agreement. The item scores are combined to produce state and trait scores for each participant, with reverse scoring on 20 items. We adopted commonly used

STAI interpretations of low anxiety; 20-37, moderate anxiety; 38-44, and high anxiety; 45-80 (Kayikcioglu et al., 2017).

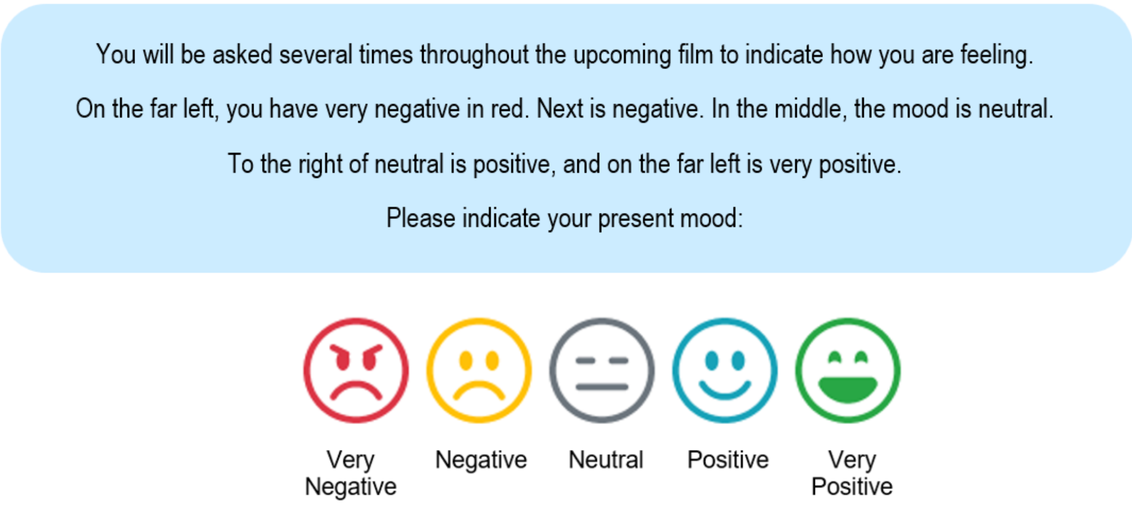
The BDI has demonstrated good psychometric properties, with an internal consistency coefficient alpha of .84 (Kühner, 2007), and STAI has coefficient alphas of .91 and .89 for the state and trait scales respectively (Barnes et al., 2002).

Mood Induction Protocol

Half of the participants viewed a 180-second duration negative mood induction film, and the other half viewed a 177-second duration neutral film (Appendix E). Before the mood induction film clip, a Likert-type mood rating scale appeared on-screen, and participants were prompted with the following on-screen instructions: “Look at this mood meter. On the far left, you have very positive, on the far right is negative, in the middle you have neutral, to the right of that the face is positive, and on the far right, you have very negative. These are all meant to represent different moods. Do you understand?". A response box was then displayed for participants to click a button labelled “I understand”. The scale was based on an adapted version of the affect grid (Larcom & Isaacowitz, 2009) and the method developed by Sui et al. (2016) to measure mood valence during the mood induction protocol. The Likert-type mood rating scale was then displayed on-screen again with further instructions, see Figure 1.

Figure 1

Mood Induction Likert Scale With Instructions



Participants were then expected to indicate their present mood on this display before the mood induction film to provide a baseline for participants' mood. The far left of the scale (points one and two) represented a positive mood, and the far right represented the negative mood (points four and five), with neutral emotion pegged at three in the middle. A five-point scale was selected over the more commonly used seven-point scales because a broader scaling has been shown to produce clearer and more reliable responses, with greater ease of use for participants (Eschrich et al., 2008). Emoticons were included in this scale to represent the various mood states. These have been shown to produce more rapid responses, with limited interruption to the mood protocol, and have demonstrated high correlations with other reliable verbal Likert-type mood scales (Kiliç et al., 2021).

In total, participants were asked to provide five self-ratings of their mood by clicking on the five-point Likert scale. Once the mood induction film clip started playing, the Likert-type emotion rating scale appeared at the bottom of the screen at 30-second intervals during the film, to assess the progression of participants' subjective mood. This occurred three times. Immediately after the end of the film, the scale was displayed for the final time, to assess participants' mood outcomes immediately following the induction protocol.

The film clip was displayed in the centre of the screen, within a rectangle on a white background. The negative mood induction clip was a scene from the movie *The Champ*, wherein a young boy finds his father dead, believes him to be asleep, and tries to awaken him (Zeffirelli, 1979). This clip has reliably been shown to elicit reports of negative mood (sadness) in healthy participants (Converse et al., 2008; Gross & Levenson, 1995; Munichor & Friedlander, 2019). We selected a sad film clip induction because sadness has been shown to decrease subjective arousal, whereas neutral films do not significantly alter arousal (Droit-Volet et al., 2011). Emotional arousal has been shown to modulate self-referential processing (Qian et al., 2020). Film clip mood protocols have been shown to be more effective in inducing negative mood compared to other common mood induction methods like autobiographical protocols (Devilly & O'Donohue, 2021). A meta-analysis by Joseph et al., (2020) reported that mood induction protocols are most effective when participants are explicitly instructed to enter the given mood state. However, this can lead to participants developing desirability biases. For purposes of this study, participants were not alerted to the intended mood state.

The neutral film clip for the control group was taken from a scene in the film *Hannah and her Sisters* (Allen, 1986). The clip features two women walking in a shopping centre talking about different events they need to buy clothing for (a date and an audition). Hewig et al., (2005) have shown that this clip reliably induces a neutral mood state.

The emotional aspects of the negative mood induction protocol could have potentially influenced the mood of the participants after the experiment in a negative manner, due to the saddening nature of the film. However, the act of watching a sad film was deemed not to be beyond the realm of everyday activities, as the consumption of sadness-inducing media is a popular pastime. The effects of this pastime have been shown to be benign (Rozin et al., 2013).

Procedure

All participants completed an encoding task, whereby participants interacted with grocery stimuli which were assigned ownership labels at three self-relational distances (self, friend, or stranger-owned) followed by an incidental memory test. This tested memory for which items belonged to each ownership label. Ethical approval was granted by the UCT Psychology Department Ethics Committee (PSY2020-05). All methods were compliant with the relevant ethical guidelines.

An email was sent out to undergraduate psychology students outlining the eligibility requirements for the study and inviting those that met these to sign up (Appendix F). Participants were then emailed the participation link and were able to complete the study at a time convenient to them. Once participants clicked on the link, the consent form (Appendix A) was displayed. Participants were then shown an instruction: “Please read the following consent form carefully” and were unable to proceed to the experiment without the insertion of an electronic signature and clicking a box in agreement with the statement “I have read and understood what is written on this page, and I agree to take part in this study”. The consent form (Appendix A) deceived participants about the real objectives behind the experiment to minimise the influence of demand characteristics. For instance, the knowledge that the study investigated self-referential memory could have led participants to pay special attention to encoding their own objects in the task. Participants were made to believe that they were involved in a study investigating the abilities of different age groups to sort household objects into different categories and that the research investigated how the storage of categorical information is affected by the ageing process. Participants were also not informed about the memory test beforehand as the nature of this task required incidental memory encoding.

The following instructions were then shown on the screen once the consent form (Appendix A) was completed: “Please complete this task on a laptop or PC-computer whilst seated in a quiet, distraction-free environment. Please do not complete this task on a cell phone or tablet. There is audio in this task, so please make sure your computer volume is turned up and that you have access to your working computer speakers or headphones.” This was to ensure that task stimuli were of relatively similar size across participants and were not displayed on smaller screen devices. This also ensured that participants heard the film’s audio. Participants clicked “OK” to proceed to the screening measures.

Participants then completed the demographic form (Appendix B) and were prompted by the following instructions: “Please fill in the relevant information in the form below”. This included selecting their device type from a drop-down menu: “Laptop, Desktop, Other - Please specify”. Data for participants who did not complete the task on a laptop or desktop were excluded before data analysis (n = 2).

Participants then completed online versions of the BDI (Appendix C) and STAI (Appendix D) questionnaires. The BDI instructions were: “This questionnaire consists of 21 statements. Please read each group of statements carefully. And then pick out the one statement in each group that best describes the way you have been feeling during the past two weeks, including today. Click on the circle beside the statement you have picked.”

For the 20-item STAI state questionnaire, participants were shown these instructions: “A number of statements which people have used to describe themselves are given below. Read each statement and then click on the circle beside the statement to indicate how you feel right now at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but click on the answer which seems to best describe your feelings best.” This was followed by the 20-item STAI trait questionnaire. Participants were shown: “A number of statements which people have used to describe themselves are given below. Read each statement and click on the circle next to the statement that indicates how you generally feel. There is no right or wrong answer. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.”

Mood Induction Protocol

Participants were then randomly allocated to view one of the two mood induction film clips. Half of the participants viewed the negative mood induction film, and the other half viewed the neutral film (Appendix E). Participants were asked to rate their mood on a five-point Likert scale before the mood induction protocol (Figure 1). The scale reappeared three times at 30-second intervals during this protocol and participants gave their final mood rating immediately after the mood induction film clip. Thus, there were five mood ratings taken for each participant.

Grocery Task: Association Phase

Our grocery task is an online adaptation of an in-person ownership task by Turk et al., (2008). This task involved on-screen representations of the participant (the self), a close other "friend" (who shares a close relational distance), and the unknown other "stranger" (with the greatest relational distance). The task is in two parts. In the first part, participants learned to associate colour-coded rectangles with relationship labels. There were three colour-coded rectangles representing shopping baskets belonging to the participant (self /blue), participant's friend (familiar other/yellow), and stranger (unfamiliar other/grey). Each shopping basket was individually presented with an instruction to associate yourself/your friend/an imaginary stranger with a rectangular basket. These figures were individually displayed in the centre of the screen, with individual labels at the top left of each figure in red font. Each basket was displayed for 40 seconds (120 seconds in total), and participants were not able to speed up or click through this process, see Figures 2, 3, and 4. Afterwards, participants were automatically directed to the encoding phase.

Figure 2

Screenshot of Online Grocery Task: Self-Association Screen

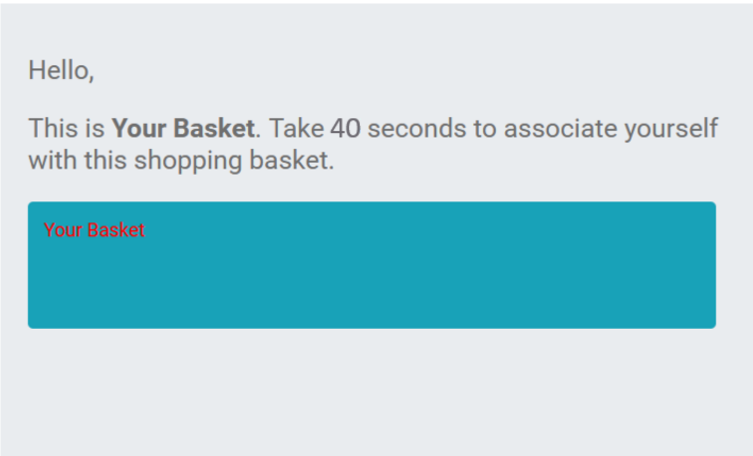


Figure 3

Screenshot of Online Grocery Task: Friend-Association Screen

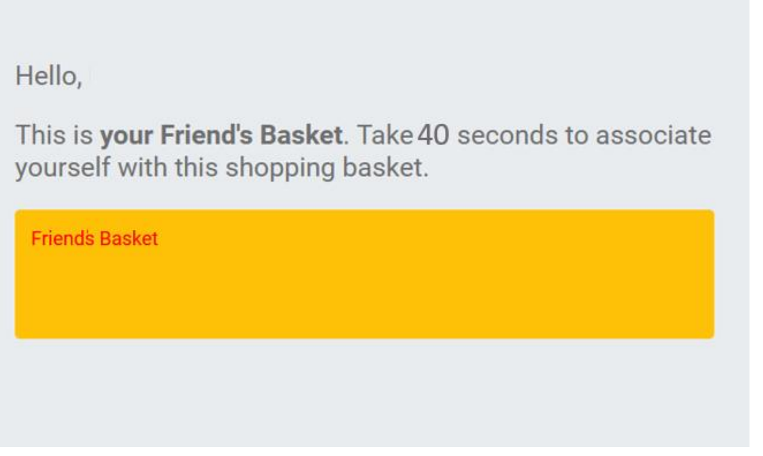
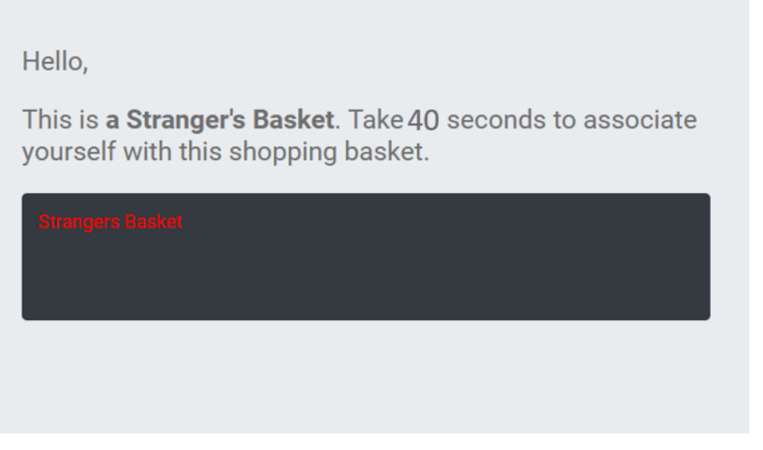


Figure 4

Screenshot of Online Grocery Task: Stranger-Association Screen

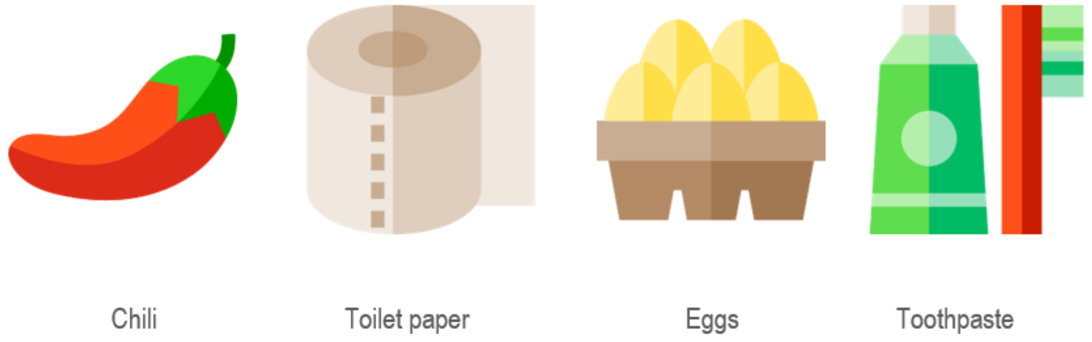


Grocery Task: Encoding Phase

The stimuli for the encoding phase of this task were colour images of everyday grocery objects in a clip-art style, see Figure 5.

Figure 5

Examples of Grocery Image Stimuli



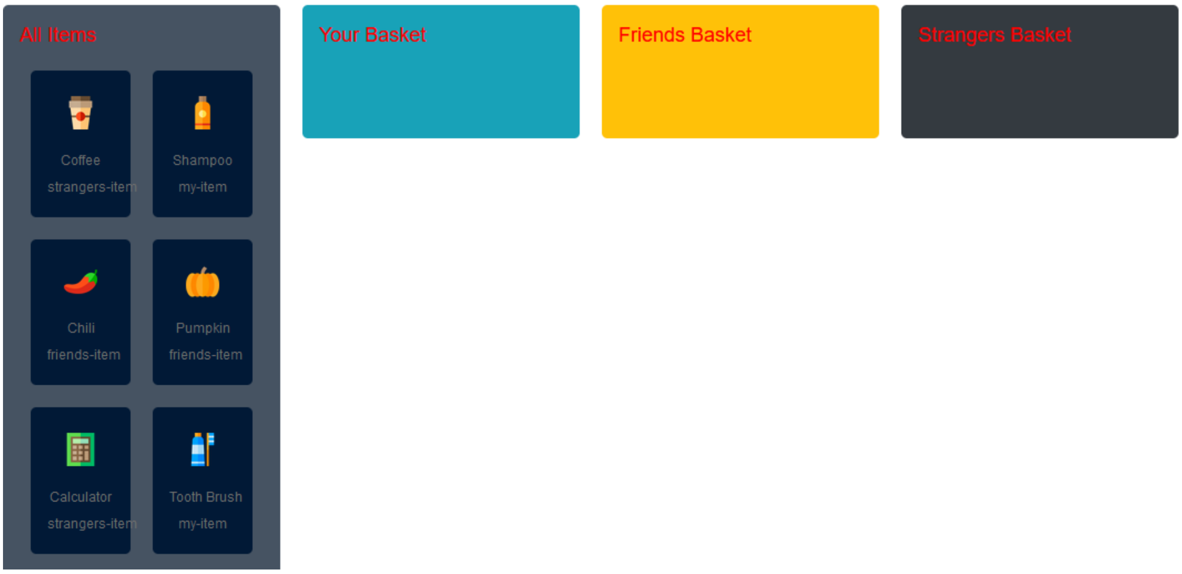
Note. Examples of the grocery image stimuli are depicted. Left to right, a chilli, toilet paper, eggs, and toothpaste are shown.

The following instructions were then presented on the screen: "Imagine that you, your friend, and a stranger have gone grocery shopping. As you go through the shop, you need to organise each person's groceries into their separate baskets. You have each bought 12 items. This computer game is going to display the grocery items you all bought on the left. If an item is labelled 'my item', it belongs to you, and you must drag it into your basket. If an item is labelled 'friend's item', it belongs to your friend, and you must drag it into your friend's basket. Finally, if an item is labelled 'stranger's item', it belongs to the stranger, and you must drag it into the stranger's basket. There is no time limit." These instructions remained at the top of the screen throughout the encoding phase.

The participants then completed a simulation task of an everyday activity, which is packing a shopping basket with groceries. Participants clicked a "Continue" button to proceed to this task and were directed to a screen which showed the task stimuli on the left, within a black rectangle labelled 'All items'. The ownership-object pairings were randomised for each participant to control for item familiarity effects. Participants could scroll downward to view all 36 grocery items and their respective ownership labels. To the right of this, the three colour-coded baskets from the association phase were displayed with their respective labels, see Figure 6.

Figure 6

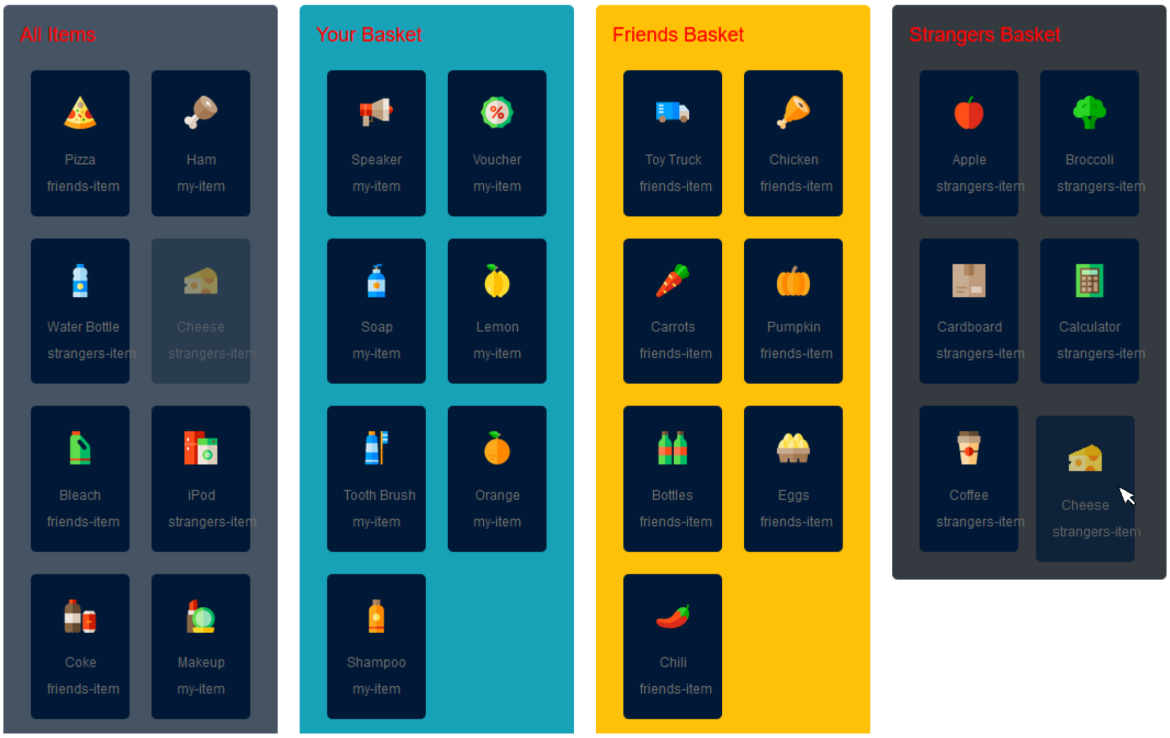
Screenshot Depicting the Grocery Encoding Phase Before Task Engagement



As per the task instructions, participants then dragged each of the grocery items into the correct rectangle (My basket, Friend's basket, or Stranger's basket) with no time limit. Once the participant dragged an object into the correct basket that matched its label, the object remained in that basket. As the items began to accumulate in each basket, the rectangles expanded vertically, see Figure 7.

Figure 7

Screenshot Depicting the Grocery Encoding Phase During Task Engagement



Participants could drag the grocery items across in any order. Should a participant have dragged an object into the incorrect basket, such as by placing a self-owned object into the stranger's basket, the object would automatically reappear in the "All items" area. This was to prevent the encoding of incorrect object-ownership pairings.

Once all baskets were packed with their appropriate items, the task automatically redirected to a brief online distractor task, which involved watching a 129-second duration film clip of an animated character moving around the screen (Appendix G). The participants were instructed to count the number of times the character's arms became crossed. This was to ensure that the object-ownership pairings were not held in working memory during the upcoming object recognition phase.

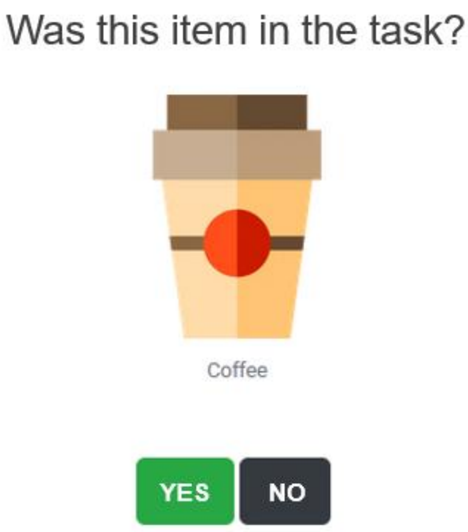
Grocery Task: Memory Test of Object Recognition

Participants were automatically directed to an on-screen multiple-choice recognition test. This was used to assess the participants' memory for which ownership identity (me, friend, or stranger) owned each grocery item in the previous encoding-phase packing task. Participants were individually presented with each object from the encoding phase (36 items) along with 12 foil grocery items which had not been present in the encoding phase (48 trials per participant). At this stage, we recorded reaction times and recognition accuracy of the participant's responses. Reaction time refers to the time in seconds that participants took to respond to each multiple-choice question, whereas recognition accuracy is defined as the number of times participants correctly identified the owner of the object.

The on-screen questionnaire asked participants to identify the shopping items they previously sorted. They were asked "Was this item in the task?", with the options for "yes" or "no", see Figure 8.

Figure 8

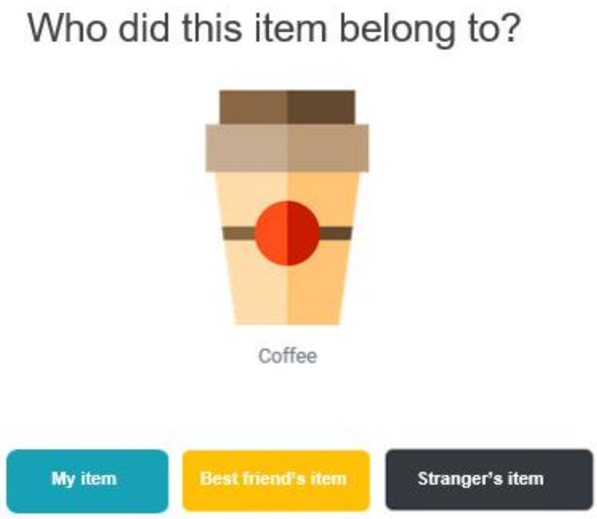
Screenshot Depicting the Object Recognition Test for one Item



Upon clicking "yes", a multiple-choice recognition question appeared: "Who did this item belong to?" with the options of "My item", "Friend's item" or "Stranger's item", see Figure 9.

Figure 9

Screenshot Depicting the Multiple-Choice Test for one Item



In the final step of the experiment, a debriefing form was displayed on-screen for participants to read, which explained the true nature of the experiment (Appendix H). The form noted that the deception in this study did not create additional risk for participants, as it was a minor deception about the purpose of the task. Should the participants have felt emotionally unwell post-participation, the debriefing form directed them to contact appropriate counselling services. Namely, the UCT student wellness clinic contact, the South African Depression and Anxiety Group hotline, and online counselling services were recommended. Furthermore, when participants' BDI (Appendix C) or STAI (Appendix D) scores indicated emotional impairment or distress, these counselling services were recommended to participants.

Table 2 outlines the structure of the entire experiment.

Table 2

Summary of Online Procedure

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Online Task	Screening.	Mood induction.	Association phase.	Encoding phase.	Distractor task.	Recognition recall task.
Materials	BDI & STAI.	Neutral or negative film with mood-rating scales.	Association with self, familiar other, and unfamiliar other identities.	Incidental encoding task packing groceries into a basket.	Distractor film clip.	MCQ test of self-referential ownership memory.

Data Management and Statistical Analyses

Main Analyses

We carried out our analyses using the International Business Machines (IBM) SPSS version 28.0.1.0, R-studio version 3.6.1 (R Core Team, 2021), and SPYDER (Raybaut, 2009) software. We calculated descriptive statistics for an initial data check with SPSS and found that the full sample (n = 169) completed the entire experimental procedure. Thereafter, we cleaned the data with SPYDER and removed two participants who completed the task on a cell phone.

A recognition accuracy score was calculated for each participant; defined as the number of correctly attributed object-ownership responses, divided by the total number of trials for each ownership condition. This created an ‘accuracy score’ for each ownership condition (self, friend, or stranger) showing the proportion of times the participant correctly identified items belonging to each ownership identity. Participants with a mean accuracy score of zero for all three ownership conditions (self, friend, and other) were removed as this reflected that participants did not apply effort and were most likely giving random responses. This process eliminated 2% of the data (n = 4). We also removed nine participants with extremely slow reaction times (over 200000 ms) on the memory test which appeared as outliers on a box-and-whisker plot. We then excluded 0.04% of correct responses with response times within 150ms as these also indicate random responding, eliminating under

0.04% of the trials. These data cleaning measures are consistent with data handling practices for research in this field.

The inferential statistics for our data were computed with SPSS, with α set to 0.5 as the statistical significance threshold. Unless stated otherwise, all assumptions of parametric statistical tests were upheld. When the assumption of sphericity was violated the Greenhouse-Geiser correction was used (Greenhouse & Geisser, 1959; Haverkamp & Beauducel, 2017).

To investigate whether our procedure elicited the ownership SRE, we investigated memory recognition accuracy for self-related material using one-way repeated measures analysis of variance (rANOVA). We noted that the recognition accuracy data were skewed left for all three ownership conditions due to several participants achieving low recognition accuracy scores and the assumptions of normality and sphericity were violated. However, rANOVA was selected due to its statistical power and its control over I errors in the face of such violations (Erceg-Hurn & Mirosevich, 2008). Furthermore, rANOVA is commonly used in SRE research, which allows for comparison between the effect sizes found for our online SRE task with those conducted in laboratory-based settings.

To further investigate overall SRE, a *d'* statistic was calculated to further assess the extent of self-prioritisation and to produce a measure of perceptual discriminability, which is the ability to detect the target stimulus amongst distractors (Dosher & Lu, 2005). In our experiment, this refers to the ability to select a given object's owner, without making a false positive error by erroneously attributing ownership to the incorrect owner. This signal detection approach (Macmillan & Creelman, 1990) is consistent with statistical analyses commonly used in SRE research (Sui & Rotshtein, 2019). Thus, to calculate the *d'* statistic, we combined correct responses in each object ownership condition with false-positive scores to create a single composite score. The false positive rate combined the number of false positive responses, divided by the sum of false positive responses and true negative responses, which were incorrect ownership attributions, for instance attributing a self-owned item to a stranger. To calculate *d'*, the false positive rate was combined with each participant's recognition accuracy score. Thus, *d'* accounts for both accurate responses and the number of false positive "false alarms", which are erroneous "present" responses to an absent stimulus, in each ownership condition (Macmillan & Creelman, 1990). rANOVA was used to investigate the relationship between the *d'* scores with each ownership condition (self, friend, and stranger).

A mixed designs analysis of variance (ANOVA) was used to investigate whether the mood induction protocol successfully induced negative mood. We assessed whether changes in mood ratings at five separate time points were associated with the mood induction film condition (neutral or negative). We compared ratings for the negative and neutral mood conditions and also compared within-subjects mood ratings over time within each mood condition.

Recognition accuracy scores on the delayed recall memory test across ownership categories for both the negative and neutral emotion conditions did not meet the normality and sphericity assumptions for the use of parametric tests. We initially investigated the effectiveness of the mood induction using mixed designs ANOVA, whereby mood (negative or neutral) was the between-subjects factor, and participants' recognition accuracy scores for each ownership condition (self, friend, and stranger) was the within-subjects factor. Mixed designs ANOVA was also used to examine the influence of the mood induction on *d'* scores for each ownership condition against memory recognition scores. To account for the influence of individual differences and the amount of variation in the recognition accuracy data, exploratory analyses were conducted.

Exploratory Analyses

Unlike ANOVA, linear mixed-effects modelling does not require that assumptions of normality, homogeneity, or sphericity are met, nor does it require that predictor variables are categorical (Baayen et al., 2008). Mixed-effects modelling is more appropriate for the analysis of clustered data (such as within-subjects data) than standard regression analysis as mixed-effects modelling since individual variation can be partitioned out and thus standard error estimates are more accurate (Bouwmeester et al., 2013). We specifically utilised random intercepts modelling with fixed and random effects whereby fixed effects refer to the experimental manipulation effects, (Baayen et al., 2008), namely mood induction condition, ownership conditions, depression scores, and anxiety scores. In contrast, random effects acknowledge inter-individual baseline variation across participants, thereby accounting for individual differences in task performance on our memory test.

Our model contained random intercepts for participants and between-subject slopes for each fixed effect. The fixed effects were object ownership condition (self, friend, stranger) coded as dummy variables, mood induction condition (neutral or negative), and mood scores (BDI and STAI scores). We used mixed-effects modelling to investigate whether mood symptoms, namely STAI anxiety scores and BDI depression scores influenced recognition accuracy data. Furthermore, mood interaction effects with mood condition and ownership condition were investigated.

Results

Sample Characteristics

Table 1 shows the sample characteristics.

Hypothesis 1: Object Ownership Self-Reference Effect with Memory Recognition Accuracy

We wanted to know if recognition accuracy for self-owned items would be significantly better than recognition of the friend and stranger's items. The descriptive data for the results are shown in Table 3.

Table 3

Descriptive Statistics

Condition	Mean Accuracy	Mean FP Rate	Mean *d'* score	Mean RT (seconds)
Self	0.38 (0.22)	.23 (0.18)	0.36 (1.58)	24.01 (44.48)
Familiar	0.35 (0.19)	.26 (0.19)	0.03 (1.47)	22.64 (44.93)
Stranger	0.31 (0.18)	.30 (0.18)	-0.39 (1.35)	32.70 (47.78)
Foil Items	0.80 (0.19)			20.15 (37.55)
Total	0.34 (0.20)	.26 (0.19)	0.09 (1.32)	25.16 (43.67)

Note. Means are provided with standard deviations in parentheses. Accuracy = Correct proportion of responses. FP = False positive. RT = Reaction time in seconds.

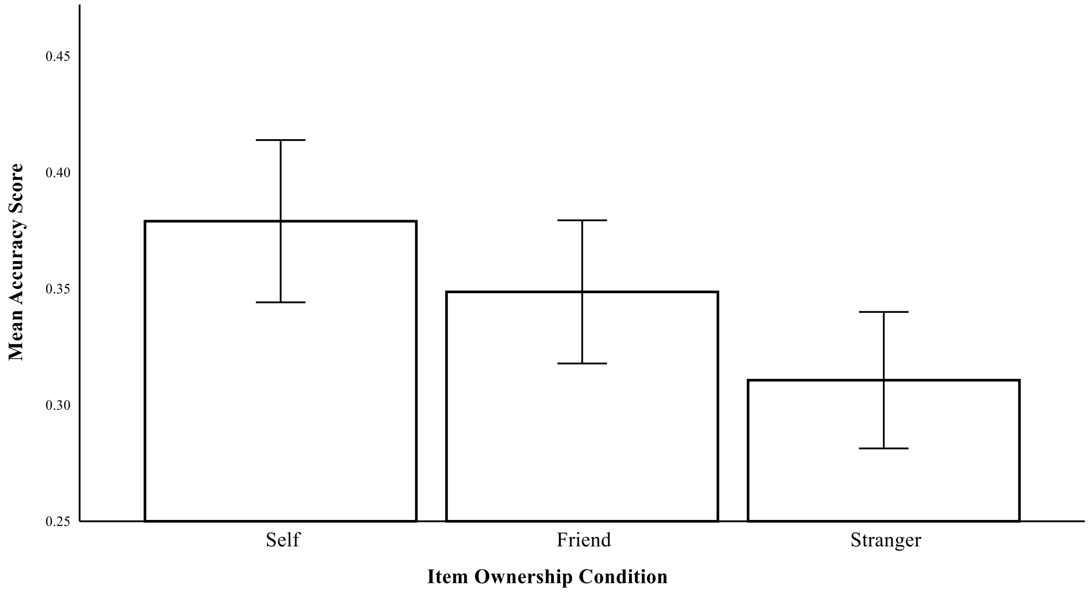
When presented with the grocery objects in a memory test, participants recalled the highest proportion of their own objects (M = 0.38, SD = 0.22) and the lowest proportion of the stranger's objects (M = 0.31; SD = 0.18). These descriptive statistics, displayed in Table 3, support our first hypothesis in which we proposed that participants would recognise the highest proportion of their own objects, the second highest proportion of their friend's objects, and the least stranger-owned objects.

Repeated-measures two-way ANOVA for recognition accuracy showed a significant main effect of ownership condition (self, friend, or stranger), F (1.92, 313.29) = 15.09, p <

.001, η^2 = .077. The differences between the number of correct responses between each ownership condition are displayed in Figure 10.

Figure 10

Bar Graph of Mean Recognition Accuracy Plotted by Object Ownership Condition



Note. Mean recognition accuracy scores are shown for self-owned, friend-owned, and stranger-owned items, plotted by the proportion of correct responses. Error bars represent standard errors at 95% confidence intervals.

We also analysed the same recognition accuracy data with mixed-effects modelling, and found a significant main effect of object ownership, B = -0.06, p < .001, η^2 = .006, meaning that the relational distance (self-proximity) influenced subsequent memory for the items. To further investigate whether participants were more accurate in recognising items within specific ownership conditions, we performed three post hoc comparisons as displayed in Table 4.

Table 4

Post Hoc Comparisons of Recognition Accuracy by Object Ownership Condition

Comparison				
Condition	Condition	Mean Difference	Standard Error	*p*
Self	Friend	0.03	0.02	.042*
	Stranger	0.06	0.01	< .001*
Friend	Stranger	0.04	0.01	.003*

Note. *p < .05

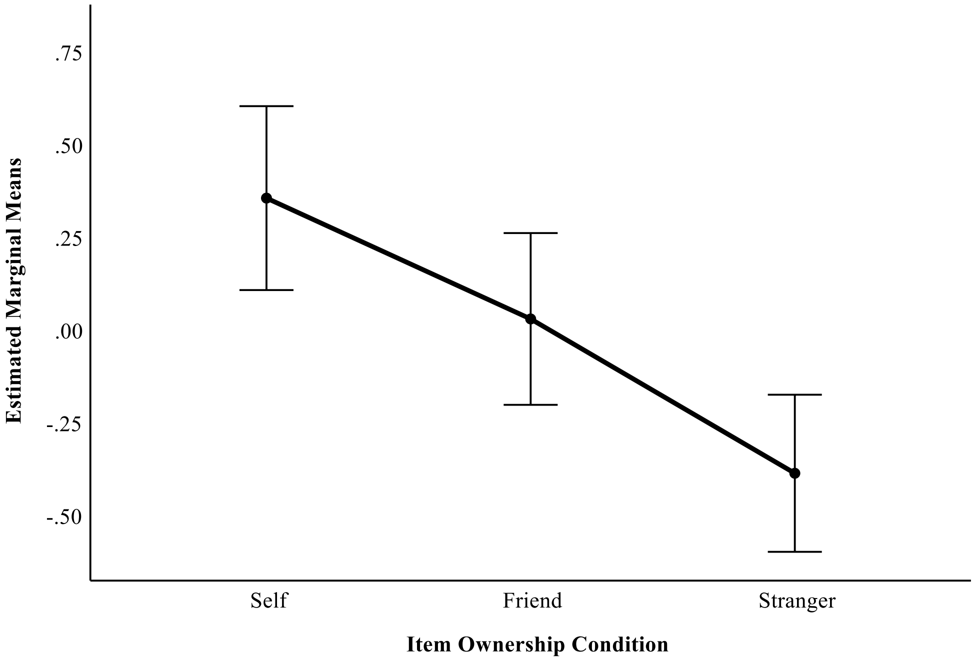
To account for the influences of the negative mood induction on the overall SRE, we analysed the neutral mood induction group's responses (*n* = 73) with two-way rANOVA and found a significant effect of object ownership label, F (2, 144) = 7.53, $p < .001$, $\eta^2 = .095$. Similarly when we controlled for depression scores during mixed-effects modelling analysis, planned linear contrasts showed significant differences between all three ownership conditions t (312) = -5.14, $p < .001$, $\eta^2 = .009$. with the highest accuracy for self-owned items, and the lowest accuracy for stranger-owned items.

Hypothesis 1: Object Ownership Self-Reference Effect with Perceptual Discriminability

To further investigate overall SRE, a *d'* statistic was calculated to assess the extent of self-prioritisation and perceptual discriminability (Dosher & Lu, 2005). We analysed the *d'* scores with rANOVA, which showed a significant main effect of ownership category, F (2, 314) = 35.37, p = < .001, see Figure 11. We also found a significant main effect of object ownership with mixed-effects modelling, B = -0.39, p = < .001.

Figure 11

Perceptual Discriminability (d' Scores) Plotted by Object Ownership Condition



Note. Estimated marginal mean scores are plotted by *d'* for self-owned, friend-owned, and stranger-owned items are shown. Error bars represent standard errors at 95% confidence intervals.

To investigate whether participants had a lower error rate (*d'*) for any object ownership condition, we performed three post hoc comparisons with Bonferroni correction. All of these were statistically significant, see Table 5. This means that the participants' own objects produced fewer errors than both their friend's and the stranger's items. Participants also made fewer errors overall when presented with their friend's items in comparison to the stranger's items.

Table 5

Post Hoc Comparisons of Perceptual Discriminability (d' Scores) by Object Ownership Condition

Comparison				
Condition	Condition	Mean Difference	Standard Error	*p*
Self	Friend	0.33	0.09	.002*
	Stranger	0.74	0.09	< .001*
Friend	Stranger	0.42	0.08	< .001*

Note. Condition = Ownership condition.

*p < .05

Reaction Time by Ownership Condition

We recorded participants' reaction times when responding to the memory test questions. Although mean reaction times were fastest in response to questions about the friend condition (M = 22.64; SD = 44.92) and the stranger ownership condition elicited the slowest responses (M = 32.70; SD = 47.78), we found no significant differences for the reaction times between the three ownership conditions. Similarly, we found that reaction time was not a significant predictor of memory accuracy within any of the object ownership conditions, (B = 0.00, p = 0.584) when the same data were analysed with mixed-effects modelling. The total time taken to complete the entire online procedure was also not a significant predictor of accuracy (B = -0.01, p = 0.343).

Hypothesis 2: The Effect of Mood Induction Protocol on the Self-Reference Effect

Mood Induction

Participants provided five self-ratings of their mood at sequential time points on a five-point Likert scale, with 1 being very negative, and 5 being very positive. Participants exposed to the negative film's mood ratings showed a progressive shift into a negative mood relative to those exposed to the neutral film. The descriptive statistics for the two mood induction protocols are shown in Table 6.

Table 6

Descriptive Statistics: Mood Induction Protocol

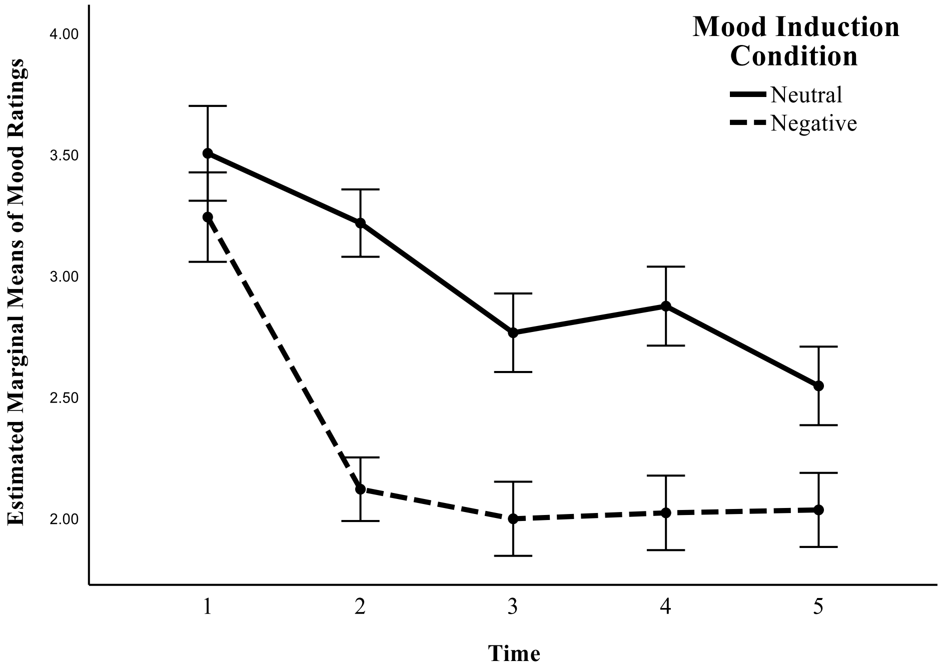
Condition	Time	Mean Mood Rating	*n*
Neutral	1	3.24 (.90)	82
	2	2.12 (.51)	
	3	2.00 (.57)	
	4	2.02 (65)	
	5	2.04 (.60)	
Negative	1	3.51 (.78)	73
	2	3.22 (.69)	
	3	2.77 (.83)	
	4	2.88 (.76)	
	5	2.55 (.80)	

Note. Means are provided with standard deviations in parentheses. *n* = sample size.

We performed a mixed-designs ANOVA to compare the mood ratings under the negative and neutral mood induction conditions, as shown in Figure 12.

Figure 12

Line Graph Showing Mood Ratings Over Time by Mood Induction



Note. Estimated marginal means for each mood rating are plotted over time for each mood condition, either negative or neutral. Error bars represent standard errors at 95% confidence intervals.

We ran mixed designs ANOVA to investigate whether mood induction conditions influenced mood ratings. We found that there was a significant main effect for the mood ratings, F (3.09, 471.97) = 79.85, $p < .001$, $\eta^2 = .343$. We also found a significant interaction effect between mood induction condition and each of the mood ratings, F (3.09, 471.97) = 10.77, $p < .001$, $\eta^2 = .066$, meaning that the mood ratings differed significantly under the two mood induction conditions. We ran pairwise comparisons with the Bonferroni correction for multiple comparisons to identify which mood ratings differed between mood induction conditions, as shown in Table 7. These showed that all mood ratings differed significantly between the two mood induction conditions ($p < .001$), except for the first mood rating, which was provided before the mood induction began ($p = .055$).

Table 7

Post Hoc Comparisons of Mood Rating by Mood Induction Protocol

	Mood Induction Comparison				
Time	Condition	Condition	Mean Difference	Standard Error	*p*
1	Neutral	Negative	0.26	0.14	.06
2	Neutral	Negative	1.10	0.10	< .001*
3	Neutral	Negative	0.77	0.11	<.001*
4	Neutral	Negative	0.85	0.11	<.001*
5	Neutral	Negative	0.51	0.11	< .001*

Note. Condition = Mood induction condition.

*p < .05

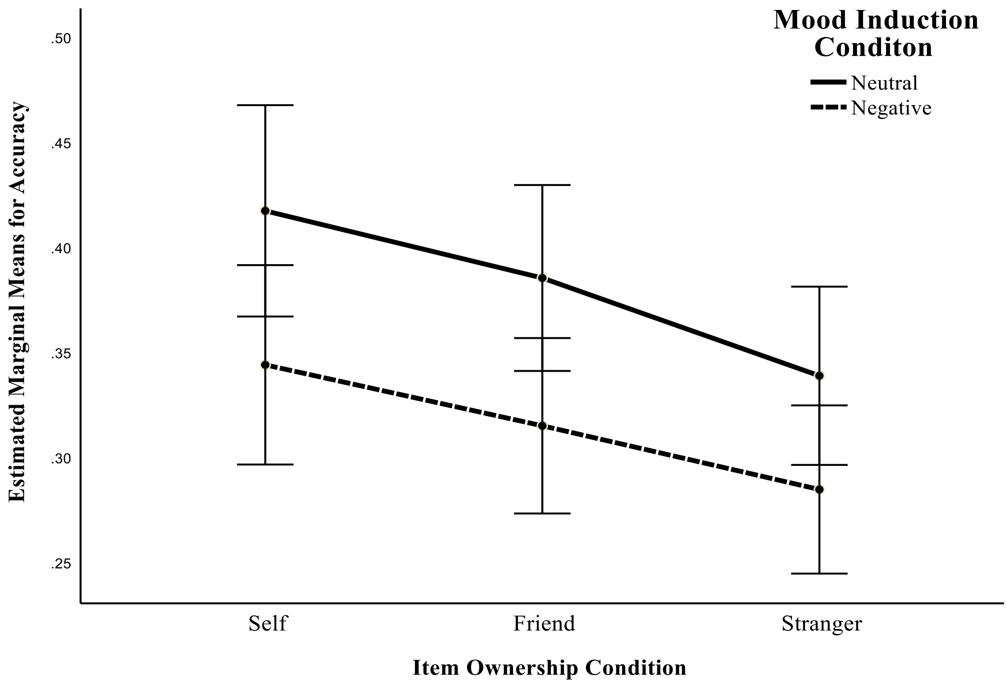
The greatest mean difference between any two mood ratings was during the second mood rating. At this point, the mean mood ratings of the negative induction group (*M* = 3.22; *SD* = .69) were in the negative range, compared to the neutral range of the control group (*M* = 2.12; *SD* = .51). This pattern was consistent for across all subsequent mood ratings. Overall, the neutral mean mood rating (*M* = 2.12; *SD* = 0.50) was more positive than the negative conditions (*M* = 3.23; *SD* = 0.70).

Hypothesis 2: Effect of Mood Induction Protocol on the Self-Reference Effect

Across all ownership conditions, mean recognition accuracy was lower following exposure to the negative mood induction (*M* = 0.31; *SD* = 0.02), compared with the neutral condition (*M* = 0.38; *SD* = 0.02), $p < .05$. We investigated whether mood induction protocol influenced accuracy within each object ownership condition (self, friend, or stranger) using two-way rANOVA. This interaction effect between mood conditions (neutral versus negative) and object ownership condition was non-significant, F (1.92, 293.66) = .29, p = .741, η^2 = .002. These results are shown in Figure 13.

Figure 13

Line Graph Showing Mean Ownership Recognition Accuracy by Mood Induction Condition



Note. Mean recognition accuracy is shown for each ownership condition, self-owned, friend-owned, and stranger-owned items, plotted by the proportion of correct responses in each mood induction condition (negative or neutral). Error bars represent standard errors at 95% confidence intervals.

We analysed the same data with mixed-effects modelling and found an interaction between the mood induction conditions (negative or neutral) with accuracy in the object ownership conditions (self, friend, stranger). There was a significant main effect of mood induction condition, $B = 0.07$, $p = < .05$, $\eta^2 = .005$, whereby the neutral mood induction group were 7% more accurate on the task overall than the negative mood induction group. This model had a weak marginal correlation ($R^2 = 0.05$) which only reflects fixed effects variation, whereas we found a moderate conditional correlation ($R^2 = 0.65$) which represents both fixed and random effects. This suggests that random effects contributed to a large proportion of the sample variation.

We also ran mixed-effects modelling to analyse the perceptual discriminability (*d'*) data, to investigate whether the mood induction conditions influenced participants' error rates overall. This showed a marginally significant main effect for mood induction condition on perceptual discriminability, *B* = - 0.44, *p* = .052, η^2 = .019. This means that participants made a greater number of errors after the negative mood induction than those exposed to the neutral mood induction across all three item ownership conditions. This model also had a weak marginal correlation, R^2 = 0.07 and a moderate conditional correlation, R^2 = 0.73, suggesting a large contribution of random effects.

The difference in accuracy between the neutral (*M* = 0.39; *SD* = 0.03) and negative mood induction groups (*M* = 0.33; *SD* = 0.03) increased when depression scores were accounted for in this model. This increased from a 7% difference to 9%, meaning that the significance of the mood induction and ownership interaction effect is not attributable to depression effects. In addition, we analysed the overall SRE when depression scores were accounted for with mixed-effects modelling and found a significant difference between both the self and friend-ownership conditions in comparison to the stranger condition (*B* = -0.080, *p* = < .05).

Secondary Hypotheses: The Extent of Self-Prioritisation Between Mood Induction Conditions

Although the interaction effect between mood induction condition and ownership was non-significant, we ran post hoc pairwise comparisons with Bonferroni adjustment, see Table 8. This was due to the possibility that there could be different emotional effects on the different relational distances (labels may have been impacted to a greater extent by emotional material), as is expected in research of this nature, e.g., Sui et al., (2016). We found that participants exposed to the neutral mood film were significantly more accurate during recognition than those exposed to the negative film when responding to both self-owned and friend-owned items, both p < .05. There was no significant difference between the two mood induction groups' ability recognise the stranger's objects (*p* = .069).

Table 8

Post Hoc Comparisons of Recognition Accuracy Between Each Mood Induction Condition

Ownership Condition	Comparison Condition		Mean Difference	Standard Error	*p*
	Mood Induction	Mood Induction			
Self	Neutral	Negative	0.07	0.04	.038*
Friend	Neutral	Negative	0.06	0.03	.024*
Stranger	Neutral	Negative	0.05	0.03	.069

Note. *p < .05

We used mixed-effects modelling to further investigate the impact of the mood induction protocol on accuracy in each object ownership condition with improved standard error estimations in the absence of a significant interaction (Bouwmeester et al., 2013). This analysis revealed a significant interaction effect when comparing participants exposed to either the neutral or negative mood induction protocol. These findings support hypothesis 3, as participants exposed the neutral mood induction recalled a significantly greater proportion of self-owned item compared with those in the negative mood condition (B = - 0.06, p < .001). Specifically, participants in the neutral mood condition recognised 6% more self-owned objects. In line with our fourth hypothesis, when participants were exposed to the neutral or negative mood inductions there were no differences in accuracy in response to either the friend's or stranger-owned items (B = -0.03, p = .067). We also found no significant difference between the two mood induction groups when recognising self-owned items compared with best-friend-owned items (B = -0.03, p = .137).

The intra-class correlation for the object ownership and mood induction interaction random intercepts model was high, showing that unmeasured variables or individual differences account for over half (64%) of the variation seen. Although several of the object ownership and mood induction effects are significant, they only account for 4.5% of the variation seen in the data.

To further characterise the effect of the SRE following mood manipulation, we investigated the degree of ownership bias within each of the two mood induction conditions. To do so, we ran pairwise comparisons with the Bonferroni correction. These showed that those exposed to the negative mood induction protocol recalled a significantly greater number of their own items in comparison to the stranger's items, p < .05. The same pattern was found for the participants exposed to the neutral mood induction, $p < .05$. In addition, participants who viewed the neutral mood induction protocol were also more accurate at retrieving friend-owned items than stranger-owned items, $p < .001$. There were no other significant differences in memory retrieval within the two mood induction conditions. Furthermore, all mean differences between accuracy scores by ownership condition were larger in the neutral condition than in the negative condition, see Table 9.

Table 9

Post Hoc Comparisons of Accuracy Within Each Mood Induction Condition

Mood Induction Condition	Comparison Condition: Ownership	Comparison Condition: Ownership	Mean Difference	Standard Error	*p*
Negative	Self	Friend	0.29	0.02	.473
		Stranger	0.59	0.02	.004*
	Friend	Stranger	0.30	0.02	.241
Neutral	Self	Friend	0.32	0.03	.426
		Stranger	0.79	0.03	.035*
	Friend	Stranger	0.47	0.03	< .001*

Note. *p < .05

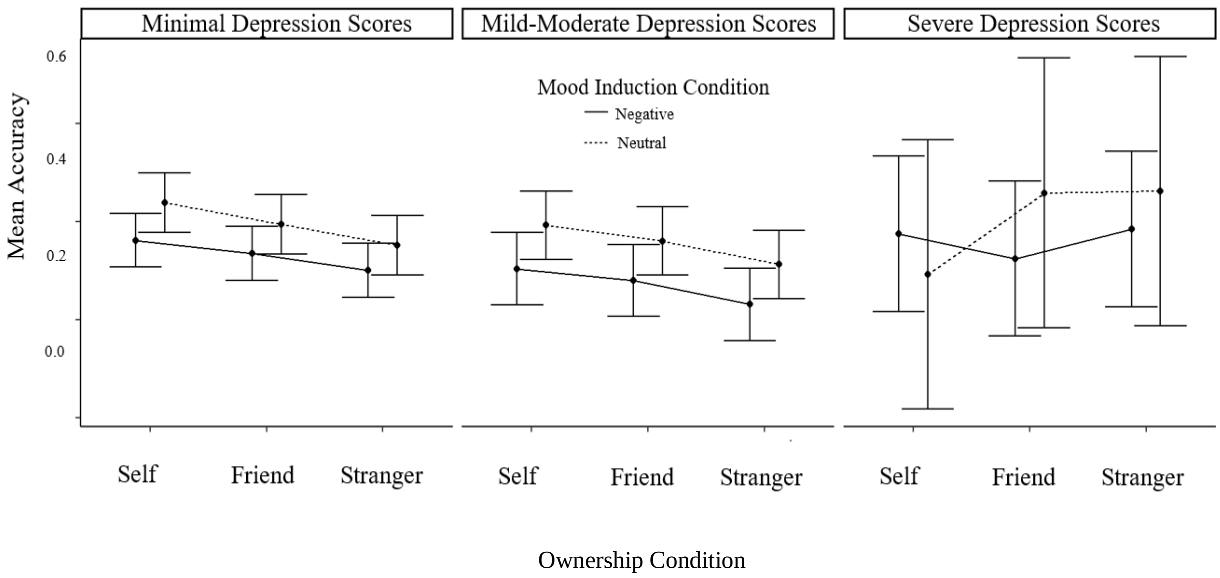
Exploratory Analysis: Mood, Depression Scores, and the Self Reference Effect

To account for the influence of anxiety and depressive symptoms on the SRE, we conducted an exploratory analysis with mixed-effects modelling. In the first model, the predicted variable was accuracy in each ownership condition (self, friend, stranger), with the fixed factor predictors of BDI depression scores and mood induction condition. There was no significant main effect of depression scores alone ($B = 0.00$, $p = .721$). The overall effect of mood condition remained significant when depression scores were accounted for ($B = 0.13$, p = < .05).

Mixed-effects modelling revealed a significant three-way interaction effect between depression scores, item ownership condition, and mood condition ($B = 0.01$, p = < .05, η^2 = .009). This model had a weak marginal correlation, $R^2 = 0.06$, and a moderate conditional correlation, $R^2 = 0.66$. To visually represent this interaction effect, the continuous depression score variable was divided into three categorical groups. To do so, we adopted commonly used depression cut-off scores (Auerbach et al., 2015); with minimal (0-13; *n* = 88), mild to moderate (14-28; *n* = 59), and severe (29-63; *n* = 8) categories. These categories are displayed in Figure 14. We note that the graphical representations are intended to represent a continuous variable, and thus the estimated marginal mean values are not necessarily interpretable. This representation is also undermined by the small number of participants meeting the criteria for the severe depression category (*n* = 8).

Figure 14

Series of Line Graphs Showing Interactions Between Mood Ratings, Mood Condition, and Depression Score Category



Note. Mean recognition accuracy is shown for each ownership condition, self-owned, friend-owned, and stranger-owned items. This is plotted by the marginal means for the proportion of correct responses in each mood induction condition (negative or neutral). Each graph represents different levels of depression scores (mild, moderate, and severe). Error bars represent standard errors at 95% confidence intervals.

Participants with low and moderate depression scores in the negative mood induction condition were less accurate when recalling items from all three ownership conditions than those with high depression scores in the neutral mood induction group. Simple effects analysis within the three depression score categories showed significant differences between the mood induction groups, see Appendix I. Specifically, we identified a disordinal effect. Participants in the negative mood induction group with severe depression scores were significantly more accurate in response to their own items (*M* = 0.38, *SD* = 0.09) than those in the neutral mood induction group with severe depression scores (*M* = 0.30, *SD* = .30). In contrast, when recalling their friend's items, the neutral mood induction group with severe depression scores was more accurate (*M* = 0.46, *SD* = 0.04) than those in the negative condition (*M* = 0.32, *SD* = 0.50). The same pattern was identified for the stranger condition. The accuracy scores produced a relatively flat line for the group with severe depression scores, with a high degree of overlapping error bars, see Figure 14.

We ran a second random intercepts model with both state and trait anxiety scores included as fixed factors. No significant anxiety-related main effect was identified for the ownership conditions (*B* = 0.00, *p* = .280) or mood induction condition (*B* = 0.00, *p* = .448). Furthermore, there were no significant interaction effects observed between anxiety scores, mood induction condition, and ownership condition (*B* = 0.01, *p* = .784)

Discussion

We aimed to investigate the robustness of the ownership SRE for object stimuli in South Africa. We ran an object ownership SRE online experiment on a sample of students at the University of Cape Town in South Africa. We managed to replicate the expected SRE pattern of results reported elsewhere (Cunningham et al., 2008, 2013; Li et al., 2022; Sui et al., 2012). Participants recognised significantly more self-related stimuli relative to the other-related ownership conditions (when items belonged to a friend or a stranger). Secondly, we investigated whether exposure to negative emotional material would reduce the ownership SRE. We found that participants who were induced into a negative mood state were less accurate in their recognition overall. Furthermore, we found that the greatest difference between these two mood induction groups occurred when the neutral mood induction group recognised a greater degree of self-owned items than the negative mood induction group. As expected, there was no difference between the negative and neutral mood induction groups' recognition of the friend's or stranger's items. We also report on the influence of depressive and anxiety symptoms on the SRE and subsequent recognition.

Hypothesis 1: Object Ownership Self-Reference Effect in an Online Setting

Participants' responses were most accurate when responding to self-owned stimuli (my item) compared to familiar-owned (friend's item) and unfamiliar-owned (stranger's item) stimuli. In addition, our participants were significantly more accurate when responding to friend-owned items, than to stranger-owned items. These results are in line with our first hypothesis. Although our experiment was conducted online during the COVID-19 lockdowns, our findings are consistent with other in-person studies examining the ownership SRE (Cunningham et al., 2008, 2011; Qian et al., 2020) whereby memory retrieval accuracy reduces as relational self-proximity decreases. This suggests that information about self-owned objects is prioritised over 'other-related' stimuli and the SRE is preserved in a virtual, online setting.

We provide further evidence that self-related biases occur when ownership stimuli are randomly allocated to the self, in keeping with previous studies (Constable, et al., 2019; Cunningham et al., 2008; Golubickis et al., 2017; Sparks et al., 2016). We were the first study to elicit the object ownership SRE in an online, remote setting. This provides evidence for the robustness of the ownership SRE as a significant effect was identified without participant supervision, which may demonstrate the ecological validity of the SRE. As is expected in remote research, our effect sizes are smaller than those produced in controlled conditions (e.g., Sui et al., 2016). Reduced attention to task stimuli was likely exacerbated in the remote setting despite requesting that participants complete the task in a quiet, distraction-free environment. We found that highly accurate participants generally performed well in response to all object ownership conditions (self, friend, and stranger). This also applies to those who achieved low accuracy scores in all three ownership conditions. This pattern may reflect attentional allocation differences to the task as a whole, with highly accurate scores being reflective of greater effort. Another explanation is that some participants' memory may have been superior to others. Although the SRE is a replicable effect in our sample, it is not the sole determinant of performance on this task and this likely applies to all SRE research. In addition, we suggest that real-world self-referential biases do not operate to the same extent seen in laboratory experiments. Given the large contribution that the virtual realm makes to current life, it is important to acknowledge how these subtle biases may influence processing. The fact that a statistically significant SRE pattern was identified supports the use of more ecologically applicable measures of how the SRE may influence processing in unsupervised environments.

When we tested for the pattern of errors that participants made, we found a statistically significant trend in the perceptual discriminability scores (d') typical of the SRE pattern. That is, participants made fewer false positive errors when presented with self-owned objects and made the most false positive errors with stranger-owned items. This provides further evidence of self-prioritisation of ownership stimuli in our sample. In a previous study investigating the impact of attentional self-prioritisation on reaction time, Sui et al. (2016) argued that perceptual discriminability scores reflect the degree of attentional allocation to the stimulus in their perceptual-matching paradigm. Accurate memory retrieval during the recognition phase of our task is heavily influenced by visual attentional allocation to the stimulus on initial exposure (Ramey et al., 2020), although other stimulus-related factors influence recall performance (e.g., stimulus familiarity; e.g., Meister & Buffalo, 2016). *d'* scores are modulated by attentional allocation to stimuli (Sui et al., 2016). Thus, attentional biases to self-related stimuli on initial encoding may have contributed to our participants' reduced false positive rates for self-owned items during the recognition phase. A competing view suggests that all objects are automatically assumed to be self-owned on the initial encounter (Firestone & Scholl, 2015). This assumption is may produce faster and more accurate categorisation of self-owned objects in matching tasks because self-owned objects require less verification (Golubickis, et al., 2018). This has been shown to occur before processing the evidence required for decision-making (Golubickis et al., 2018; White & Poldrack, 2014). Either of these competing explanations of attentional self-bias may explain our finding of a reduced false positive rate for self-owned stimuli.

Whilst higher *d'* scores are suggestive of increased attentional allocation to stimuli; it is also possible that retrieval mechanisms were directly enhanced by self-referential encoding. This can occur in combination with attentional effects. Our multiple-choice memory test provided executive and attentional scaffolding to cue memory more efficiently than would occur in a free-recall task due to recognition of the correct response. Our methodological design therefore tested memory encoding and retrieval to a much greater extent than, for instance, the matching paradigms used in perceptual saliency tasks. Thus, attentional processes were not directly examined in our study. Since we were able to demonstrate that memory retrieval was most accurate in the self-ownership condition, the multiple-choice attentional scaffolding was most efficient for assisting recall of self-related ownership stimuli.

Several studies have used various methodologies to control for the influence of stimulus familiarity, including the use of arbitrary geometrical shapes (Stolte et al., 2017; Sui et al., 2012) and random allocation of object ownership (Cunningham et al., 2008). Participants' familiarity with particular grocery image stimuli may have increased accuracy for these items. However, the random assignment of items to each object owner was used to limit these effects by forming novel ownership associations within the grocery task (Truong et al., 2013). Furthermore, objects were randomly assigned to each owner across participants. It remains plausible that certain groups of participants were generally more familiar with grocery stimuli in general than other participants. For instance, some participants in a university student sample may have more experience with grocery shopping than those residing in catered facilities.

Overall, our study provides further evidence for the object-ownership SRE. We were also able to elicit this effect in a remote, online setting. This may reflect the robustness of self-bias, as it was not possible to provide a more controlled environment during participant performance. These findings support a recent body of research showing processing advantages for self-owned items in a range of settings (Golubickis et al., 2020; Qian et al., 2020). Broadly, our pattern of results is in keeping with findings from studies examining the SRE with a range of stimuli, such as trait adjectives. This supports current conceptualisations of self-related information as a distinct biasing mechanism operating across multiple contexts (Stolte et al., 2017).

Our study offers a convenient tool to remotely elicit the object ownership SRE. In the context of restrictions that came come as a results of pandemics like COVID-19 there is a need for remote research tools in psychology (O'Connor et al., 2020). Our design potentially allows for larger sample sizes and may be used in the future to assess the SRE in multicultural groups outside of the commonly accessible undergraduate student population. Furthermore, it can be utilised to investigate how the SRE influences other forms of processing, such as emotional stimuli.

Hypothesis 2: Effect of Mood Induction Protocol on Self-Reference Effect

Mood Induction Protocol

We were also interested in mood effects on the SRE. To investigate this we pre-exposed one group of participants to an emotionally neutral film clip and another to a negative (sad) film clip and then noted their subsequent performance on the SRE grocery task. Film clips have been shown to provide the most effective protocols for mood induction (Devilly & O'Donohue, 2021; Joseph et al., 2020). Of the few studies that examined the relationship between mood and the SRE, none have utilised film clip mood induction techniques. The vast majority of SRE mood research has been conducted using self-referential mood induction protocols which use self-related stimuli that are emotionally coded as positive or negative. For instance Sui et al. (2016) utilised Velten mood statements and a music mood induction protocol. Our study is the first to examine how film clip-induced moods with no relevance to the ownership task influence subsequent recall.

Half of our participants were randomly assigned to view a negative mood induction film clip protocol, which successfully induced negative mood (as evidenced from participants' mood self-ratings). In contrast, our control group were exposed to an emotionally neutral film. There was no difference between the two mood induction groups' mood ratings before the film clips began, with both groups reporting neutral mood. Thereafter, the two groups showed differences between their subjective mood ratings at all three mood rating time points across their duration. Immediately after the mood induction protocol, the negative mood induction group reported a higher degree of negative mood than the neutral mood induction group. In addition, the interaction between mood induction condition and mood ratings produced a medium effect size. Thus, the mood induction produced a greater degree of negative mood in the target group.

We also note that the neutral mood induction group provided slightly more negative mood ratings as time progressed during the neutral film clip. Neutral or control protocols commonly produce mild negative mood through boredom or annoyance effects (Devilly & O'Donohue, 2021). Such effects are unlikely to be sustained relative to negative mood inductions. This is because boredom has been shown to arise when uneventful, dull tasks fail to prompt sustained executive attentional control (Danckert & Merrifield, 2018). We requested that participants watch and therefore engage with the neutral film clip of two people having an everyday discussion, which is uneventful compared to the emotionally arousing events within *The Champ* (Zeffirelli, 1979). Thus, we may have incited boredom. However, the subsequent events such as the shopping task likely eradicated the monotonous nature of the neutral film clip task requirements. Thus, the bored mood was not likely sustained. Support for this is also seen in the neutral mood induction group's superior performance on the self-referencing task overall, which reflects a higher degree of effort. This presumably demonstrates a heightened degree of task engagement, which is not associated with subjective boredom (Danckert & Merrifield, 2018). Despite this, we found that the overall mean mood rating in the neutral mood induction group when averaging all five mood ratings, was at the neutral scale point, at three. Thus, the trend towards negative mood at the final mood rating likely reflects boredom or annoyance effects, rather than strongly induced negative mood (Droit-Volet et al., 2011).

The Effect of Mood Induction Protocol on the Self-Reference Effect

We used our online SRE task to assess the influence of transient negative mood on the ownership SRE. In support of our second hypothesis we found that participants in the negative mood induction condition were less accurate on the task overall than the neutral mood induction group.

Mixed designs ANOVA did not show a significant interaction effect between ownership condition (self, friend, other) and film watched (neutral, negative). However, three ANOVA assumptions were violated due to the skewed accuracy and reaction time data. We selected mixed-effects modelling as this method does not require that these assumptions are met, and also provides more accurate measures of standard error (Baayen et al., 2008; Bouwmeester et al., 2013). Furthermore, this method acknowledges inter-individual baseline variation across participants, thereby accounting for individual differences in task performance on our memory test. This model showed that the negative mood induction group were 7% less accurate than the neutral mood induction group overall on the grocery task memory test.

Accuracy during recognition tasks of emotional content, such as this memory test, requires detailed stimulus processing on initial exposure. Because emotional stimuli rapidly capture attention (Carretié, 2014), detailed stimulus processing has been shown to not occur when they are presented. Therefore, categorisation of emotional stimuli has been shown not to occur in attentional experiments (Stolte et al., 2017). In our memory test, it is plausible that attentional allocation was directed to participants' internal mood state, rather than to the task stimuli (Mor & Winquist, 2002) leading to poorer recall. More specifically, sad mood lowers arousal in comparison to neutral mood (Droit-Volet et al., 2011). *The Champ* (Zeffirelli, 1979) mood induction protocol that we used is intended to produce sad mood. Qian, et al. (2020) showed that highly arousing moods produced greater self-prioritisation. The authors argued that emotional arousal is required to produce the attentional SRE following mood induction. Thus, lowered arousal may explain the poorer general accuracy in the negative mood induction condition of our experiment. Another possibility is that negative mood does not directly reduce these attentional effects, but rather alleviates the advantage bestowed by positive self-referential material (Sui et al., 2016). Thus, our findings add to the growing body of recent evidence showing that negative mood reduces accuracy on a range of cognitive tasks. Specifically, we provide evidence that information encoding and memory retrieval (recall) on a recognition memory test is reduced for object-ownership information.

Secondary Hypotheses: The Influence of Mood Induction Protocol on the Extent of Self-Prioritisation

As the difference between self-accuracy and stranger-accuracy was significantly lower in the negative mood induction group, we showed that the extent of self-prioritisation was reduced in comparison to the neutral mood induction group. This supported our third hypothesis. Furthermore, as predicted by our fourth hypothesis, memory performance was equal for friend-owned items and stranger-owned items for both the negative and neutral mood induction groups.

The negative mood induction group was less accurate specifically when recalling self-owned items in comparison to stranger-owned items. There were no significant accuracy differences between the two mood induction groups regarding recall for the friend-owned or stranger-owned objects. This suggests that the negative mood induction condition uniquely reduced self-prioritisation in comparison to stranger items. This matches the pattern of self-prioritisation identified by Sui et al. (2016) following their negative mood induction protocol. Furthermore, the participants in our negative mood induction group had smaller differences between accuracy scores between all three of their item ownership conditions than the neutral mood induction group. For instance, the difference between accuracy for self-owned items compared to friend-owned items was greater in the neutral mood induction group than it was in the negative mood induction group. This shows that the more self-proximal friend’s items were awarded a greater degree of bias in the neutral mood condition than the negative protocol. We note that the descriptive statistics indicated that the negative mood induction group performed in the predicted typical SRE pattern; with the highest accuracy for self-owned items and lowest accuracy for stranger-owned items. However, the reduced mean differences in the neutral mood induction group suggest that the differentiation between accuracy in response to the differing ownership conditions occurs to a lesser degree when in a negative mood. We note that negative mood reduced self-prioritisation, despite the overall trend towards negative mood in both the negative and neutral mood induction groups. In a related study by Sui et al. (2016) their Velten statement mood induction protocol established positive mood in their neutral control group. Thus, the possible boredom effects potentially reduced more distinct self-proximity effects in the neutral mood induction group. Inducing a positive mood in our control group may have illustrated even greater between-group differences.

Current research suggests that negative mood reduces the perceptual and attentional salience of self-referential material (Sui et al., 2016), whereas positive self-related material appears to enhance the SRE in healthy participants (Hu et al., 2020). Participants induced into negative moods have previously shown a reduced degree of self-bias in perceptual matching tasks (Sui et al., 2016). Therefore, negative mood has been shown to reduce attention to self-referential material. These attentional effects may explain why participants induced into a negative mood showed a reduced degree of self-prioritisation. Thus, our findings support those of Sui et al. (2016), who suggest that sufficient attentional allocation to self-related stimuli underpins self-bias.

Previous SRE mood investigations (e.g., Qian et al., 2020; Sui et al., 2016) have typically compared only the self and stranger categories. However, we investigated within-group differences at three levels of object-ownership (self vs friend vs stranger). We have additionally shown that negative mood eliminates the self-proximal bias for the friend label. The neutral mood induction group produced the typical SRE self-proximity pattern. This occurred as accuracy for the self-proximal friend's objects is greater than accuracy for the more distal stranger condition. There was no significant difference between the negative mood induction group's accuracy in response to the other-referenced ownership conditions (friend and stranger). Exposure to negative emotional material may have led to reduced differentiation between the friend and stranger conditions. Thus, memory for less self-proximal, stranger-owned items appears to be reduced by negative mood state, supporting the findings of Sui et al. (2016), with our additional finding of reduced friend-label differentiation.

Most studies have examined the SRE with emotionally valanced stimuli, such as trait adjectives which negatively or positively describe the self. Along with Sui et al. (2016), we provide evidence that transient mood states influence self-referential processing when self-referential task requirements are not emotional stimuli. This suggests that self-referential processing may be altered by transient mood states even when the self-referential material is not inherently emotional. Mood appears to interact with self-referential biases which may influence cognition in daily life. Our findings support recent attempts to target self-referential biases in therapeutic interventions, such as mindfulness meditation techniques (Lin et al., 2018).

Mixed effects analyses showed that the model for the interaction between mood induction and self-referential memory had a high level of intra-class correlation. This showed that over half of the data variation (64%) is attributable to unmeasured variables or individual differences between participants. There is a growing body of research demonstrating attentional self-prioritisation effects (Blume et al., 2017; Herbert et al., 2011; Sui et al., 2014; Sui & Rotshtein, 2019). These effects are assumed to contribute to the SRE in memory. Therefore, differences in individual participant attentional capacities may have significantly impacted our participants' memory retrieval processes. For instance, an individual participant who devoted little attention to the task stimuli would likely have shown reduced performance across the task in all ownership conditions. It follows that some participants may not have shown self-prioritisation because they performed equally poorly across conditions. Furthermore, attentional difficulties (e.g., attention deficit disorders) were not controlled for. Another possibility is that individual memory retrieval differences impacted performance. However, this appears less likely than attentional discrepancies as the task tested rudimentary memory retrieval with a sample of participants receiving an undergraduate level of education. An exhaustive discussion of interindividual differences is beyond the scope of this paper and there are multiple possible inter-individual differences that may account for our findings. What is clear is that the SRE is not sole determinant of performance on this task, as individual factors appear to reduce the effect size in a remote setting. For instance, Sui et al. (2016) found a moderate effect size, $\eta^2 = .52$, in comparison to $\eta^2 = .005$ in our study. We suggest that the interaction between mood state and self-referential bias likely influences cognition in subtle ways in more ecologically valid settings.

We did not find a reduced SRE for reaction time following the negative mood induction, unlike Sui et al. (2016). Importantly, Sui et al. (2016) performed an attentional perceptual matching experiment, whereas our task examined implicit memory retrieval for object ownership. Unlike in the perceptual matching paradigm, our participants were not encouraged to respond quickly. Slower responses during a memory task may reflect a greater degree of task effort. An effortful approach may reflect effortful attempts to think back the encoding phase, as opposed to rapid guessing when having difficulty remembering (De Boeck & Jeon, 2019). Thus, these differences in our findings are more reflective of distinctive task requirements.

Our findings raise the possibility that exposure to emotional media may impact self-referential processing in everyday functioning through or changes in mood. These emotional effects may contribute to cognitive biases in memory for everyday objects. It is not yet clear whether these outcomes are related to changes in arousal, for instance. One important interaction we considered was how the mood-SRE relationship was associated with mood symptoms.

Exploratory Analysis: Mood, Depression Scores, and the Ownership SRE

Neither mood, nor depression scores showed individual interactions with object ownership. However, exploratory analysis showed a significant disordinal interaction effect between the combination of object ownership condition, mood induction condition, and depression scores. Higher depression scores (severe) in the negative mood induction group were associated with lower mean accuracy for self-owned items. In contrast, severe depression scores in the neutral mood induction group were associated with higher accuracy for self-owned items.

No specific ownership category produced higher accuracy scores in the negative mood induction group with severe depression scores. The accuracy plot depicted a flat line across all three conditions for this group (see Figure 14). This suggests that no self-prioritisation occurred for this group. In contrast, the neutral mood induction group with severe depression scores were least accurate when presented with self-owned items. In addition, these participants were equally accurate with their friend's and the stranger's objects, with higher accuracy than the negative mood induction group in both of these conditions. Thus, it appears that higher depressive symptom scores in combination with neutral mood induction was associated with reduced self-bias, with no reduction, or possibly an increase in accuracy, for the other-referenced conditions.

One possibility which may explain the superior performance with self-owned items in the negative mood induction group with severe depression scores is mood-congruent recall effects. Mood-congruency may have boosted their self-referential memory in comparison to the neutral mood induction group. Research shows that MDD influences self-referential biases through mood-congruency when presented with self-relevant, affective stimuli, such as negative trait adjectives (Derry & Kuiper, 1981; Gaddy & Ingram, 2014). Participants with severe depression scores are likely to experience a greater degree of negative mood in daily life and may have emotion regulation difficulties (Berking et al., 2014). After both groups were induced into a negative mood state, the effects of the mood induction may have reduced over time. Depressed participants are more likely to return to their more typical negative mood state, over neutral or positive mood states (Joormann & Quinn, 2014). There would therefore be a match between negative mood during encoding and retrieval conditions. This allows for mood-congruent retrieval benefits to emerge during recall (Blaney, 1986). Furthermore, our participants with severe depression scores may have more robustly maintained the negative mood for a longer period (Clasen et al., 2013). Specifically, Clasen and colleagues (2013) showed that mood recovery is reduced in depressed participants following exposure to *The Champ* negative mood induction protocol. As the neutral mood induction group was also made up of participants with severe depression scores, these participants were also likely to revert into a negative mood state, over a neutral one (Joormann & Quinn, 2014). However, this negative mood would not have matched the mean neutral mood reported by the neutral mood induction group who were not induced into any particular mood state. Thus, the mood state during encoding and recognition phases may have been closely matched in the neutral mood induction group, as both were negative, boosting performance through mood-congruency effects. Thus, their accuracy for the self-condition may have been increased through this mechanism.

From the above, a question arises as to why only the self-owned condition benefits from mood-congruent effects, as the neutral mood induction group showed superior recognition in both the friend and stranger conditions. A unique contribution of our study is that it is the first to examine how transient mood states influence the ownership SRE. Previous research has typically introduced object-ownership in the absence of mood manipulation, or used stimuli that are inherently affective, such as valanced trait adjective stimuli. Thus, rather than investigating how the SRE is influenced by emotionality, which is relatively well-established, we examined the relationship between emotional mood processing and affectively neutral ownership stimuli, in the form of the grocery object images. Participants with MDD tend to interpret ambiguous self-referential stimuli as negative (Everaert et al., 2017). This finding also applies to ambiguous social scenarios (Moser et al., 2012). It is plausible that participants with high levels of depressive symptoms in both the neutral and negative conditions interpreted the self-referential task stimuli as negative to a greater extent. This may have occurred in response to lack of affective associations present within the stimuli. Furthermore, perhaps the social nature of the object-ownership labels influenced the performance of participants with severe depression scores. Given the negative self-related interpretation bias associated with depression (Hindash & Amir, 2012), participants in the neutral mood induction group may have ascribed negative associations to ambiguous self-related stimuli. Mood-congruency effects may have therefore reversed this pattern of performance for only the negative mood induction group.

We note that when depression scores were accounted for, we saw an increase in effect size of the mood induction and object ownership interaction effect. Where the neutral mood induction group had been 7% more accurate than the negative mood induction group, this difference increased to 9% with the inclusion of depression scores. This suggests that depression scores reduced the differences in self-referential memory following mood manipulation. This further demonstrates that depression scores and transient mood states interact to influence self-referential memory recognition.

We acknowledge the small effect size of the three-way interaction effect, $\eta^2 = .009$. Whilst this may be due to our online, remote setting, it may also reflect that these biases influence cognition in subtle ways. For instance, our sample provided BDI-II depression scores. It is likely that participants with MDD were present in our sample, as MDD is a common disorder amongst South African undergraduates (Bantjes et al., 2019). However, this was not a requirement of the study to preserve its ecological validity. Thus, only small number of participants had severe depression scores when examining the interaction effect between depression, negative mood, and the SRE. Future studies should gather a large sample of clinically depressed participants to further examine this interaction effect. In addition, it may illustrate that this interaction is a small effect in reality. Thus, in line with our findings for the main effects of mood, it appears that severe depression and mood likely interact in subtle ways to influence self-related processing.

Our findings have clinical implications for interventions which target attenuated self-related cognitive biases in affective disorders, such as the use of mindful meditation for MDD (Lin et al., 2018; Shi & He, 2020). Studies have shown that these interventions can produce increased awareness of others and reduce self-focus. Our participants with high depression scores showed differing patterns of awareness from the rest of the sample for both the ‘self’ and ‘other’ categories, depending on their mood states. Specifically, the negative mood induction group displayed no SRE (equal performance across ownership conditions). In contrast, the neutral mood induction group showed reduced self-prioritisation for their own items, with a high proportion of items recalled belonging to the friend and stranger. Thus, mood effects may underpin how self-biases influence processing in those with high levels of depressive symptoms. Therefore, the influence of prior mood effects should be considered when evaluating the effectiveness of therapeutic self-bias interventions.

Our findings for low and moderate depression scores are in keeping with the overall SRE pattern; participants in the negative condition showed reduced accuracy in all three ownership conditions compared to those in the neutral condition. Thus, the significant interaction effect only applies to participants with severe depression scores. There are multiple possibilities which may have produced this pattern of results, some of which have been discussed above. However, more research is needed to understand the complex interactions between mood symptoms, transient mood states, and the SRE. We recommend that future researchers gather a large sample of clinically depressed participants of varying severity to examine this effect in more detail.

General Limitations and Suggestions for Future Research

Our study was the first to identify the ownership SRE in a majority South African population. We note that our sample is made up of South African university undergraduates taking psychology courses. This significantly skewed the gender identity within the sample (85% female) but also likely does not adequately represent the full range of South Africa's cultural groups. However, our findings provide a comparison group with which to compare the performance when investigations into whether cultural differences may influence the SRE in South Africa.

Although mood induction techniques are essential for the experimental manipulation of affect, such protocols have widely recognised limitations. We selected the most effective mood induction protocol, a negative film (Joseph et al., 2020). However, all mood induction protocols are prone to demand characteristics, as participants may be alerted to the desired outcome, which may artificially alter responses (Fernández-Aguilar et al., 2019). Future research should include a range of mood induction stimuli, such as naturally-occurring mood due to environmental stressors. Although our induction did not aim to produce a specific mood state, mood induction research is often unable to capture the participants experiencing a blend of various emotions (Kučera & Haviger, 2012). Our neutral mood induction group was exposed to a neutral film, which was intended to prevent participants entering a particular mood state. However, mood generally became more negative regardless of the induction group. Although the neutral mood induction group declined to a lesser extent and this likely reflected boredom effects (Danckert & Merrifield, 2018). Future studies could prevent this by inducing specific mood states.

An unavoidable limitation of both experiments is their online, remote setting. Whilst task instructions aimed to reduce their influence, extraneous stimuli impact all remote research. The accuracy data were skewed left for all 3 ownership conditions due to several participants achieving low accuracy scores. This may reflect on limited effort in an unsupervised, remote environment. In addition, the course credit reward for completing the task may also have motivated limited engagement. There was also a lack of control over participants' environmental factors, such as time of day or extraneous distractors. Although most participants completed the task during working hours, participants were able to complete the task at any time of day. Thus, fatigue effects may have reduced task engagement in these cases. In addition, we found that a high degree of the variance in the sample was attributable to individual differences, whereby over half of the variation was due to unmeasured variables. Future researchers should replicate this experiment within laboratory conditions to alleviate the influence of such stimuli.

SRE ownership tasks are intended provide more ecologically-valid outcomes. However, the grocery task scenario remains somewhat unrealistic and could arguably be investigating an effect which has no influence on real-world social cognition (James et al., 2014). Whilst it may reflect more ecologically valid scenarios (such as online grocery shopping), future SRE researchers should consider using a more realistic technique for the encoding phase of the task. For instance, virtual reality simulation techniques in which participants interact with more realistic representations of the self, friend and stranger may provide greater ecological validity.

Conclusion

We showed that the ownership SRE is present in a sample of majority South African university students, in a remote, online setting. In addition, we showed that negative mood induction reduces accuracy in a self-referential ownership task. Specifically, negative mood was associated with reduced accuracy recalling self-owned items. Our findings suggest that transient mood states influence self-biases in a virtual setting, which may influence self-referential biases within real-world scenarios. Furthermore, exploratory analyses showed an interaction between negative mood and high depression scores, which appears to eliminate self-bias effects. We provide evidence that the interaction between mood, depression scores, and the SRE extends to stimuli that are arbitrarily assigned to the self. Our findings provide new perspectives on the relationship between the SRE and mood, as we showed that transient mood states influenced memory retrieval of self-related objects when the encoded stimuli are not inherently emotionally valanced as positive or negative. Mood-congruency effects may reduce self-referential biases specifically when there are high levels of depressive symptoms present. This has implications for interventions which target negative self-referential cognition (e.g., mindfulness meditation). To the best of our knowledge, this experiment was the first to examine the impact of mood on self-owned stimuli. Whilst it is clear that mood and self-prioritisation interact, there are very few studies in this field, thus more research is needed to examine the mechanisms of this relationship. To this end, our study offers a novel tool to examine the ownership SRE in a remote, online setting.

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Appendix A
Consent Form

Please read the following Consent Form carefully:

Consent to Participate in a Research Study (2 SRPP points)
University of Cape Town

Thank you for taking the time to participate in my study. This study is being conducted as part of my master's degree in the Psychology department at the University of Cape Town. It will measure your ability to sort household objects into different categories. Before agreeing to participate, please read the following carefully:

Why am I doing this study?

This study investigates the abilities of different age groups to sort household objects into different categories. This research investigates how aging influences people's ability to sort objects into different categories, and whether aging can negatively influence a person's processing of household object categories, such as grocery items.

What will I be asked to do if I participate in this study?

If you choose to take part, you will first complete an online questionnaire about your mood. Then, you will watch a short film. Next, you will complete a basic computer task which is a simulation of packing grocery items into a bag. Next, you will fill in an online questionnaire about the task. Finally, you will fill out an online questionnaire about how often you use or buy the objects in the task. The whole study will take approximately 1 hour.

What are the risks?

There are no risks involved in taking part in this study that you would not encounter in your everyday life.

What are the benefits?

You will receive 2 SRPP points in return for your participation in this study. Indirectly, you can also benefit by learning about the research process, and the knowledge that you have helped contribute to the body of research on ageing.

Who will participate in the study?

Approximately 100 undergraduate students from the university of Cape Town.

What are my rights as a participant?

Your participation in the study is voluntary. You may stop taking part in this study at any point, and there will be no punishment. You do not have to give anyone a reason for your withdrawal. You are not being forced to participate in this study. If you feel emotionally upset during any point of this study, please feel free to discontinue. Your response time data will not be available to anybody, aside from the researchers, as the computer will anonymously record your responses according to your participant number. Your identity is not attached to your responses. If you would like to know more about your rights as a participant, you may contact Ms Rosalind Adams: 021 650 3417 or rosalind.adams@uct.ac.za.

Please note: Random clicks will mean that you will NOT get an SRPP point for your participation in this experiment. You need to try your best in each task, because a high error rate, as indicated by careless clicking, will mean that you will not be awarded points for this task, so try your best!

For further information, feel free to contact the researcher, Nicole McIver: MCVNIC001@myuct.ac.za. You can also contact the supervisor, Dr. Progress Njomboro: progress.njomboro@uct.ac.za.

Should you feel the need for emotional or mental support, feel free to contact the UCT Student Wellness Centre at any time: 021 650 1017 between 8am-8pm Monday to Sunday.

Electronic Signature:

Full name: ______________________________

Date: ______________________________

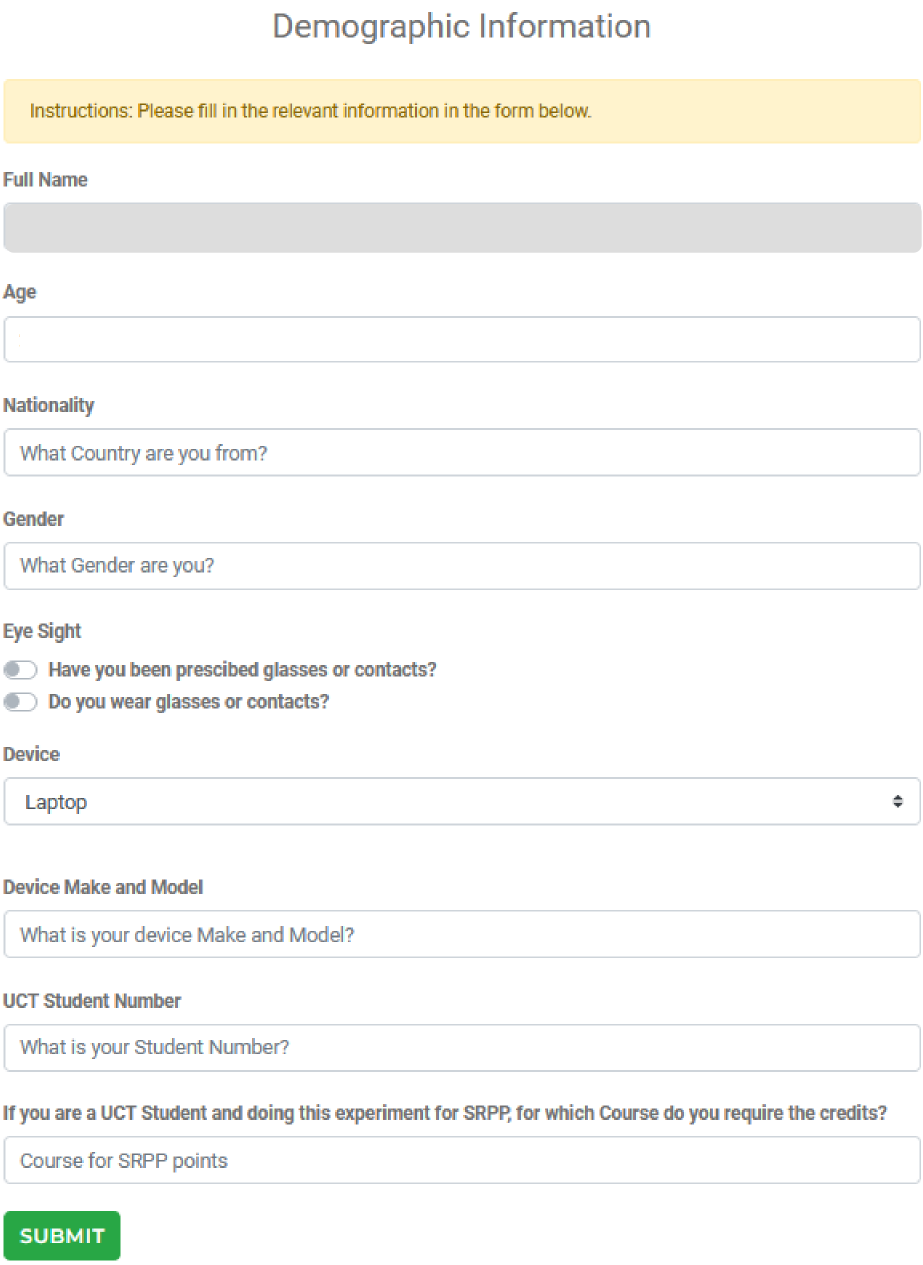
Click OK to Proceed

Please complete this task on a laptop or PC computer whilst seated in a quiet, distraction-free environment. Please do not complete this task on a cell phone or tablet.

There is audio in this task, so please make sure your computers volume is turned up and that you have access to your computer speakers or headphones.

Appendix B

Demographic Form Screenshot



Demographic Information

Instructions: Please fill in the relevant information in the form below.

Full Name

Age

Nationality

What Country are you from?

Gender

What Gender are you?

Eye Sight

Have you been prescibed glasses or contacts?

Do you wear glasses or contacts?

Device

Laptop

Device Make and Model

What is your device Make and Model?

UCT Student Number

What is your Student Number?

If you are a UCT Student and doing this experiment for SRPP, for which Course do you require the credits?

Course for SRPP points

SUBMIT

Figure B1. Screenshot of the online demographic form.

Appendix C
Beck Depression Inventory II

This questionnaire consists of 21 statements. Please read each group of statements carefully. And then pick out the one statement in each group that best describes the way you have been feeling during the past two weeks, including today. Click on the circle beside the statement you have picked.

1.

I do not feel sad.

I feel sad.

I am sad all the time and I can't snap out of it.

I am so sad and unhappy that I can't stand it.

2.

I am not particularly discouraged about the future.

I feel discouraged about the future.

I feel I have nothing to look forward to.

I feel the future is hopeless and that things cannot improve.

3.

I do not feel like a failure.

I feel I have failed more than the average person.

As I look back on my life, all I can see is a lot of failures.

I feel I am a complete failure as a person.

4.

I get as much satisfaction out of things as I used to.

I don't enjoy things the way I used to.

I don't get real satisfaction out of anything anymore.

I am dissatisfied or bored with everything.

5.

I don't feel particularly guilty

I feel guilty a good part of the time.

I feel quite guilty most of the time.

I feel guilty all of the time.

6.

I don't feel I am being punished.

I feel I may be punished.

I expect to be punished.

I feel I am being punished.

7.

I don't feel disappointed in myself.

I am disappointed in myself.

I am disgusted with myself.

I hate myself.

8.

I don't feel I am any worse than anybody else.

I am critical of myself for my weaknesses or mistakes.

I blame myself all the time for my faults.

I blame myself for everything bad that happens.

9.

I don't have any thoughts of killing myself.

I have thoughts of killing myself, but I would not carry them out.

I would like to kill myself.

I would kill myself if I had the chance.

10.

I don't cry any more than usual.

I cry more now than I used to.

I cry all the time now.

I used to be able to cry, but now I can't cry even though I want to.

11.

I am no more irritated by things than I ever was.

I am slightly more irritated now than usual.

I am quite annoyed or irritated a good deal of the time.

I feel irritated all the time.

12.

I have not lost interest in other people.

I am less interested in other people than I used to be.

I have lost most of my interest in other people.

I have lost all of my interest in other people.

13.

I make decisions about as well as I ever could.

I put off making decisions more than I used to.

I have greater difficulty in making decisions more than I used to.

I can't make decisions at all anymore.

14.

I don't feel that I look any worse than I used to.

I am worried that I am looking old or unattractive.

I feel there are permanent changes in my appearance that make me look unattractive.

I believe that I look ugly.

15.

I can work about as well as before.

It takes an extra effort to get started at doing something.

I have to push myself very hard to do anything.

I can't do any work at all.

16.

I can sleep as well as usual.

I don't sleep as well as I used to.

I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.

I wake up several hours earlier than I used to and cannot get back to sleep.

17.

I don't get more tired than usual.

I get tired more easily than I used to.

I get tired from doing almost anything.

I am too tired to do anything.

18.

My appetite is no worse than usual.

My appetite is not as good as it used to be.

My appetite is much worse now.

I have no appetite at all anymore.

19.

I haven't lost much weight, if any, lately.

I have lost more than 2 kilograms.

I have lost more than 4 kilograms.

I have lost more than 6 kilograms.

20.

I am no more worried about my health than usual.

I am worried about physical problems like aches, pains, upset stomach, or constipation.

I am very worried about physical problems and it's hard to think of much else.

I am so worried about my physical problems that I cannot think of anything else.

21.

I have not noticed any recent change in my interest in sex.

I am less interested in sex than I used to be.

I have almost no interest in sex.

I have lost interest in sex completely.

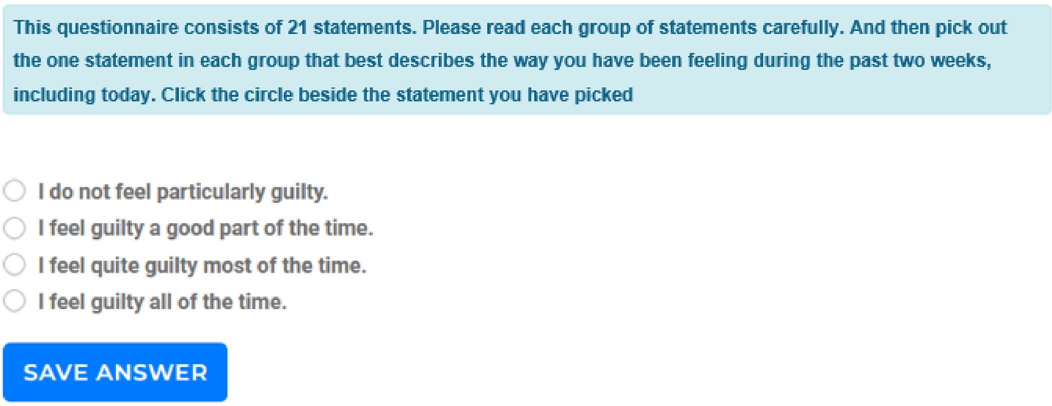


Figure C1. Screenshot from the Online Version of the Beck's Depression Inventory.

Appendix D
State-Trait Anxiety Inventory

Part 1: State-Trait Anxiety Inventory - State

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you **feel right now at this moment**. There are no right or wrong answers. Do not spend too much time on any one statement but click on the answer which seems to best describe your feelings best.

1. I feel calm
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so
2. I feel secure
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

3. I am tense
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so
4. I feel strained
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so
5. I am at ease
    1. Not at all
    2. Somewhat

   3. Moderately so
   4. Very much so

6. I feel upset
   1. Not at all
   2. Somewhat
   3. Moderately so
   4. Very much so

7. I am presently worrying over possible misfortunes.
   1. Not at all
   2. Somewhat
   3. Moderately so
   4. Very much so

8. I feel satisfied.
   1. Not at all
   2. Somewhat
   3. Moderately so
   4. Very much so

9. I feel frightened.
   1. Not at all
   2. Somewhat
   3. Moderately so
   4. Very much so

10. I feel comfortable.
   1. Not at all
   2. Somewhat
   3. Moderately so
   4. Very much so

11. I feel self-confident.
   1. Not at all
   2. Somewhat
   3. Moderately so
   4. Very much so

12. I feel nervous

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

13. I am jittery.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

14. I feel indecisive.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

15. I am relaxed.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

16. I feel content.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

17. I am worried.

1. Not at all
2. Somewhat
3. Moderately so

4. Very much so

18. I feel confused.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

19. I feel steady.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

20. I feel pleasant.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

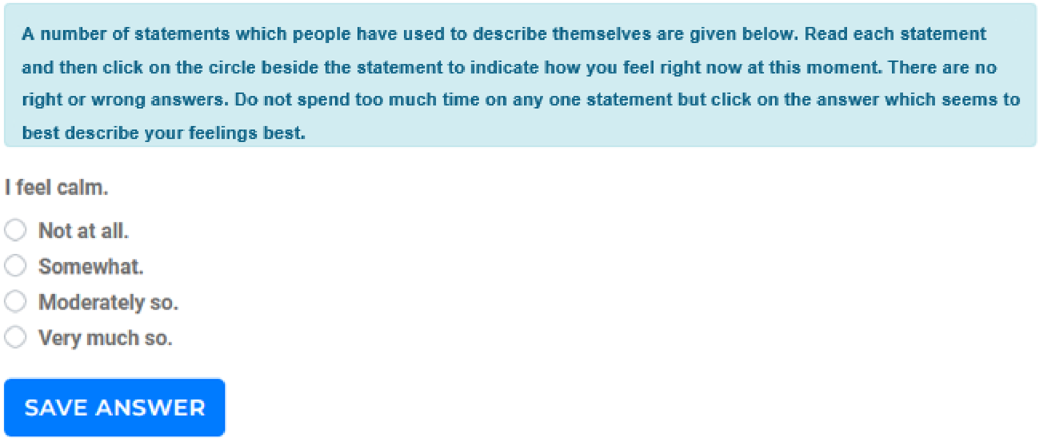


Figure D1. Screenshot of the Online Version of the State-Trait Anxiety Inventory-State Questions.

Part 2: State-Trait Anxiety Inventory-Trait

A number of statements which people have used to describe themselves are given below. Read each statement and click on the circle next to the statement that indicates **how you generally feel.** There is no right or wrong answer. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

1. I feel pleasant.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

2. I feel nervous and restless
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

3. I feel satisfied with myself
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

4. I wish I could be as happy as others seem to be.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

5. I feel like a failure.
    1. Not at all
    2. Somewhat

3. Moderately so
4. Very much so

6. I feel rested.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

7. I am “calm, cool, and collected”.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

8. I feel that difficulties are piling up so that I cannot overcome them.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

9. I worry too much over something that really doesn’t matter.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

10. I am happy.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

11. I have disturbing thoughts.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

12. I lack self-confidence.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

13. I feel secure.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

14. I make decisions easily.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

15. I feel inadequate.

1. Not at all
2. Somewhat
3. Moderately so
4. Very much so

16. I am content.

1. Not at all
2. Somewhat

3. Moderately so
4. Very much so

17. Some unimportant thought runs through my mind and bothers me.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

18. I take disappointments so keenly that I can’t put them out of my mind.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

19. I am a steady person.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

20. I get in a state of tension or turmoil as I think over my recent concerns or interests.
    1. Not at all
    2. Somewhat
    3. Moderately so
    4. Very much so

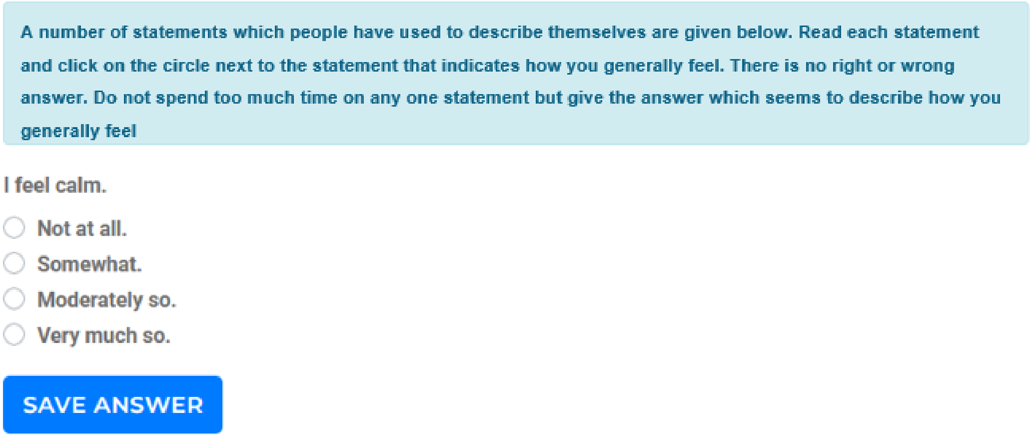


Figure D2. Screenshot of the online version of the State-Trait Anxiety Inventory: Trait Questions.

Appendix E
Screenshots of the Mood Induction Protocol

Figure F1 depicts a screen display from the 1986 film *Hannah and her Sisters* (Allen, 1986). In this clip two women, Hannah and Holly, have gone shopping and are walking through a shopping centre. As they walk, they talk about the events of the previous evening (a date) and what Holly should buy to wear to an audition. The pair do not discuss emotional topics in this scene and the clip is 177 seconds in duration.

Figure F1. Screen Display from Neutral Mood Induction Clip, Hannah and her Sisters.

Figure F2 shows a screen display from the sadness-inducing clip from the 1979 movie *The Champ* (Zeffirelli, 1979). In this film clip, a young boy finds his father dead after a boxing match and believes him to be asleep and tries to awaken him. This clip is 180-seconds in duration and is intended to produce negative (sad) affect.

Figure F2. Screen Display from Negative Mood Induction Clip, The Champ.

Appendix F
Email Inviting Undergraduate Students to Participate

Why not get your second-semester SRPP points sorted during vac from the comfort of your own home by completing this online study?

Why would I do this study?

This research investigates how aging influences people’s ability to sort objects into different categories. We are looking at whether aging can reduce a person’s processing of different object categories, such as the ability to organise their groceries.

What will I be asked to do if I participate in this study?

If you choose to take part, you will first complete an online questionnaire about your mood. Then, you will watch a short video. Next, you will complete a basic computer task/computer game which is a simulation of packing grocery items into a bag. Next, you will fill in an online questionnaire about the task. Finally, you will fill out an online questionnaire about how often you use or buy the objects in the task. The whole study will take approximately 30 minutes.

What are the risks?

There are no risks involved in taking part in this study that you would not encounter in your everyday life.

What are the benefits?

You will receive 2 SRPP points in return for your participation in this study, which you can put towards your second-semester psychology courses. Indirectly, you can also benefit by learning about the research process, and the knowledge that you have helped contribute to the body of research on ageing.

Who will be participating in this study?

Approximately 100 undergraduate students from the University of Cape Town.

NB PLEASE NOTE:

Random clicks will mean that you will not get an SRPP point for your participation in this experiment. You need to try your best in each task. A high error rate, cause by careless clicking, will mean that you will not be awarded points for this task, so try your best!

What are my rights as a participant?

Your participation in the study is voluntary. You may stop taking part in this study at any point, and there will be no punishment. You do not have to give anyone a reason for your withdrawal. You are not being forced to participate in this study. If you feel emotionally upset during any point of this study, please feel free to discontinue. Your data gathered in this study (e.g., reaction time data) will not be available to anybody, aside from the researchers. The website will anonymously record your responses according to your participant number. Your identity is not attached to your responses.

If you would like to know more about your rights as a participant, you may contact Ms Rosalind Adams: 021 650 3417 or rosalind.adams@uct.ac.za

To complete this study, please email the researcher at this address to receive the link: MCVNIC001@myuct.ac.za

Appendix G

Screenshots From Online Grocery Task: Distractor Film

In the distractor film clip, an animated ‘stick-figure’ character comes down from the sky and looks around an empty space. The figure then begins moving rapidly, crossing their arms repeatedly, while other larger ‘stick figures’ fall to the ground behind them. The figure shows no facial expressions (has a neutral face throughout) and there are no emotional events in this film clip. The clip is intended to capture the viewer’s attention. It has no audio. See Figure G1.

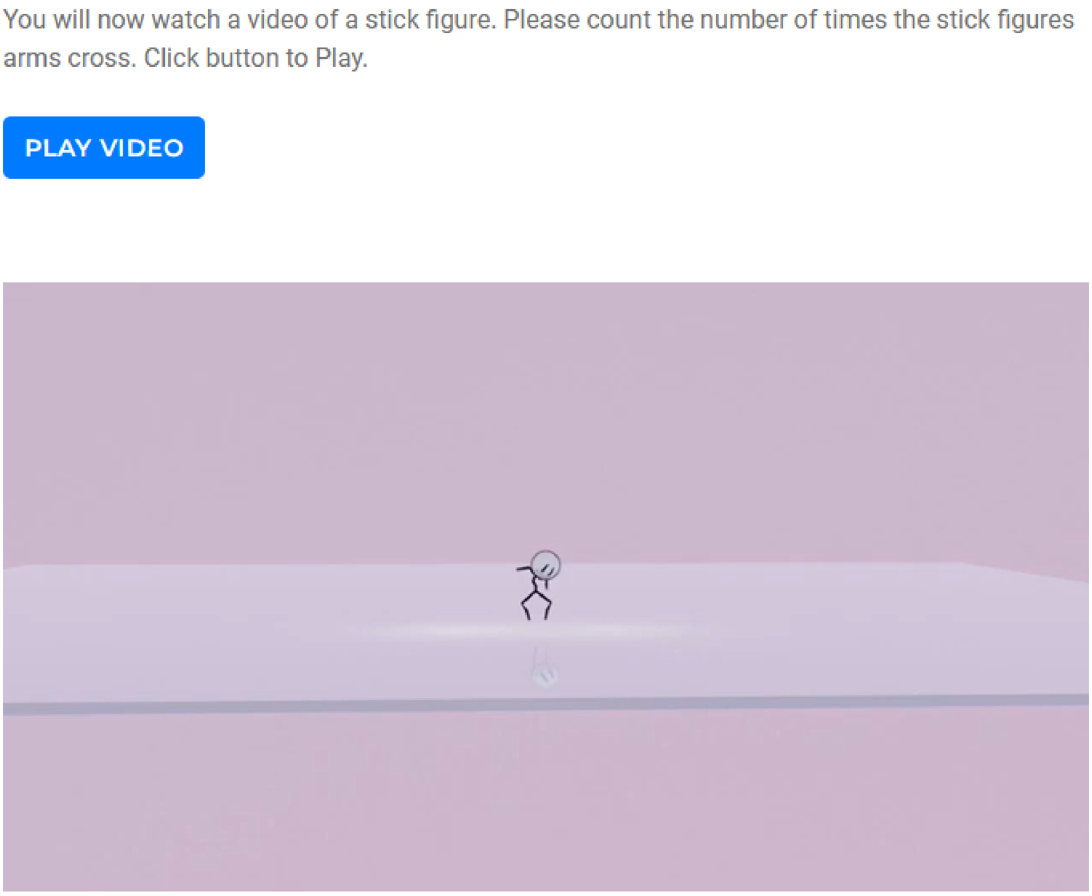


Figure G1. Screenshot Depicting the Distractor Task Animation and Instructions.

Appendix H
Debriefing Form

Debriefing Form: Please Read Carefully

University of Cape Town

Thank you for taking the time to participate in my study. This true purpose of this study was to investigate memory for who put each item into the baskets after exposure to an emotional film.

Aim of this research:

Your consent form told you that this study is investigating the abilities of different age groups to sort household objects into different categories. It also stated that this study investigates how aging influences people's ability to sort objects into different categories, and whether aging can negatively influence a person's processing of household object categories, such as grocery items.

However, in this study, we wanted to see if the sad or neutral film you watched had an effect on your ability to remember who put each of the items into the shopping bags. What you did not know is that we were investigating how accurately you were able to remember who put each item into the bag. This is called "self-referential" memory, because we wanted to see if your memory was stronger for yourself, compared to your memory for the friend and stranger categories. We are interested in this is because some promising research has shown that problems with self-referential processing play key roles in disorders like major depression, so a better understanding self-referential processing is needed. We also wanted to see our website that you used could successfully elicit self-referential memory at all, as online tools are needed in the COVID-19 pandemic era.

Why deception was used:

This process of slight deception was necessary because if you had been aware that you were being tested on self-referential memory, you may have intentionally or unintentionally paid more attention to your own items in the task. Because it is a test of implicit memory (which is memory that you make without meaning to), the fact that it is a memory test needs to be revealed only at the end. This deception used does not create additional risk for participants, as it is a minor deception about the purpose of the task.

I**, (type name here)________________________,** have read and understood what is written on this page, and by signing here, I acknowledge that I am aware of the true purpose of this research.

Participant's signature: (**type name as signature**) _________ **Type date here: ________.**

For further information, feel free to contact the researcher, Nicole McIver: MCVNIC001@myuct.ac.za.

You can also contact the supervisor, Dr. Progress Njomboro: progress.njomboro@uct.ac.za.

Should you feel the need for emotional or mental support, feel free to contact the Student Wellness Centre at any time: 021 650 1017 between 8am-8pm Monday to Sunday. You can also contact a counsellor through this link: https://docs.google.com/forms/d/e/1FAIpQLSd0ShEMUdtKhzh2UBBH4CoEzArUli43P7EAJ0TtCC_sjclWdA/viewform

If you feel emotionally unwell at any point during or after your participation, please feel free to contact a counsellor from the South African Depression and Anxiety Group the 011 234 4837

Appendix I

Additional Data Analysis: Mixed Effects Modelling

Table I1

Planned Contrasts by Depression Score, Mood Induction Condition, and Object Ownership Condition

Depression Score	Mood Induction Condition	Comparison Condition: Ownership	Comparison Condition: Ownership	Standard Error	*p*
		Self	Friend	.02	.26
Minimal	Negative		Stranger	.02	.001*
		Friend	Stranger	.02	.14
		Self	Friend	.03	.09
Minimal	Neutral		Stranger	.03	<.001
		Friend	Stranger	.03	.09
		Self	Friend	.03	.46
Mild to Moderate	Negative		Stranger	.03	.02*
		Friend	Stranger	.03	.12
		Self	Friend	.03	.02*
Mild to Moderate	Neutral		Stranger	.03	<.001
		Friend	Stranger	.03	.12
		Self	Friend	.07	.46
Severe	Negative		Stranger	.07	.89
		Friend	Stranger	.07	.61
		Self	Friend	.12	.16
Severe	Neutral		Stranger	.12	.15
		Friend	Stranger	.12	.98

Note.

*p < .05