THE SPATIAL AND TEMPORAL DYNAMICS OF SELF-RELEVANCE ON ATTENTION FOR OBJECTS

by

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Abstract

Ownership is a powerful mechanism for influencing attention. Objects that are owned by the self receive more attention and are more likely to be remembered than equivalent objects that are owned by another person. The most common explanation for this ownership effect is self-referencing/self-relevance: the act of associating an object with the self such that it is personally relevant to the self. What remained unknown is how the ownership-attention relationship functions when the scope of the self is expanded to include the influences of the body and the continuity (or lack thereof) of self-relevance over time. Over three studies, my dissertation aims to contextualize the attentional effects of ownership within these broader dimensions. In the first study, I found that the presence of the body could moderate the classic effect of ownership but that this moderation depends on the body's ability to directly manipulate the contents of its environment. In the second study, I found that ownership might operate as a form of affective salience, altering attentional prioritization and, in turn, temporal perception. In the third study, I found that objects that cease to be self-owned still receive greater attentional resources than objects that are not initially self-owned, suggesting that the effects of self-relevance are robust to subsequent changes in ownership. My research demonstrates that the effects of ownership on attention may rely on multiple aspects of self, including embodiment and motivational significance. Importantly, one critical element that emerges from these studies is that of an active or agentic self that is distinguishable from more object-based aspects of self. Collectively, these findings suggest that a deeper understanding of ownership effects on attention necessitates a deeper understanding of the self.

Lay summary

People tend to show an ownership effect: they pay more attention to objects they own than other people's objects. Before my research, not much was known about how this effect would change if a person could actually act on these owned things. I found that the particular way you interact with owned objects affects how strong the ownership effect is. Another thing that was unknown was how owning stuff changes the way you notice things in your environment. I found that you are more likely to notice an object you own before noticing an object someone else owns, even when they show up at the same time. Lastly, I found that when you stop owning certain things, you still react to them the same way as you did when you owned them. Overall, my research suggests that it is important to look at the many ways ownership affects attention.

Preface

I prepared the content of this dissertation, with minor edits from Todd Handy and Rebecca Todd. The research presented in Chapters 2 to 4 was primarily conducted by myself, and I was responsible for the description of theory and summary of current research described in Chapters 1 and 5. The research studies in Chapters 2 and 3 have been published or submitted for publication (see details below).

A version of Chapter 2 has been published as Truong, G., Chapman, C. S., Chisholm, J. D., Enns, J. T., & Handy, T. C. (2015). Mine in motion: How physical actions impact the psychological sense of ownership. *Journal of Experimental Psychology: Human Perception and Performance,* 42(3), 375-385. I was responsible for study conception and design, data analysis and interpretation, and manuscript composition. S. Ho, A. Rothwell, and J. Ho were primarily responsible for data collection. C. S. Chapman, J. D. Chisholm, J. T. Enns, and T. C. Handy were responsible for study conception and design, interpretation, and critical review of the manuscript. This study was approved by the University of British Columbia's Research Ethics Board, H11-00946: Human attention while reaching.

A version of Chapter 3 has been published as Truong, G., Roberts, K. H., & Todd, R. M. (2017). I saw mine first: A prior-entry effect for objects with newly acquired ownership. *Journal of Experimental Psychology: Human Perception and Performance, 43(1), 192.* I was responsible for study conception and design, data analysis and interpretation, and manuscript composition. K. Roberts was responsible for experimental design and implementation. C. Cowie, E. Kent, and P. V. Herrera were primarily responsible for data collection. R. M. Todd was responsible for study conception and design, interpretation, and critical review of the manuscript. This study was approved by the University of British Columbia's Research Ethics Board, H13-02205: The effects of self-relevance on temporal order judgments.

Portions of Chapter 1 and Chapter 5 have been published as Truong, G., & Todd, R. M. (2016). SOAP opera: Self as object and agent in prioritizing attention. *Journal of Cognitive Neuroscience*. I was responsible for manuscript composition. R. M. Todd was responsible for manuscript composition and critical review of the manuscript.

Portions of Chapter 1 and Chapter 5 have been submitted for publication as Truong, G., & Handy, T. C. (*Submitted*). The methodological and conceptual challenges of studying self-related processing in the brain. I was responsible for manuscript composition. T. C. Handy was responsible for manuscript composition and critical review of the manuscript.

All of the internet links in this thesis were verified to be active as of July 20, 2017.

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Acknowledgments

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Dedication

To my parents, for their unwavering belief in me.

Chapter 1: Introduction

Imagine that you are helping a friend move. As you are packing things in boxes and throwing out junk, something in the corner of the room catches your eye. In a pile of clothes, you notice the sweater you thought you lost all those months ago. There is really nothing unusual about the sweater, it's not particularly bright or new but it grabs your attention because it is yours. How did it manage to pop out amongst all the other items in the pile? Is it possible you were primed to notice it? Next, imagine your boss dumps a load of documents on your desk and asks you to make sense of it all. You go through the stack and start organizing the files by recipient, tossing some towards the far ends of your desk, placing others nearer to you. Which ones make it beyond the filter of your mindless sorting and actually draw your focus? Would it have mattered where they ended up on your desk or is the recipient the only factor? Finally, imagine you are walking in the park and a bicycle rushes passed you. As it happens, that bicycle used to belong to you but you sold it a few weeks back in order to purchase a new one. Does this bicycle still capture your attention even though it is not yours anymore? How long does its grip on you last? Everyday we are surrounded by the things we own and everyday we make decisions (conscious or otherwise) about what we pay attention to. Unsurprisingly, we pay attention to our own possessions. However, the full picture may be more complicated than that. We can move our possessions, we can keep mental tabs on them, and we can even give them up to other people. How do these actions, which involve spatial and temporal contexts, alter the way we pay attention to things we own? In this dissertation, I will seek to answer these questions.

A sense of ownership over an object gives it a pervasive psychological advantage over other objects. When everyday objects are conceptualized as *mine* (versus *not mine*), even when arbitrarily assigned, we treat them differently – we implicitly prefer them (Huang, Wang, & Shi, 2009), assign them higher value (Morewedge, Shu, Gilbert, & Wilson, 2009) and give them higher favorability ratings (Beggan, 1992). Recently, researchers have begun to look at how ownership affects attention and memory. For example, Cunningham et al. (2008) presented participants with images of everyday objects and told participants that they owned some of the objects and that the experimenter owned some of the objects. In a subsequent presentation of the set of objects, participants were significantly more likely to recognize the objects they owned relative to objects owned by the experimenter. This "ownership effect" has since been replicated multiple times (e.g., van den Bos, Cunningham, Conway, & Turk, 2010; Cunningham, Vergunst, Macrae, & Turk, 2013; Kim & Johnson, 2014; Englert & Wentura, 2016) with additional neuroimaging work showing that there is differential attention towards self-owned objects within 300 ms of learning that an object is owned by the self (Turk et al., 2011; Truong, Turk, & Handy, 2013). Assumed to be at the heart of these ownership effects is the psychological construct of the self, and in particular, the cognitive relationship between the self and one's possessions (e.g., Cunningham et al., 2008; van den Bos et al., 2010). Specifically, the ownership effect observed in Cunningham et al. (2008) and similar work can be considered a variation of the self-reference effect. Ownership parallels self-referencing in that a stimulus (i.e., an object) is encoded as being associated with the self ("I own this") and then is subsequently remembered to a greater degree than stimuli that were encoded in reference to other people. In the next section, I will briefly review self-referencing.

The Self-Reference Effect

For over half a century, researchers have observed that aspects of the world that are linked to the self receive prioritized cognitive resources. One's name is preferentially attended to and liked over others' names (Cherry, 1953; Nuttin, 1985; Shapiro, Caldwell, & Sorensen, 1997; Sui, Zhu, & Han, 2006), and one's own face preferentially captures and holds attention relative to others' faces (Tong & Nakayama, 1999; Brédart, Delchambre, & Laureys, 2006; Devue, Van der Stigchel, Bredart, & Theeuwes, 2009). Whereas face and name are representations of identity that remain relatively stable over time, other research suggests that the cognitive advantage for self-relevant stimuli is not solely the domain of longstanding associations. In fact, self-relevance can be rapidly acquired.

One of the first instances of differential cognitive processing resulting from relating stimuli to the self was the discovery of the self-reference effect (SRE; Rogers, Kuiper, & Kirker, 1977; Kuiper & Rogers, 1979). In the seminal experiments on the self-referencing effect, participants encoded a set of trait adjectives by judging each word on one of four qualities: structure ("Rate whether you feel the word is long or short"), phonemes ("Rate whether you feel the word has a rhythmic or lyrical sound"), semantics ("Rate whether you feel the word is meaningful to you") or, self-reference ("Indicate whether the word describes you.") Following the encoding task, participants were asked to recall as many of the adjectives as they could remember. Self-referentially encoded traits were recalled significantly more often than traits encoded using the other methods. The SRE was subsequently replicated multiple times (e.g., Klein & Kihlstrom, 1986; Conway & Dewhurst, 1995).

In subsequent work on the self-reference effect, Klein and Loftus (1988) investigated potential mechanisms for the SRE and found that organizational and elaborative processing could account for the increased recall of self-referentially encoded words. Organizational processing refers to linking a given stimulus (trait word) to other stimuli in the stimulus set, thus creating relational information that may boost recall. Elaborative processing refers to linking a given stimulus to multiple existing concepts or experiences in memory (Craik, 1979), thus creating many "routes to retrieval." Klein and Loftus argued that the self (as a cognitive construct) promotes both types of processing and therefore would be expected to (and did) yield higher recall. Relatedly, Bower and Gilligan (1979) compared self-referencing to other-referencing in order to explore whether the ability to associate trait words with specific episodic memories could explain the enhanced recall of self-referenced trait words. In doing so, they were among the first researchers to contrast two person-based types of encoding. They found that recall was lower when participants related a word to an episode from their mother's life than when they related a word to an episode from their own life. Bower and Gilligan went onto conclude that memory for stimulus words depended on the target of referencing (i.e., self or other) possessing a well-differentiated memory structure, which is more robust for the self.

Although the self-reference effect is the most widely studied phenomenon relating to self and cognitive processes, referentially linking various stimuli with the self concept has also been found to affect rates of associative learning. In a recent study, geometric shapes were randomly assigned to represent specific individuals (self, close other, stranger) (Sui, He, & Humphreys, 2012). A subsequent matching task presented participants with shape-label pairs that were either congruent or incongruent with the initial linkages and participants judged whether a shape was matched with its original label. Participants were faster to respond when they saw a correctly matched self-pair relative to the other pairings. Follow-up experiments revealed that the comparative strength of the self-shape relationship could not be accounted for by other stimulus properties (Sui, He, and Humphreys, 2012).

The effects of relating the self to stimuli have also been explored using neuroimaging methods. Much of the work has adapted the classic trait ascription task (in which participants judge some words on whether they are descriptive of themselves, and judge other words on whether they are descriptive of another person) to scanner settings. To this end, numerous researchers have found that the "self" and "other" conditions show differential activation in myriad cortical midline areas and associated subcortical areas (Zysset, Huber, Ferstl, & von Cramon, 2002; Fossati et al., 2004; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Northoff et al., 2006; Northoff et al., 2009; Yaoi, Osaka, & Osaka, 2009; Wagner, Haxby, & Heatherton, 2012; D'Argembeau & Salmon, 2012; Martinelli, Sperduti, & Piolino, 2013; Sui et al., 2013). ERP/EEG studies, though lower in spatial resolution, have also pointed to cortical midline structures as a key region in self-related processing (Berlad & Pratt, 1995; Gray, Ambady, Lowenthal, & Deldin, 2004; Esslen, Metzler, Pascual-Marqui, & Jancke, 2008; Zhao, Wu, Zimmer, & Fu, 2011; Turk et al., 2011; Truong, Turk, & Handy, 2013).

Notwithstanding the considerable body of literature on self-referencing, the self is not *just* a psychological construct. It also has a physical counterpart—the body, which can exert a biasing influence on cognitive processes (e.g., Jostmann, Lakens, & Schubert, 2009; Niedenthal, 2007; Proffitt, 2006).

Self as Body

My focus in Chapter 2 is to examine how the body would modulate the bias towards self-owned objects. As this section will illustrate, there is much behavioral and physiological evidence showing that the body and its actions can influence attention and perception.

The significance of the physical body for cognition arises from two of its major functions: integrating afferent and efferent information and then being able to act on said information (Tsakiris, Schutz-Bosbach, & Gallagher, 2007). First, the body registers external information. As a presence in the environment, the body acts as an anchor for orienting representation and integrating sensory inputs. Accordingly, the brain combines tactile, visual, and proprioceptive information through body-centric frames of reference (for reviews, see

Maravita, Spence, & Driver, 2003; Ladavas, 2002). The bias towards a self-body frame of reference over other frames of reference is referred to as egocentric primacy (Golledge, 1992; Hart & Moore, 1973; Pick & Lockman, 1981) and can lead to diverging effects on the accuracy of perception and behavior. Spatial judgments are more accurate when encoded through an egocentric (versus allocentric) perspective (Ruggiero, Ruotolo, & Iachini, 2009). Egocentric frames of reference also aid in remembering object locations (Coluccia, Mammarella, De Beni, Ittyerah, & Cornoldi, 2007) and trait adjectives (Zhang, Zhu, & Wu, 2014). In contrast, research has found that both children and adults have a tendency to interpret spoken instructions egocentrically during a referential communication task, with results suggesting that adults retain an egocentric bias but are better able to correct for it subsequently (Epley, Morewedge, & Keysar, 2004).

In addition to the body functioning as a frame of reference for processing sensory information, it can also affect the cognitive processing of space near itself - a region known as peripersonal space. Previc (1998) and others (e.g., Rizzolatti, Fadiga, Fogassi & Gallese, 1997; Holmes & Spence, 2004) characterized peripersonal space as the physical space surrounding the body that could be reached by moving the upper torso (including arms) without moving the whole body (i.e., without walking to another location in space). He posited several brain regions were involved in processing information from peripersonal space including the dorsolateral (thick-striped magnocellular) visual pathway, inferior parietal cortex, dorsal postarcuate frontal cortex, and subcortical areas such as the cerebellum, globus pallidus, and putamen (Previc, 1998). Since Previc first defined peripersonal space, research on human and non-human primates has shown that there is enhanced processing of stimuli near the body for both the auditory domain and the visual domain (Làdavas, Pavani, & Farnè, 2001). Furthermore, researchers have found regions in the ventral intraparietal area (VIP) of the monkey brain that contain multimodal neurons that prioritize nearby space for upcoming action (for a review, see Graziano & Cooke, 2006). On a more local level, there is preferential processing of objects near the hand (for review, see Brockmole, Davoli, Abrams, & Witt, 2013), such as improved visual detection and spatial discrimination (Reed, Grubb, & Steele, 2006; Dufour & Touzalin, 2008), visual orientation (Reed, Betz, Garza, & Roberts, 2010; greater stimulus-detail processing (Davoli, Brockmole, & Goujon, 2012), and even faster change detection (Tseng & Bridgeman, 2011), though there is some evidence to the contrary (e.g., Suh & Abrams, 2015; Davoli, Brockmole, Du, & Abrams, 2012).

With respect to the current work, there is evidence that self-relevance can impact the perception of stimuli in peripersonal space. In one study, participants sat at a table on which nine colored dots were placed at varying distances from the participants with some placements within peripersonal space and some beyond peripersonal space (Coventry, Griffiths, & Hamilton, 2014). On each trial, an experimenter placed a coin belonging to the experimenter or to the participant on one of the colored dots in full view of the participant. Following ten seconds of viewing the placement, participants were instructed to close their eyes for twenty seconds while the coin was removed from the table. Upon opening their eyes again, participants estimated the distance of the coin placement. Analysis of distance measurements showed a main effect of ownership such that the placements of self-owned coins were more accurately estimated relative to experimenter-owned coins (Coventry et al., 2014). This finding suggests that self-relevance may modulate spatial perception.

In addition to integrating and orienting information from the external world, a second function of the body is to act as an active agent, dynamically altering our cognitive perspective on the environment as we move. The prominence of action as a key influence on attention and perception was first pioneered by Gibson (1979). He argued that affordances, motor possibilities offered by an object in the environment, directly impact and constrain the visual information gleaned from the environment. Since then, research stemming from the notion that action biases attention has revealed that affordances (specifically, evoked grip types) affect neuronal firing in visual processing cells as early as 250 ms (Breveglieri, Galletti, Bosco, Gamberini, & Fattori, 2015). It has further revealed that the differential affordances of tools over non-tool objects are electrophysiologically distinguishable. This effect is found even when differentiating tools from non-tools is orthogonal to task demands (Proverbio, Adorni, & D'Aniello, 2011). Moreover, it can be disentangled from the conceptually related Simon effect (Riggio et al., 2008), a phenomenon in which responses to stimuli are faster when the stimuli are in the same relative location as the response. Importantly, affordances have been used to explain action selection with one theory proposing that potential actions compete against each other for selection until sufficient information accumulates to bias one action over the others (Cisek, 2007).

Part of the importance in considering the body's ability to execute action lies in its ability to affect attention and perception (Bekkering & Neggers, 2002; Symes, Tucker, Ellis, Vainio, & Ottoboni, 2008). In one study, participants prepared to make and then carried out grasping and reaching actions (Fagioli, Hommel, & Schubotz, 2007). Between planning and the execution of each action, participants completed visual discrimination trial in which they had to locate a deviant in a sequence of stimuli. The deviant could differ in either size or location. The results revealed that detection of size deviants was faster during grasping actions relative to reaching actions and the detection of location deviants was faster during reaching actions relative to grasping actions. The authors concluded that action planning alters attention towards relevant stimulus properties (Fagioli et al., 2007).

There is evidence that suggests that the importance of peripersonal space arises from the constraints of the body to reach and act on nearby objects. In other words, attention to peripersonal space may be due to its association with action. For example, Costantini and colleagues (2010) presented participants with mugs at different distances and instructed them to perform reach-to-grasp actions. They found a spatial alignment effect when objects were within but not beyond peripersonal space. However, when the experimenters placed a transparent barrier between the participant and an object that was in peripersonal space, thus precluding the possibility of acting on the object but not affecting visual information, the effect was abolished. Here the truncation of actionable distance was associated with an attenuation (to zero) of a previously observed effect of peripersonal space. Complementarily, the perception-enhancing effects of peripersonal space have also been found to expand when actionable space expands. Yang and Beilock (2011) measured participants' sensitivity to object orientation during a grasping task. Participants demonstrated greater sensitivity when the experiment apparatus was close to the body (and within participants' reach) compared to when the experiment apparatus was far from the body (and beyond participants' reach). Crucially, greater sensitivity was observed in a different condition in which participants were given grasping tools that extended participants' reaches to the far location suggesting that actionable space rather than solely proximal space may account for attentional and perceptual biases in peripersonal space.

As with peripersonal space, several brain regions have been implicated in action planning and action execution. There are multiple areas in the cortex devoted to movement-oriented representations of space (Kasai, 2008; Colby, 1998; Graziano & Gross, 1998), including the lateral intraparietal area, which has been shown to encode category-specific movement direction (Freedman & Assad, 2006). It has also been found that action can even alter the sensitivity of action-related neurons. Famously, in one study macaques were trained to use a rake to draw food towards themselves (Iriki et al., 1996). Post-training, the receptive fields of bimodal neurons in these macaques that responded to visual information around the macaque's hand had expanded to include the length of the tool. This receptive field plasticity was only observed when the macaques used the rake and not when they only held the rake in their hands, suggesting that active manipulation was crucial to the incorporation of the rake into the body schema. Given the large body of evidence showing that the body can influence the cognitive processing of objects in the environment, my focus in Chapter 2 was to examine how the body modulates how ownership influences attention to objects.

Attentional Prioritization

My focus in Chapter 3 was to examine whether ownership can engage implicit attentional sets to bias initial attentional deployment. Whereas previous research has shown that other motivationally significant stimuli can elicit attentional sets, I hypothesized that ownership (as a form of self-relevance) could do so as well. As this section will illustrate, self-relevance may exert influence over attention through affective salience.

Current models of selective attention expand traditional models of top-down and bottom-up processes to propose that sources of prioritization include (a) visual salience based on low-level stimulus features (traditionally bottom-up), (b) one's current explicit goals (traditionally top-down) [e.g., (Folk, Remington, & Johnston, 1992)], as well as (c) one's personal history with a stimulus (Chelazzi et al., 2014; Todd et al., 2012). This last category can include multiple time scales ranging from the short-term scale of selection history within an experimental task (Awh, Belopolsky, & Theeuwes, 2012; Becker, Folk, & Remington, 2013; Becker, Folk, & Remington, 2010; Folk & Remington, 1999; Correa & Nobre, 2008; Rushworth, Passingham, & Nobre, 2005) and recently learned associations with reward (Chelazzi et al., 2014). On longer time scales, an individual's semantic associations with stimuli (Moores, Laiti, & Chelazzi, 2003), as well as past experiences of associating certain categories of stimulus with emotional arousal or reward, also strongly shape attentional prioritization (for review see Pourtois, Schettino, & Vuilleumier, 2013; Todd, Cunningham, Anderson, & Thompson, 2012; Chelazzi, Perlato, Santandrea, & Della Libera, 2013; see also West, Anderson, Ferber, & Pratt, 2011; West, Anderson, & Pratt, 2009; Chelazzi et al., 2014; Baruni, Lau, & Salzman, 2015; Anderson; 2005; Keil, & Ihssen, 2004). There is also increasing evidence that what gets prioritized at any given time can shift as different goals are emphasized (Chelazzi et al., 2013; Cunningham, Van Bavel, & Johnsen, 2008), revealing what Chelazzi and colleagues have referred to as *experience-dependent attentional flexibility (*Chelazzi et al., 2013).

Attentional sets are mental templates that tune attention to prioritize object features or spatial locations relevant to the demands of a particular task (Folk, Remington, & Johnston, 1992). Such an attentional set enables enhanced processing of relevant features and suppressed processing of distracting ones. Typically, as studied in the lab, attentional sets have been determined by such explicit and intentional task-related goals (e.g., Becker et al., 2013; Becker et al., 2010; Folk & Remington, 1999; Correa & Nobre, 2008; Rushworth et al., 2005). However, mounting evidence indicates implicit attentional sets can be built up over the course of a task through learning (Kristjánsson & Campana, 2010; Zhao, Cosman, Vatterott, Gupta, & Vecera, 2014). It has been further suggested that one can maintain implicit attentional sets related to longer term goals (Todd et al., 2012).

Affective salience, defined as the tendency for an item to stand out due to its emotional relevance stemming from associations with reward and punishment (Todd et al., 2012), has also been implicated in attentional sets. There is both behavioural and neural evidence that visual prioritization observed for affectively and/or motivationally salient stimuli resembles prioritization elicited by common manipulations of explicit executive attention (e.g., Chelazzi et al., 2013; West et al., 2011; West et al., 2009; Miskovic & Keil, 2012; Serences & Saproo, 2010; Kiss, Driver, & Eimer, 2009; Hickey, Chelazzi, & Theeuwes, 2010; Hickey & van Zoest, 2012; Raymond & O'Brien, 2009; A. K. Anderson, 2005; Chelazzi et al., 2014; Keil et al., 2006; Niu, Todd, Kyan, & Anderson, 2012; Todd et al., 2015; Tsuchiya et al., 2009; Della Libera & Chelazzi, 2009). Arguably, self-relevance is a definitional component of affective salience, since events are salient in relation to their rewarding or punishing consequences to the self (Christoff et al., 2011; Northoff & Hayes, 2011; Todd et al., 2012). Thus, self-owned objects are a viable category of stimulus for engaging an attentional set.

One effective way of indexing the presence of an attentional set is by measuring a prior-entry effect, an attention-mediated distortion in perception (Stelmach & Herdman, 1991; Shore, Spencer, & Klein, 2001; Schneider & Bavelier, 2003; Zampini, Shore, & Spence, 2005). Prior entry effects are determined through the use of a temporal order judgment (TOJ) task in which observers see two stimuli presented slightly offset in time and must report which stimulus appeared first. If attention is directed to the spatial location of one of the stimuli, when stimuli are presented simultaneously, the stimulus in that location is likely to be perceived as appearing first [for review, see (Spence & Parise, 2010)]. Subsequent systematic variation of the stimulus onset asynchronies (SOAs) help to quantify the magnitude of the effect. Temporal order judgment tasks have been employed in non-visual modalities such as somatosensation (Yates & Nicholls, 2009), and audition (Kanai, Ikeda, & Tayama, 2007), with an abundance of research using TOJ tasks in cross-modal contexts (Sternberg, Knoll, & Gates, 1971; Vibell, Zampini, Spence, & Nobre, 2007; Eskes, Klein, Dove, Coolican, & Shore, 2007; Boenke, Deliano, & Ohl, 2009; van Damme, Gallace, Spencer, Crombez, & Moseley, 2009). Furthermore, they have been used to investigate various stimulus properties including but not limited to luminance (Jaskowski, 1992; Jaskowski & Verleger, 2000), figural region (Lester, Hecht, & Vecera, 2009), degree of action affordance (Roberts & Humphreys, 2010), and task-relevance (Vogt, De Houwer, Crombez, & Van Damme, 2013).

More recently it has been observed that stimuli with well-established and species-typical emotional relevance (“motivational significance”) can also elicit prior entry effects similar to those elicited through spatial cueing (West et al., 2009; 2010; Fecica & Stolz, 2008). In West et al. (2009), participants judged the order of appearance of pairs of angry and neutral faces in a TOJ task. When an angry face was paired with a neutral face, participants were significantly more likely to report that the angry face had appeared first. These findings are thought to unambiguously reflect attentional sets for emotional expressions, which are prioritized to reach awareness more quickly than neutral ones (West et al., 2009). It is notable that, in the affective sciences, such findings have typically been interpreted as driven by a “hardwired” prioritization of evolutionarily significant stimuli that elicits physiological arousal (e.g., Ohman, 2002). Yet emotional faces that capture attention may fail to elicit physiological arousal (Anderson, Yamaguchi, Grabski, & Lacka, 2006), and there is evidence that implicit attentional sets for relevant stimuli are modulated by emotional learning (e.g., B. A. Anderson, Laurent, & Yantis, 2011; Lim, Padmala, & Pessoa, 2009). Given that ownership can extend self-relevance to objects and that self-relevance is viable category of stimulus for engaging an attentional set, my focus in Chapter 3 was to examine whether self-owned objects could elicit a prior entry effect.

Ownership/Self-relevance Changes Across Time

My focus in Chapter 4 was to examine whether the effects of ownership on attention are maintained when ownership is given up. Previous studies have shown that when self-relevant stimuli are used as distractors or task-irrelevant stimuli, they tend to receive significantly greater attention (and cause greater interference) than equivalent but non-self-relevant stimuli (Gronau, Cohen, & Ben-Shakhar, 2003; Gray et al., 2004). Notably, the deployment of attention towards self-relevant but task-irrelevant stimuli occurs without reinforcement of self-relevance. In other words, one's name can distract from a task without a fresh reminder that one's name is personally meaningful. Such results suggest that the biases of self-relevance are maintained over time. However, in evaluating the temporal stability of self-biases, two caveats emerge. First, the stimuli used in the aforementioned studies used representations of self that were predominantly longstanding and unchanging over time such as one's name or face. To that end, it is unknown whether newly self-relevant stimuli can engender the same effects. (This particular question was explored in Chapter 3.) Second, the aforementioned studies did not examine stimuli that varied in self-relevance over time. An object's self-relevance can change through changes in ownership. A possession may be given away, sold, or lost and it has yet to be determined how the attentional biases afforded to self-owned objects change when ownership changes hands.

While there is a dearth of research on how attention to objects changes when ownership is given up, a substantial body of research stemming from the field of economics has shown that changes (or simply consideration of changes) in self-relevance (and in ownership specifically) impact numerous economic variables. One of the most well known examples of this is the endowment effect (Thaler, 1980; Kahneman, Knetsch, & Thaler, 1990). The effect is characterized by a discrepancy between the amount of money one is willing to accept (WTA) in order to sell a given object that one owns and the amount of money one is willing to pay (WTP) to buy the same object if one does not already own it (Mandel, 2002; van Dijk & van Knippenberg, 1998; Lerner, Small, & Loewenstein, 2004; Zhang &

Fishbach, 2005; Krigolson, Hassall, Balcom, & Turk, 2013). Although there are multiple psychological and situational factors contributing to this effect (Carmon & Ariely, 2000; Nayakankuppam & Mishra, 2005; Johnson, Haubl, & Keinan, 2007), recent evidence supports ownership as a form of self-anchoring as a likely mechanism underlying the endowment effect (Gawronski, Bodenhausen, & Becker, 2007; Morewedge et al., 2009; Dommer & Swaminathan, 2013). The endowment effect illustrates that the contemplation of giving up ownership (i.e., selling a self-owned object) influences object valuations in a way that is orthogonal to an object's other qualities.

Whereas the endowment effect shows how ownership/self-relevance impacts valuations at initial/first point of sale, there is also evidence that reversals in ownership over time can affect object valuations. Participants in a study by Ong and Tan (2015) played a computer-based game in which they acquired an everyday object (e.g., a mug) and over successive rounds retained it, lost it to another player (L), or re-won it (W). The outcomes of each round were predetermined by the experimenter in order to control for number of reversals (i.e., stability of ownership) and final outcome (i.e., win or loss). The authors found that an object was valued highest when it was regained in the final round (after losses in all previous rounds: L, L, L, L, L, W). Interestingly, valuation was higher when ownership alternated between rounds (e.g., W, L, W, L, W, L) relative to completely stable ownership (W, W, W, W, W, W) or completely stable non-ownership (L, L, L, L, L, L). These findings suggest that the valuation of an object partially depends on its unique temporal history.

With most research examining either the initial effects of ownership/self-relevance or the effects of longstanding ownership/self-relevance, not much is known about whether the biases associated with self-relevance withstand changes in ownership. Consequently, the crucial dynamic aspect of self has been relatively neglected in the literature on attention and self-relevance. In Chapter 4, I sought to fill this gap in the literature by exploring how changing the degree of self-relevance (via ownership) of objects affects the attentional bias for those objects.

Overview of Dissertation

The three following chapters of my dissertation will examine three distinct ways ownership and the self can bias attention to objects. The aim of my proposed dissertation is to contextualize the attentional effects of ownership within some broader dimensions. In the second chapter, I examined whether object-directed actions moderate or contribute to the cognitive effects of object ownership. In three experiments, I observed that the body moderates the effect of ownership on subsequent recognition of an object, but only when the body was used to act on the object and not when it was merely proximal to the object.

The third chapter examines whether self-relevance as expressed through ownership can engage attentional sets and bias perceptual processing in a manner similar to other affectively salient stimuli. In the first two experiments, I demonstrated that self-relevance can elicit a prior entry effect such that self-owned objects are significantly more likely to be perceived first when presented simultaneously with an other-owned object. I observed that the degree of bias towards self-owned objects was unrelated to other measures of self-bias. Lastly, in a third experiment I found that the self-bias seen in the first two experiments were not solely artifacts of the experimental design. Taken together, these results reveal that self-relevance can influence temporal perception through attentional prioritization.

The fourth chapter examines whether the cognitive bias towards self-owned objects is robust to changes in ownership as well as over time. In the first experiment, I found that when object ownership switched from self-owned to other-owned and vice versa, participants responded quicker to objects that were originally self-owned than objects that were originally other-owned. A second experiment demonstrated that the difference observed in the first experiment could not be explained by encoding strategy and a third experiment showed that the bias towards objects that were originally self-owned persisted over a ten minute delay and was not dependent on final ownership status. Collectively, these findings show the attentional bias towards initially self-relevant items is maintained across changes in time and degree of self-relevance.

My dissertation concludes with an integrated discussion of the relationship between self-relevance and attention, including some points of consideration regarding the cross-cultural generalizability of research on self-related processing, and an overview of limitations and potential future directions.

Chapter 2: Peripersonal space, action, and ownership on attention to objects

Introduction

Given the impacts of physical actions on numerous cognitive processes, I aimed to examine whether our object-directed actions moderate or contribute to the cognitive effects of object ownership. Specifically, I investigated whether the location of, and actions we perform on, owned and other objects relative to the body would interact with recall performance for those objects. To incorporate the body into an object ownership context, I modified a paradigm used by Cunningham et al. (2008) who asked participants to sort images of objects based on an arbitrary assignment to an ownership category (“mine” or “other”) and found subsequent recognition was higher for self-owned objects. In my adaptation, sorting occurred on an interactive touch table. In Experiment 1, participants were required to move some objects from a start position to a location close to themselves, while other objects were moved to a location far from themselves. This novel use of the physical movement of stimuli emphasized the dynamic spatial relationship between the participant’s body and the objects. To assess object processing, after the sorting task I examined participants’ recognition of the objects via a surprise memory test. I predicted that the manipulation of object location would differentially affect encoding and subsequent recall of the objects, such that the previously reported memory advantage for owned objects would be stronger for objects that were moved towards vs. away from the physical body.

Experiment 1

Methods

Participants. Final sample size was based on sample sizes from other studies involving reaching behaviour (e.g., Chapman et al., 2014; Milne et al., 2013) and adjusted upwards to equalize the number of participants in each configuration order (e.g., self-close/other-far, then other-close/self-far). Additional support for this decision came from a recent review by Gallivan & Chapman (2014), which stated that researchers should aim for approximately thirty participants in order to achieve sufficient power in reaching tasks. Fifty participants were recruited to do the experiment. Exclusions were as follows: one participant was left-handed, seven participants misunderstood or ignored experiment instructions (e.g., mixed up the colour-ownership associations, or did not look at the objects), seven failed our manipulation check (i.e., when verbally quizzed, these participants reported that they did not feel like they "owned" the self-owned objects more than the other-owned objects), and three demonstrated extreme variability in their reaching movements (i.e., subject-level standard deviations for movement times were more than two group-level standard deviations beyond the grand-averaged standard deviations). In the end, thirty-two right-handed participants (29 women, Age: M = 20.38 years, SD = 2.96) completed the experiment in exchange for course credit. Participants had normal or corrected-to-normal vision, and provided written informed consent.

Set-up. Participants sat at a table covered with white poster board onto which experimental stimuli were projected. The projector (Dell M410HD) was mounted ~2m above the table and produced a projected image of ~90 cm x ~70 cm. A passive reflective marker was attached to the right index finger of each participant and was tracked using six Optitrak V100:R2 cameras (NaturalPoint, Inc., Corvallis, Oregon) mounted on three tripods around the table (see Figure 2.1a). The position of the finger marker was sampled at 60 Hz (synchronized with the projector refresh rate) and was co-registered in space with the projected image to allow for the table top to be used as a touch interactive surface. All stimuli presentation and data collection were controlled with Matlab (Version 2010a) using Psychtoolbox (Version 3, Brainard, 1997; Pelli, 1997; Kleiner et al., 2007).

Participants viewed and sorted images of everyday objects (e.g., baseball, mango, clothespin, randomly selected from a 315-image stimulus set) in two different tasks, a sorting task followed by a surprise memory task. Projected object images were ~9 cm x ~9 cm and set against a white background. In the sorting task, participants dragged objects into one of two square (18 cm x 18 cm) target regions projected on the table, one labeled “Mine” and the other labeled “Other person’s” (see Figure 2.1b). These two regions were aligned horizontally on the lateral midline (participants sat centered on this point), with one closer to (center 12 cm away) and one farther from (48 cm away) the front edge of the projected image. The “far” distance was pilot-tested to ensure that participants would need to fully extend their arm to touch the box but not need to also shift their torso forward. To minimize variability in movement trajectories, starting positions were designated for each task and projected onto the table. In the sorting task, the start position (~2 cm black ring) was located ~22.5 cm to the right of the lateral midline and 30 cm from the front edge of the projected image.

In the memory task, the entire display was rotated 90 degrees clockwise around the display center and the target region labels were changed to “Old” and “New”. This resulted in a start position placed at lateral midline 7.5 cm from the front edge of the display and target regions aligned in depth (in the plane of the table) 30 cm from the front edge of the display, one 18 cm to the left of midline and one 18 cm to the right of midline (see Figure 2.1c).

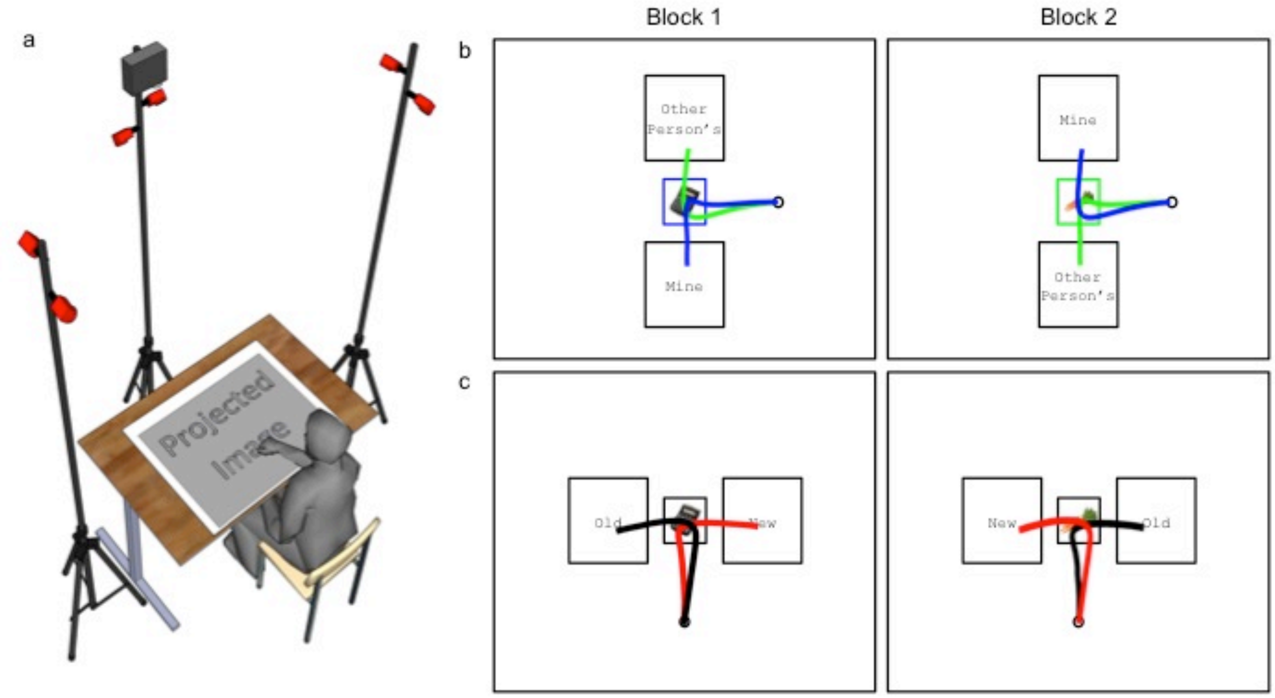

Figure 2.1. (a) Depiction of experimental setup. Participants sat at a table onto which the images, target boxes and start position were projected from above. A reflective marker was placed on the right index finger and its position was tracked by six Optitrak cameras (red objects) mounted on tripods around the table. (b) Layout and average trajectories for both ownership/location configurations in the sorting task. To-be-sorted objects appeared between two target areas. Participants reached from a start circle, and dragged the image into the one of the target areas, determined by the border color of the object. The traces depict the average trajectory across all participants on all correctly sorted trials for the other person (green) and mine (blue) conditions when mine is close (Block 1) or far (Block 2). (c) Layout and average trajectories for both memory/space configurations in the memory task. The traces depict the average trajectory across all participants on all correctly categorized memory trials for the old (Black) and new (Red) conditions when old is left (Block 1) or right

(Block 2).

Procedure.

Sorting task. Participants were told they had just returned home from a shopping trip with the research assistant and that it was time to sort out which items belonged to the participant ("Mine") and which items belonged to the research assistant ("Other Person's"). For each trial, participants began by placing their right index finger on the start position. After a variable interval of 500-1000 ms the object image was presented. It appeared between the two sort boxes with its center on lateral midline, 30 cm from the front edge of the projected image. Following another variable interval of 400-800 ms, a colored border (either blue or green) appeared around the image, denoting ownership category (e.g., blue = Mine and green = Other Person's, counterbalanced across participants). At the same time, a beep signaled participants to initiate their sort movement, requiring them to quickly and accurately touch the object image and drag it into the appropriate target region. Participants were given error feedback projected on the table regarding the reaching movement if the movement was "Too Early" (initiated < 100 ms post-beep), "Time Out" (initiated > 2 s post-beep), or "Too Slow" (movement completion was > 3 s following initiation). Feedback regarding sorting accuracy (i.e., whether the participant correctly put an object in the right box) was verbally given during practice trials but withheld during regular trials. Participants completed 10 practice trials followed by 52 regular trials with one configuration of target regions (e.g., Block 1: Mine-close/Other-far) followed by another 10 practice trials and 52 regular trials in the other configuration of target regions (e.g., Block 2: Other-close/Mine-far). The starting configuration of target regions was counterbalanced across participants.

Memory task. Upon completion of the sorting task, participants were given a surprise object recognition test. Participants were presented with individual images that were seen during the sorting task ("old") and an equal number of not previously seen images ("new", but from the same 315-item stimulus set) and were required to move the images into the appropriate target regions. Trials for the memory test followed the same timing as the sort task, but differed in that the object image borders were always black. Participants completed 20 practice trials and 104 regular trials for each target region configuration (e.g. Block 1: Old-left/New-right, Block 2: Old-right/New-left) with the first target region configuration counterbalanced across participants. "Old" objects from the first block of trials in the sorting task appeared in the first memory task block, and old objects from the second sorting block appeared in the second memory task block. For the following analyses (Experiments 1, 2, and 3), all of the manipulations and dependent measures, whether statistically significant or otherwise, have been reported.

Results

Sorting Task.

Reaction Time. For descriptive statistics of Experiment 1, please refer to Tables 2.1 and 2.2. Reaction time was defined as the time elapsed between the beep and the initiation of a movement. A 2x2 (ownership x location) repeated-measures (RM) ANOVA revealed a marginal effect of ownership, $F(1,31) = 3.86$, $p = .058$, partial $\eta^2 = 0.11$, such that movements for self-owned objects tended to be initiated more quickly relative to other-owned objects. The main effect of location was not significant, $F(1, 31) = 1.49$, $p = .23$, partial $\eta^2 = .05$, nor was the ownership by location interaction, $F(1, 31) = 0.02$, $p = .89$, partial $\eta^2 = 0.001$.

Reach Time. Reach time was defined as the time elapsed between the initiation of movement and the time at which the object image was moved fully into one of the target regions. A 2x2 (ownership x location) RM-ANOVA revealed a main effect of ownership, $F(1,31) = 8.13$, $p = .008$, partial $\eta^2 = 0.21$, such that movements were faster for self-owned objects. There was also a main effect of location, $F(1,31) = 54.52$, $p < .001$, partial $\eta^2 = 0.64$, such that movements were faster for the far location (consistent with the biomechanics of the movement). The ownership by location interaction was not significant, $F(1,31) = 0.06$, $p = .81$, partial $\eta^2 = 0.002$.

Table 2.1. Mean reaction and reach times for the sorting task in Experiment 1. Standard deviations are in parentheses. Reaction and reach times reflect all trials as accuracy was at ceiling.

Condition	Reaction Time (s)	Reach Time (s)
Self-owned		
Close	0.25 (0.05)	0.59 (0.09)
Far	0.25 (0.05)	0.55 (0.09)
Other-owned		
Close	0.26 (0.05)	0.60 (0.09)
Far	0.26 (0.06)	0.56 (0.10)

Memory Task.

Object Recognition. Object recognition was defined as the percent of old objects that were correctly identified as being "Old". A 2x2 (ownership x location) RM-ANOVA revealed a main effect of ownership, $F(1,31) = 9.79$, $p = .004$, partial $\eta^2 = 0.24$, $CI_{.95} = [1.94, 9.19]$, such that recognition for self-owned objects was significantly higher than that of other-owned objects. There was a marginal effect of location, $F(1,31) = 2.07$, $p = .16$, partial $\eta^2 = 0.06$, such that objects moved to the close location were recognized marginally more than objects moved to the far location. This was qualified by a significant ownership by location interaction,

$F(1,31) = 5.22$, $p = .029$, partial $\eta^2 = 0.15$ (see Figure 2.2a). Simple main effects analysis showed recognition for self-owned objects was significantly higher for objects that had been moved to the close location relative to the far location ($p = .012$, $CI_{.95} = [1.72, 12.93]$), while recognition for other-owned objects did not differ by location ($p = .402$, $CI_{.95} = [-3.23, 7.86]$). Pairwise contrasts between self-owned objects moved close and the other conditions confirmed that self-owned objects moved close were the most recognized (all ps < .012).

Since the current research question focused on memory for "Mine" and "Other", all subsequent memory task analyses included only trials where old objects were correctly identified as being old were analyzed. Incorrect trials have been excluded, as the reasons for selecting the incorrect option are many and indistinguishable.

Reaction Time. A 2x2 (ownership x location) RM-ANOVA revealed a main effect of ownership, $F(1,31) = 4.84$, $p = .035$, partial $\eta^2 = 0.14$, such that participants reacted more quickly to self-owned items than other-owned items. There was no main effect of location $F(1,31) = 0.52$, $p = .47$, partial $\eta^2 = 0.02$. There was also a significant ownership by location interaction, $F(1,31) = 9.86$, $p = .004$, partial $\eta^2 = 0.24$ (see Figure 2.2b). Simple main effects analysis showed reaction times for self-owned objects were significantly faster for objects that had been moved to the close location relative to the far location ($p = .003$) whereas reaction times for other-owned objects did not differ by location ($p = .13$).

Reach Time. A 2x2 (ownership x location) RM-ANOVA revealed no main effect of ownership, $F(1,31) = .002$, $p = .96$. The main effect of location was also not significant, $F(1,31) = 0.02$, $p = .88$, nor was the ownership by location interaction, $F(1,31) = 0.09$, $p = .77$ (all partial η^2s < 0.005).

Table 2.2. Mean percentage of "Old" objects correctly recognized, mean reaction times, and mean reach times for the memory task in Experiment 1. Reaction and reach time values are for correct trials only. Standard deviations are in parentheses.

Condition	Objects Recognized (%)	Reaction Time (s)	Reach Time (s)
Self-owned			
Close	68.50 (18.61)	0.23 (0.06)	0.63 (0.10)
Far	61.18 (19.74)	0.25 (0.07)	0.64 (0.10)
Other-owned			
Close	58.12 (19.83)	0.25 (0.08)	0.63 (0.11)
Far	60.43 (18.69)	0.24 (0.07)	0.63 (0.11)

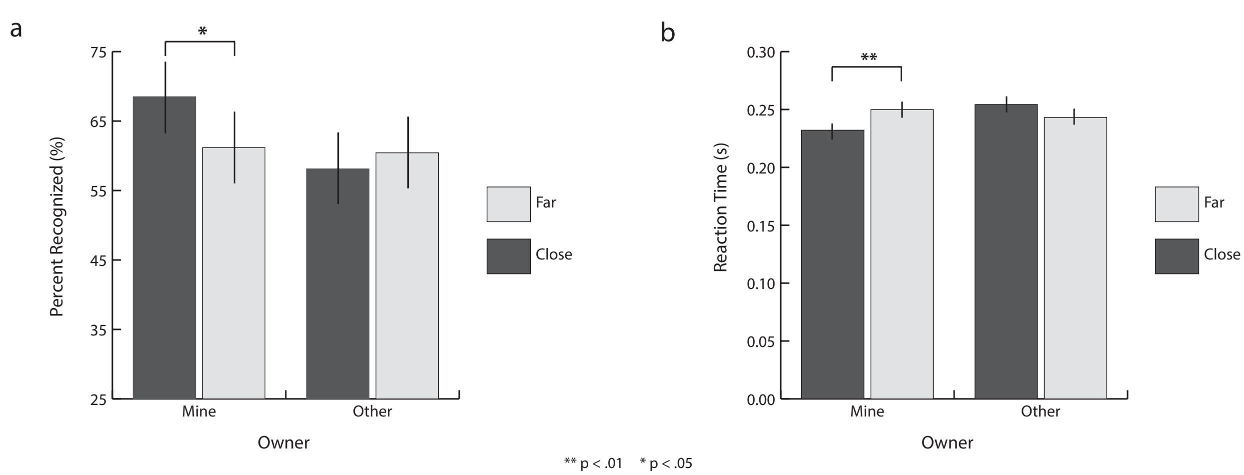

Figure 2.2. (a) Mean percent recognition scores as a function of ownership and target location for Experiment 1. (b) Mean reaction times for correct trials in the memory task as a function of ownership and target location for Experiment 1. Error bars represent 95% confidence intervals calculated for within-subject designs (Loftus & Masson, 1994).

Discussion

In this experiment, I integrated the physical self into a paradigm traditionally used to look at the influence of the psychological self and observed a unique pattern of results. I found that when self-owned objects were sorted into target regions close to the body, they were subsequently recognized with higher accuracy and recalled more quickly in a subsequent surprise memory test than either self-owned objects sorted away from the body, or other-owned objects sorted to either target location. The present findings demonstrate that the body exerts an impact on the cognitive biases associated with object ownership, and that these influences go beyond those previously reported for the psychological construct of ownership, such as enhanced memory recall for self-owned objects (e.g., Cunningham et al., 2008).

Although these findings demonstrate that the body can have a moderating effect on cognitive ownership bias, it remains uncertain whether the effect is driven by body as perceiver, body as actor, or both. For example, there is ample evidence of attentional differences between peripersonal and extrapersonal space (Kasai, 2008; Gallivan, Cavina-Pratesi, & Culham, 2009), and likewise, there is preferential processing for objects that are nearer versus farther from the body (Graziano & Cooke, 2006). Furthermore, there is also enhanced visual processing in the peri-hand area (Brockmole et al., 2013). Collectively, such findings suggest that spatial proximity alone may be sufficient to trigger the body-related effects of ownership found in Experiment 1. Therefore, to better understand the effect of the physical body on the ownership effect, I ran a second experiment, one designed to isolate the influence of peripersonal space from the influence of action.

Specifically, participants completed an experiment that mirrored Experiment 1 but rather than directly manipulating object location via reaching movements, participants pressed keyboard keys to “sort” self-owned or other-owned objects into locations close to or relatively further away from the body. By presenting stimuli at different distances from the body but not allowing participants to touch or physically move them, I manipulated the effect of location in the absence of movement action. If proximity to the body were sufficient to generate encoding differences, I would anticipate some effect of location. On the other hand, if space were only meaningful if you acted in it, then I would anticipate only the typical ownership effect and no location effect.

Experiment 2

Methods

Participants. Sample size was chosen to match Experiment 1 and I applied the same exclusion criteria, including a verbal manipulation check. No observations were excluded, likely a function of the less-demanding nature of the task (i.e., button-pressing is less demanding than time-sensitive reaching movements), as well as improved/clarified instructions at the outset of the experiment. Thirty-two right-handed participants (22 women, Age: *M* = 20.31 years, *SD* = 2.33) completed the experiment in exchange for course credit. Participants had normal or corrected-to-normal vision, and provided written informed consent.

Set-up. Participants completed a sorting task and a memory task using the same stimulus presentation set-up and same pool of stimulus images as Experiment 1. The box locations, the coloured borders, and their respective counterbalances also remained unchanged. Since the participants no longer needed to move object images across the table surface, the start position landmarks were removed from the projected display and the participants did not wear motion-tracking markers. Instead, a keyboard was set up at the front edge of the table.

Procedure.

Sorting task. Like in Experiment 1, participants were given a shopping scenario and were told they needed to sort the items by owner into “boxes” at different locations on the table. Again, each trial featured an object image appearing between the two boxes, followed by the appearance of a coloured border (denoting ownership category) around the image. A beep, time-locked to the border, signaled participants to respond via keyboard press (e.g., “D” for Mine box or “K” or Other Person’s box, counterbalanced across participants). Pressing one of the two assigned keys would lead to the image disappearing from the center of the screen and re-appearing in the corresponding box selected by the participant.

Trials were rejected and participants were given error feedback projected on the table if the keyboard response was “Too Early” (initiated < 100 ms post-beep), or given later than 2 seconds post-beep (“Time Out”). Feedback regarding sorting accuracy was verbally given during practice trials but withheld during regular trials. The remaining procedure (practice vs. experimental trials, configuration block ordering etc.) was identical to Experiment 1.

Memory task. The memory task for this experiment mimicked that of Experiment 1 with respect to the ratio of “Old” to “New” objects, as well as the temporal order of stimulus presentation. For each trial, participants again responded via keyboard press. Key presses would lead to the displayed image disappearing from the central location and reappearing in the box selected by the participant. The remaining procedure (practice vs. experimental trials, configuration block ordering etc.) was identical to Experiment 1.

Results

Sorting Task.

Response Time. For descriptive statistics of Experiment 2, please refer to Table 2.3. A 2x2 (ownership x location) repeated-measures (RM) ANOVA revealed no main effect of ownership, $F(1,31) = 0.15$, $p = .71$, partial $\eta^2 = 0.005$. The main effect of location was not significant, $F(1,31) = 0.86$, $p = .36$, partial $\eta^2 = 0.027$, nor was the ownership by location interaction, $F(1,31) = 0.21$, $p = .65$, partial $\eta^2 = 0.007$.

Memory Task.

Object Recognition. A 2x2 (ownership x location) repeated-measures (RM) ANOVA revealed a significant main effect of ownership, $F(1,31) = 10.33$, $p = .003$, partial $\eta^2 = 0.25$, $CI_{.95} = [2.08, 9.29]$, such that recognition for self-owned objects was significantly higher than recognition for other-owned objects (see Figure 2.3). The main effect of location was not significant, $F(1,31) = 2.16$, $p = .15$, partial $\eta^2 = 0.065$, nor was the ownership by location interaction, $F(1,31) = 1.62$, $p = .21$, partial $\eta^2 = 0.05$.

Response Time. Only trials where old objects were correctly identified as being old were analyzed. A 2x2 (ownership x location) repeated-measures (RM) ANOVA revealed no main effect of ownership, $F(1,31) = 0.60$, $p = .44$, partial $\eta^2 = 0.019$, as well as no main effect of location, $F(1,31) = 0.10$, $p = .92$, partial $\eta^2 < .001$, and no ownership by location interaction, $F(1,31) = 0.05$, $p = .83$, partial $\eta^2 = 0.001$.

Table 2.3. Mean percentage of "Old" objects correctly recognized in the memory task, and mean response times for the sorting task and memory task in Experiment 2. Response times for the sorting task reflect all trials as accuracy was at ceiling. Response times for the memory task are for correct trials only. Standard deviations are in parentheses.

Condition	Objects Recognized (%)	Response Time (s)	
		Sorting Task	Memory Task
Self-owned			
Close	62.79 (19.13)	0.53 (0.14)	0.49 (0.21)
Far	64.05 (17.57)	0.52 (0.15)	0.50 (0.22)
Other-owned			
Close	60.20 (19.50)	0.52 (0.15)	0.51 (0.21)
Far	55.27 (17.42)	0.52 (0.15)	0.51 (0.18)

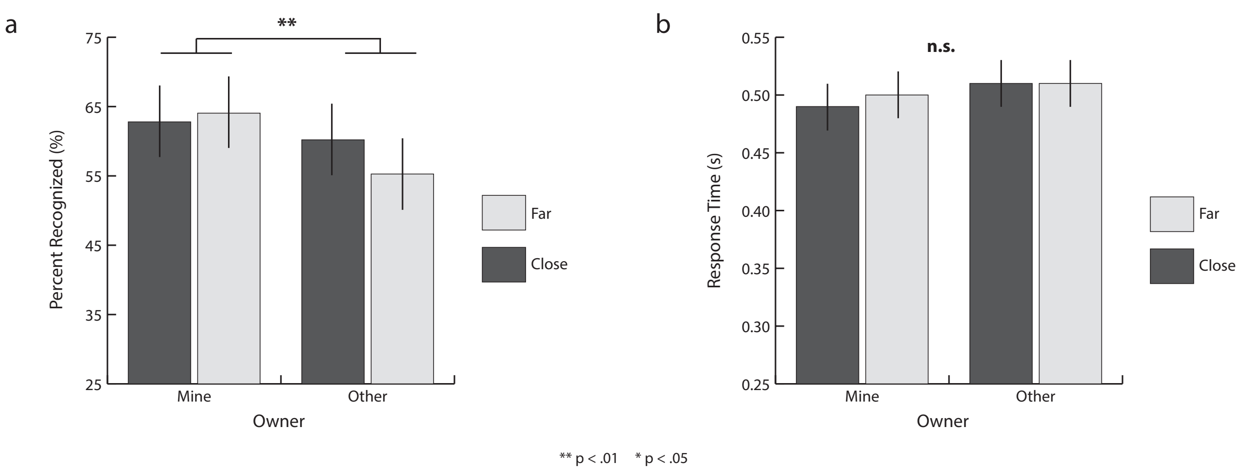

Figure 2.3. (a) Mean percent recognition scores as a function of ownership and target location for Experiment 2. (b) Mean response times for correct trials in the memory task as a function of ownership and target location for Experiment 2. Error bars represent 95% confidence intervals calculated for within-subject designs (Loftus & Masson, 1994).

Discussion

In Experiment 2, I disentangled the dual influences of the physical body on the ownership effect by limiting its role to only a passive viewer of relative spatial proximity. I found that when participants experienced this “proximity without action” version of the experiment, there was still a significant effect of ownership in which self-owned objects were recognized more often than other-owned objects. However, the removal of action from the paradigm abolished the body’s moderating effect on the ownership bias. This suggests that the widespread evidence that spatial proximity can lead to enhanced neurocognitive processing of an object (e.g., Brockmole et al., 2013; Gallivan et al., 2009; Graziano & Cooke, 2006) necessarily depends on motor-related engagement with those objects.

Although the necessity of motor action is clear, the nature of the actions is as yet unresolved. Previous findings by Cunningham and colleagues (2008), whose paradigm I adapted for the current work, partially complement our Experiment 2’s “space only” design by employing an “action only” design. In their study, the authors implemented an ownership by action factorial design: participant-confederate dyads took turns placing object image cards into one of two side-by-side baskets based on who (the participant or the confederate) “owned” each item. Subsequent recognition memory tests showed the typical ownership effect, but neither an effect of action nor an action by owner interaction. While this result suggests that *actor* may not make a discernible difference, the type of *action* still might.

During Experiment 1, participants made movements towards and away from themselves. By moving an object to the close location, participants were also making a “pulling” motion whereas moving an object to the far location could be seen as a “pushing” motion. While the pushing motion was used to push an object into a “Mine” box location (for instance), such a movement could be denoted with some sense of “rejecting” the object. To this point, several studies have investigated pulling and pushing movements in approach/avoid contexts and have found pulling movements are more easily associated with positively-valenced/approach-oriented stimuli (e.g., Markman & Brendl, 2005; Cacioppo, Priester, & Berntson, 1993). Because movement towards the body could not be distinguished from movement close to the body, the question of what underlies the original ownership by location interaction remains. To address this question, I returned to the touch interactive table for a third and final experiment.

Experiment 3

In Experiment 3, participants reached for self-owned and other-owned objects and pushed or pulled them to adjacent target boxes. An action-type-based explanation would predict another two-way interaction with pulled self-owned attaining the highest levels of recognition and, given the equal distance of the target boxes away from the body, an action-destination-based explanation would predict only a main effect of ownership.

Methods

Participants. Forty-six participants were recruited to do the experiment. Exclusions were as follows: due to experimenter error six participants were given the wrong number of trials, three participants misunderstood or ignored experiment instructions (e.g., mixed up the colour-ownership associations, or did not look at the objects), and two demonstrated extremely poor performance in the memory task (less than 30% of old objects recognized, averaged across all factors levels). No participants failed our manipulation check. In the end, thirty-five right-handed participants (23 women, Age: M=20.06 years, SD=2.70) completed the experiment in exchange for course credit. Participants had normal or corrected-to-normal vision, and provided written informed consent.

Set-up. The projection of the experiment onto a tabletop, motion-tracking via Optitrak, and use of the pool of stimulus images was identical to Experiment 1.

In order to manipulate the type of action required to move the images, the target regions and start position were altered. In the sorting task, the target region boxes for “Mine” and “Other Person’s” were located side by side and centered 29 cm from the front edge of the projected image, one centered 11 cm to the left of midline and one centered 11 cm to the right of midline. The start position was centered 29 cm from the front edge of the projected image, and 22 cm to the right of midline. In the memory task, the display was again rotated 90 degrees with target region boxes for “Old” and “New” aligned horizontally on the lateral midline, with one closer to (center 18 cm away) and another farther from (center 41 cm away) the front edge of the projected image. The start position for the memory task was 8 cm the front edge of the projected image, centered along the midline (see Figure 2.4).

Procedure.

Sorting task. All details were identical to Experiment 1 except for the configuration changes outlined above and the location that the object image was initially presented. It appeared laterally centered either 11.5 cm or 48.5 cm from the front edge of the projected display during “push” or “pull” trials, respectively (see Figure 2.4). The order of push versus pull trials was randomized.

Memory task. All details were identical to Experiment 1 except for the configuration changes outlined above and the location that the object image was initially presented. It appeared 29cm from the front edge of the display and was centered 20cm to the left or right of the midline during “Right” or “Left” trials, respectively (see Figure 2.4).

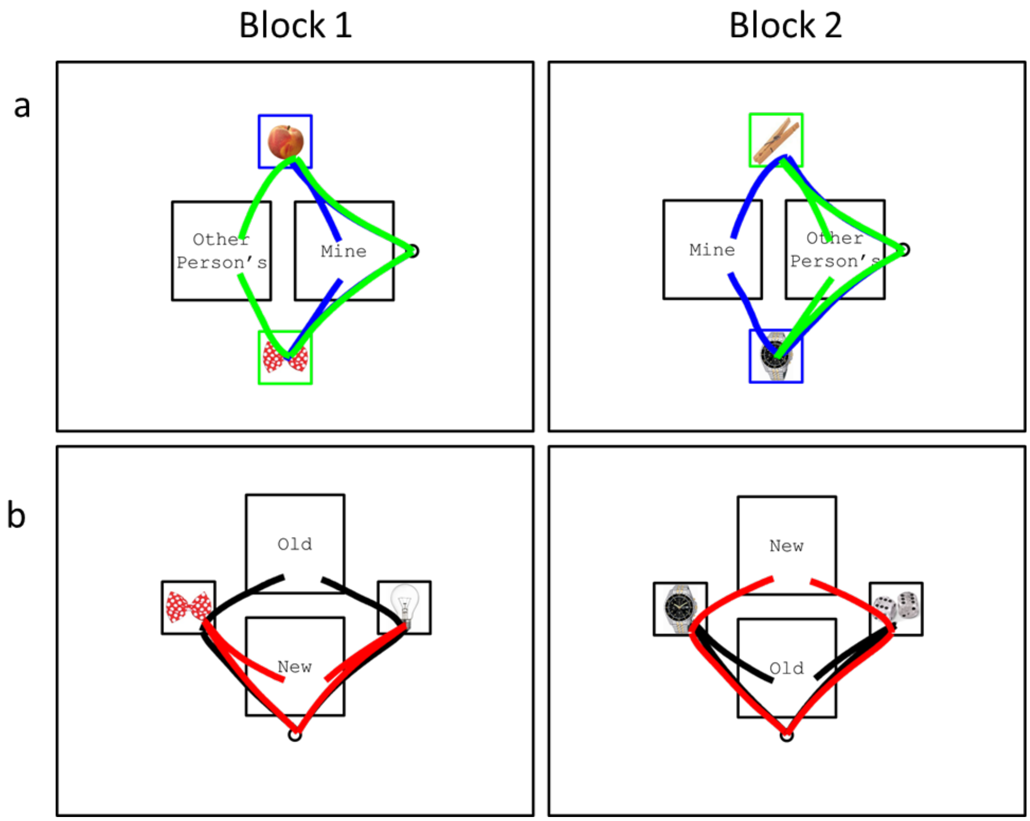

Figure 2.4. Layout and average trajectories for the sorting task (a) and memory task (b) in Experiment 3. (a) To-be-sorted objects appeared in one of two locations requiring either a "Pull" or "Push" action to move them into one of the target areas, determined by the border color of the object. The traces depict the average Pull and Push trajectories across all participants on all correctly sorted trials for the Other Person (Green) and Mine (Blue) conditions when Mine was on the Right (Block 1) or Left (Block 2). (b) To-be-sorted objects appeared in one of two locations requiring either a "Left" or "Right" action to move them into one of the target areas, determined by the memory of the participant. The traces depict the average Left and Right trajectories across all participants on all correctly categorized memory trials for the Old (Black) New (Red) conditions when Old is Far (Block 1) or Close (Block 2).

Results

Note that for all analysis conducted in Experiment 3, I collapsed across the irrelevant factor of configuration (e.g. across Blocks) such that Pull (and Push) actions to Left and Right locations in the sort task were grouped together. Similarly Left (and Right) actions to Close and Far locations in the memory task were also grouped together.

Sorting Task.

Reaction Time. For descriptive statistics of Experiment 3, please refer to Tables 4 and 5. A 2x2 (ownership x action) RM-ANOVA revealed no main effect of ownership, $F(1,34) = 1.82$, $p = .19$, partial $\eta^2 = 0.058$, no main effect of action, $F(1,34) = 0.003$, $p = .96$, partial $\eta^2 < 0.001$ and no ownership by action interaction, $F(1,34) = 0.32$, $p = .86$, partial $\eta^2 = 0.001$.

Reach Time. A 2x2 (ownership x action) RM-ANOVA revealed no main effect of ownership, $F(1,34) = 0.001$, $p = .98$, partial $\eta^2 < .001$. There was a significant main effect of location, $F(1,34) = 115.37$, $p < .001$, partial $\eta^2 = 0.77$, such that pushing movements were faster than pulling movements (consistent with Experiment 1). There was no ownership by action interaction, $F(1,34) = 0.15$, $p = .70$, partial $\eta^2 = 0.004$.

Table 2.4. Mean reaction and reach times for the sorting task in Experiment 3. Standard deviations are in parentheses. Reaction and reach times reflect all trials as accuracy was at ceiling.

Condition	Reaction Time (s)	Reach Time (s)
Self-owned		
Pulled	0.32 (0.06)	0.85 (0.21)
Pushed	0.32 (0.07)	0.74 (0.21)
Other-owned		
Pulled	0.32 (0.07)	0.84 (0.18)
Pushed	0.32 (0.07)	0.74 (0.19)

Memory Task.

Object Recognition. A 2x2 (ownership x action) RM-ANOVA revealed a main effect of ownership, $F(1,34) = 4.89$, $p = .034$, partial $\eta^2 = .13$, $CI_{.95} = [0.35, 8.21]$, such that recognition for self-owned objects was significantly higher than that of other-owned objects. There was a marginal main effect of action, $F(1,34) = 3.58$, $p = .067$, partial $\eta^2 = .10$, $CI_{.95} = [-0.02, 6.43]$, such that recognition for pulled objects was marginally higher than that for pushed objects. There was a significant ownership by action interaction, $F(1,34) = 4.64$, $p = .038$, partial $\eta^2 = .12$. Simple main effects analysis for this interaction revealed that when objects were pulled, self-owned objects were recognized significantly more than other-owned objects ($p = .005$, $CI_{.95} = [2.23, 11.87]$), and when objects were pushed, recognition for self-owned versus other-owned objects did not differ ($p = .51$, $CI_{.95} = [-3.10, 6.13]$, see Figure 2.5). Pairwise contrasts between pulled self-owned objects and the other conditions confirmed that pulled self-owned objects were the most recognized (all *p*s < .01).

For the following Reaction Time and Reach Time analyses, only trials where old objects were correctly identified as being old were analyzed.

Reaction Time. A 2x2 (ownership x action) RM-ANOVA revealed a marginal main effect of ownership, $F(1,34) = 2.30$, $p = .14$, partial $\eta^2 = 0.063$ such that self-owned items were marginally reacted to faster than other-owned objects. There was a marginal effect of action, $F(1,34) = 3.13$, $p = .086$, partial $\eta^2 = .084$ such that initially-pulled objects were marginally reacted to faster than initially-pushed objects. Lastly, there was no ownership by action interaction, $F(1,34) = 0.22$, $p = .64$, partial $\eta^2 = .006$.

Reach Time. A 2x2 (ownership x action) RM-ANOVA revealed no main effect of ownership, $F(1, 34) = 1.38$, $p = .25$, partial $\eta^2 = .039$, and a marginal effect of action, $F(1, 34) = 2.32$, $p = .14$, partial $\eta^2 = .064$ such that initially-pulled objects were moved marginally faster than initially-pushed objects. There was no ownership by action interaction, $F(1, 34) = 0.22$, $p = 0.64$, partial $\eta^2 = .006$.

Table 2.5. Mean percentage of "Old" objects correctly recognized, mean reaction times, and mean reach times for the memory task in Experiment 3. Reaction and reach time values are for correct trials only. Standard deviations are in parentheses.

Condition	Objects Recognized (%)	Reaction Time (s)	Reach Time (s)
Self-owned			
Pulled	59.66 (15.30)	0.30 (0.10)	0.85 (0.22)
Pushed	53.80 (15.73)	0.31 (0.09)	0.88 (0.23)
Other-owned			
Pulled	52.62 (14.96)	0.30 (0.11)	0.88 (0.27)
Pushed	52.28 (15.08)	0.32 (0.11)	0.89 (0.23)

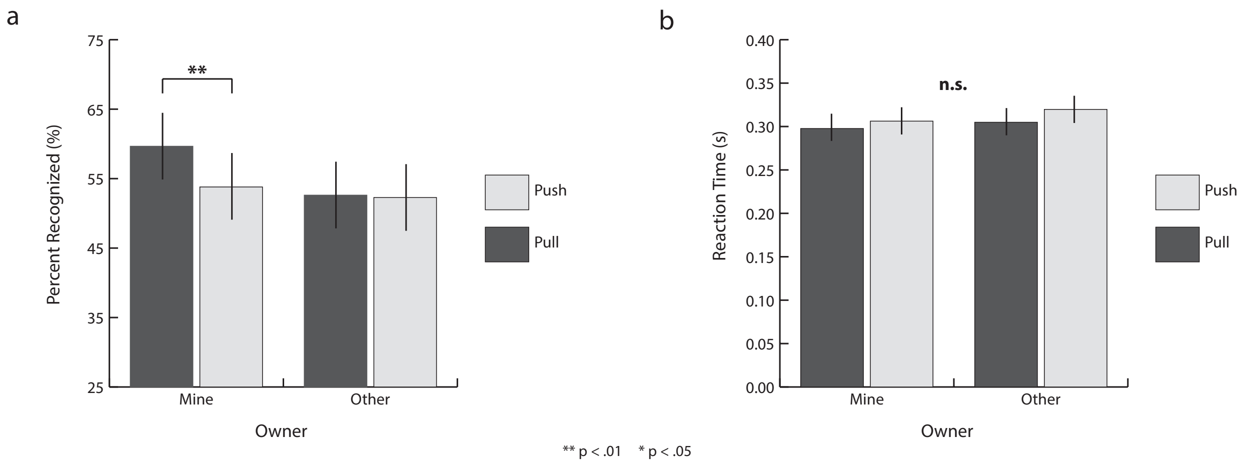

Figure 2.5. (a) Mean percent recognition scores as a function of ownership and action type for Experiment 3. (b) Mean reaction times for correct trials in the memory task as a function of ownership and target location for Experiment 3. Error bars represent 95% confidence intervals calculated for within-subject designs (Loftus & Masson, 1994).

Discussion

In Experiment 3, I manipulated the type of action required to sort self-owned and other-owned objects by having participants either pull or push the objects into adjacent target regions. This allowed a disentangling of the effect of motion-direction from motion-destination. Consequently, I found an action by ownership interaction that very closely mirrored the initial ownership by location interaction in Experiment 1: in addition to a significant and expected main effect of ownership, self-owned objects that were pulled (that is, moved towards the self) were subsequently recognized the most often relative to all other objects.

General Discussion

The self is a complex, multi-dimensional construct that wields influence on the processing of stimuli in the environment through a number of mechanisms. In the present study, I investigated two aspects of the self – physical and psychological – and examined their independent and interactive effects on cognitive processing. Experiment 1 showed that self-owned objects moved to a location close to the body are subsequently remembered significantly better than self-owned objects moved to a far location as well as other-owned objects moved to either location. Experiment 2 showed that the modulatory effect of relative body proximity is absent when participants only experienced the location manipulation passively. Lastly, Experiment 3 showed that pulling self-owned objects *towards* the self and not necessarily moving objects *near* the self leads to greater recognition. Taking these findings together, the data suggest that the physical, active self plays a vital role in moderating the cognitive enhancements afforded to self-owned objects.

What do the current results regarding ownership, proximity, and action tell us about the body's role in object ownership effects? The evidence is that enhanced object processing is seen only when the object is both self-related and self-moved towards the self. I believe the resultant self-relevance allows for a convergence between the *ability* to act on an object and the *desire* or *appropriateness* to act on objects that you own. Acting on an object through bringing it towards the body may enable the body to incorporate the object into an egocentric frame of reference in a way that is different than static objects already existing in peripersonal space. I argue that this represents a conjunction of two aspects of the self: as an actor and as a receiver. Here these aspects work together to prioritize certain objects – an effect that mirrors recent work with feeding behaviours showing that bringing food items toward the self specifically for the purposes of being a receiver (eating) results in different kinds of movements than those produced when the self is not the target of the action (Flindall &

Gonzalez, 2014). In other words, when you are the actor moving objects toward your own body as a receiver, self-relevance can literally be brought to attention.

From a theoretical perspective, the current data lend support to embodied theories of cognition which are centered on the physical self rather than abstract representations of self. For example, Markman and Brendl (2005) conducted a study in which participants pulled and pushed a lever to move positive and negative words on a computer screen towards or away from their name (an abstract representation of self). The authors found movements were faster for positive-towards/negative-away trials than negative-towards/positive-away trials regardless of movement direction. They argued that the representation of self (i.e., one's name) superseded the physical location of self. In contrast, the current work showing no memory enhancement for pushed self-owned objects suggests a disembodied view of cognition is not viable, a conclusion also reached by van Dantzig, Zeelenberg, and Pecher (2009) who found approach/avoidance movements do rely on relative distance between the physical self and a stimulus. Importantly, the use of real reaching/sorting movements on an immersive touch table serves as a more direct test of the influence of physical self than the lever actions in Markman and Brendl (2005).

Importantly, the presence of an ownership by action interaction in Experiment 3, and the functionally equivalent ownership by location interaction in Experiment 1, aligns with other recent studies examining the relationship between action, space, and self. For example, Constable, Kritikos, and Bayliss (2011) found a stimulus-response compatibility effect, demonstrating faster right responses for right facing mug-handles, but only for participants moving their own mugs and not the experimenter's mugs. Similarly, Lugli et al. (2012) observed faster sensibility discriminations during a sentence-judgment task, but only for positively-valenced words that moved toward the body. Collectively, these studies reveal an attentional asymmetry in which the influence of action works to stratify the saliences of stimuli associated with the self without impacting the relative salience of stimuli associated with another.

Across all three experiments, the “other” contrasting the self was the experiment’s research assistant, a choice that has been used previously (e.g., Constable et al., 2011) but not exclusively (e.g., Turk et al., 2013). In these experiments, the research assistant remained in the room but did not actively participate in the moving of objects or sit close enough to the participant to reach into his/her peripersonal space. Despite the relative detachment of the “other” from the experimental proceedings, the main effects of ownership appear to be similar in effect size to that of Cunningham et al. (2008) who did use an active but non-overlapping other. Had the research assistant partaken in the sorting task, there is evidence that suggests different results could emerge. Griffiths and Tipper (2012) found that when action environments are shared, one person’s movements affect the other person’s subsequent movements towards the same objects. Furthermore, participants’ perception of space can be altered as a function of observing another person moving in said space (Bloesch, Davoli, Roth, Brockmole, & Abrams, 2012). These behavioural and perceptual changes could affect object encoding; future research in needed to address these factors.

One plausible alternative explanation for the data emerges from previous research by Chen and Bargh (1999) who found that people are faster to push negative items away and pull positive items towards themselves. Combined with Beggan’s (1992) finding that self-owned objects are viewed more favourably than non-self-owned objects, one might expect an ownership by action interaction on the various movement related measures and perhaps in turn, some downstream effects on object recognition. This was not the case in the current work for a couple of possible reasons. First, Seibt, Neumann, Nussinson, and Strack (2007) found that push (and pull) movements can represent both approach and avoidance actions and are based on and sensitive to experimental context. Our task instructions framed the encoding phase as a “sorting task” and likely did not strongly signal either approach or avoidance motivations. Second, each trial required a movement towards the object followed by a movement to drag the object to a box. This complex two-part action may have diminished prospective latency-related effects.

More broadly, McClelland (1951) argued over half a century ago that ownership creates a strong connection between external objects and the people who possess them, and that such objects become part of the psychological self when they can be controlled in the same way as one’s limbs. In the decades since then, other researchers have discovered psychological processes are often embodied (e.g., Glenberg, 2010; Wilson, 2002), leading to greater recognition of the physical self as a key component to cognition. In the present work, I investigated the unique contributions of the psychological and physical self to the differential encoding of everyday objects. Crucially, I considered both the presence/absence of action and the type of action made during exposure to objects. The present results suggest that the act of bringing an already self-relevant object towards the self leads to greater cognitive processing for the object than merely having the object nearby. These findings reveal the distinctive way in which ownership, body, and action and interact, and reinforce the importance of seeing cognition as something that extends well beyond mere processes in the brain. In the next chapter, I turn to another aspect of self-relevance: its ability to prioritize attention to stimuli in the environment.

Chapter 3: Self-relevance through ownership engages an attentional set

Introduction

The goal of the present study was to examine the hypothesis that participants will show a prior-entry effect for objects that they have recently learned belong to them. In Experiment 1, participants completed a TOJ task in which pairs of stimuli contained one self-relevant (self-owned) item and one other-relevant (other-owned) item. Importantly, self-relevance was assigned to stimuli during the experiment itself. This *ad hoc* approach was key for two reasons. First, unlike previous experiments that have used what would be considered universally salient stimuli (e.g., angry faces), what is salient in this context is specific to the individual. Critically, selecting everyday objects and ascribing relevance online tests the prospect of “customizable” affective/motivational prioritization. Second, experimentally controlling the set of self-relevant stimuli attenuates the influence of other factors such as history with the items and self-selection issues. I hypothesized that participants would perceive self-owned as appearing prior to simultaneously presented other-owned objects.

While there is a sizable literature showing a bias towards the self on average, there is also growing evidence showing considerable variability among people in terms of the strength of these biases. Some effects that are driven by self-referencing may be affected by culturally-influenced construals of self as independent or interdependent (e.g., Feng, Zhao, & Donnay, 2013). For example, Chiao et al. (2009) found greater activation in the medial prefrontal cortex for individualists relative to collectivists during a self/other trait judgment task. The endowment effect, which indexes differential valuation of self-owned objects relative to other-owned objects, has also been shown to vary across cultural groups (Maddux et al., 2010). Therefore in addition to our main hypothesis, I also aimed to explore the notion of “self” as a construct that varies across cultures and contexts (Markus & Kitayama, 1991; Zhu & Han, 2008). With this body of work in mind, I explored several potential sources of individual differences in self-bias including self-construal, implicit ownership positivity, and loss aversion. If attentional biases for the self are modulated by the extent to which the self-concepts exist separately from concepts of others, the magnitude and direction of the bias should correlate with self-construal. In Experiment 1, I included a measure of self-construal to control for the possibility that self-related prior-entry effects might be a function of this explicit view of one’s self concept. Likewise, if attentional biases for the self are modulated by differences in valence or valuation of self-owned objects, the magnitude and direction of the bias should correlate with implicit positivity for self-owned objects or loss aversion, respectively. In Experiment 2 I aimed to replicate the results of Experiment 1 while examining the role of implicit biases in the value of self-owned objects on prior-entry effects. Experiment 3 controlled for potential confounds related to the structure of the task.

Experiment 1

Methods

Participants. Prior to data collection, a power analysis was performed to determine the necessary number of subjects. Assuming a moderate effect size (Cohen’s $d = 0.35$), moderate power ($1 - \beta = 0.80$), and a two-tailed single sample *t*-test, approximately 70 participants were required. Data collection ceased at the end of the academic term in which this minimum number was reached. This approach was applied to all three experiments.

A group of 102 University of British Columbia undergraduates was initially recruited to participate in the experiment in exchange for course credit. Exclusions were as follows: 16 participants were removed due to data recording errors related to software malfunction, six were outliers, five demonstrated abnormal psychometric functions (see Results), and two demonstrated and expressed severe difficulty in memorizing the stimulus categorizations. Participants were classified as outliers if their point of subjective simultaneity (PSS) estimates were larger than the largest stimulus offset asynchrony (SOA) or greater than 3 standard deviations from the group mean. In the end, 73 participants (57 women, Age: M= 20.27 years, SD = 2.69) completed the experiment. Participants had normal or corrected-to-normal vision, and provided written informed consent. This study was conducted with approval from the research ethics board of the University of British Columbia and in accordance with the provisions of the World Medical Association Declaration of Helsinki.

Stimuli and measures.

Object images. A total of 48 photographic images of everyday objects (e.g., eggplant, toothbrush) were used with permission from the Bank of Standardized Stimuli (BOSS; Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010). Each image was converted to grey-scale, sized to 7.5° by 7.5°, and displayed on a laptop monitor. Since low level visual properties like luminance alone can affect attentional orienting (Turatto & Galfano, 2000), the stimulus sets were constructed to control for such dimensions. The images were evenly divided into four stimulus sets (12 images/set), which did not differ in luminance, ($F(3, 44)$ = 1.05, p = .38), number of edges, ($F(3, 44)$ = 1.05, p = .38), contrast, ($F(3, 44)$ = 0.17, p = .92), familiarity ($F(3, 44)$ = 0.21, p = .89), and manipulability ($F(3, 44)$ = 0.40, p = .75). Values for these qualities were taken from (Brodeur et al., 2010). The selection of stimulus set for each ownership category was counterbalanced across participants and all images were set against a white background. During the TOJ task, the center of each object image deviated 6.7° to the left or right of the center of the screen. For the full list of stimuli, see Table 3.1.

Self-construal. In light of findings (e.g., Maddux et al., 2010) that show self-related biases can be attenuated by a more group-oriented view of the self, I measured self-construal via the Self-Construal Scale (SCS; Singelis, 1994). This questionnaire assesses independent (e.g., “I am comfortable with being singled out for praise or rewards”) and interdependent (e.g., “It is important for me to maintain harmony within my group”) self-construal as separate dimensions. Participants reported their agreement or disagreement with each statement on a 7-point Likert scale (*strongly agree* to *strongly disagree*). The SCS has satisfactory reliability, Cronbach’s α = 0.69 to 0.74 depending on sample and subscale (Singelis, 1994)

Table 3.1. Stimulus sets used for learning task, memory task, and temporal order judgment task for all three experiments.

Stimulus Set			
1	2	3	4
Eggplant	Cap	Mitten	Life Jacket
Shorts	Grater	Binder	Alarm Clock
Toy Dinosaur	Coconut	Bow	Drum
Swim Goggles	Honeydew Melon	Toy Tank	Radish
Box	Keyboard	Gum	Ribbon
Bandage	Comb	Violin	Orange Juice
Nail Clipper	Baseball	Ice Skate	Pliers
Hammer	Playing Card	Remote Control	Dice
Toothbrush	Vase	Pear	Toilet Paper
Telephone	Pill	Envelope	Shoe
Asparagus	Nail	Fork	Knife
Beer Mug	Pencil	Paint Can	Ruler

Procedure.

Learning task. The experiment was conducted on a PC laptop with a refresh rate of 60 Hz using the program Experiment Builder (SR Research, 2007). Participants sat approximately 40 cm away from the monitor.

For this first task, participants were told that they would be seeing a series of objects and that these objects either “belonged” to them (for the purposes of the experiment) or to the research assistant in the room. Next, they were told that the objective of the task was to memorize the object-owner categorizations. Importantly, participants were encouraged to use deep encoding methods such as thinking about what the “owner” of each object could do with their object (Craik & Lockhart, 1972).

Each trial began with a fixation cross presented in the middle of the screen for 800 or 1200 ms (randomly assigned per trial) after which an object image appeared in place of the fixation cross. At the same time, a colored border appeared around the object (green or blue, 0.38°), signaling the ostensible object owner. The association of border color and owner was counterbalanced across participants and the order of stimulus presentation was randomized within participant. Participants responded via mouse click (left or right) to indicate to whom the object belonged and had an unlimited response time, thus allowing for a relatively long period of encoding. Participants went through the full set of 24 objects (12 per owner) six times for a total of 144 trials. The research assistant monitored participant performance during this task to ensure participants did not accidentally switch the color-owner relationship. A schematic of a typical learning task trial sequence is shown in Figure 3.1.

Memory task. For this second task, participants were tested on their memory for the object categorizations. Each trial began with a fixation cross presented in the middle of the screen for 800 or 1200 ms, after which an object image appeared in place of the fixation cross. Participants responded via mouse click (left or right) whether they thought the object belonged to themselves or the research assistant. Accuracy feedback was given after every trial with explicit mention of object owner (e.g., “Correct! That object belongs to the research assistant!”). If participants were correct for all 24 objects, they proceeded directly to the TOJ task. If one or more trials were incorrect, participants redid the learning task and then the memory task again. Repeats of the learning and memory tasks continued until the participant categorized every object correctly. Thus all participants demonstrated perfect acquisition of the association between an object and it's "owner" prior to moving on to the temporal order judgment task. A schematic of a typical memory task trial sequence is shown in Figure 3.1.

Temporal order judgment task. Prior to the experimental trials, participants completed twenty practice trials of the TOJ task using shapes instead of object images. Between each block of experimental trials, participants completed the memory task to ensure retained memorization of object categorizations, although it is important to note that remembering the categorizations was orthogonal to performance on the temporal order judgment task.

Each trial began with a fixation cross presented in the middle of the screen, after which a pair of stimulus images appeared asynchronously, one in each visual field. Each pair consisted of one object owned by the participant and one object owned by the research assistant. The pairings stayed consistent throughout the experiment but were randomized across participants. The stimulus onset asynchronies (SOAs) were 16, 50, 83, and 116 msec, and were counterbalanced by object owner and by left/right side. These SOAs reflected the full range of difficulty in judging the temporal order of stimuli, with trials (SOA = 16 ms) in which objects seemed nearly simultaneous and accuracy performance was low as well as trials (SOA = 116 ms) in which the order of appearance was clearly discriminable and accuracy performance was high. After they appeared, both images were displayed together for 66 ms. The left/right locations of the self-owned objects were randomized within participants. Participants were given a maximum of four seconds to report which object appeared first (left or right) via keyboard press ("z" or "/"). Each factor combination (SOA x first object [self, other] x first side [left, right]) was repeated four times per block for six blocks for a total of 384 trials. A schematic of a typical temporal order judgment task trial sequence is shown in Figure 3.1.

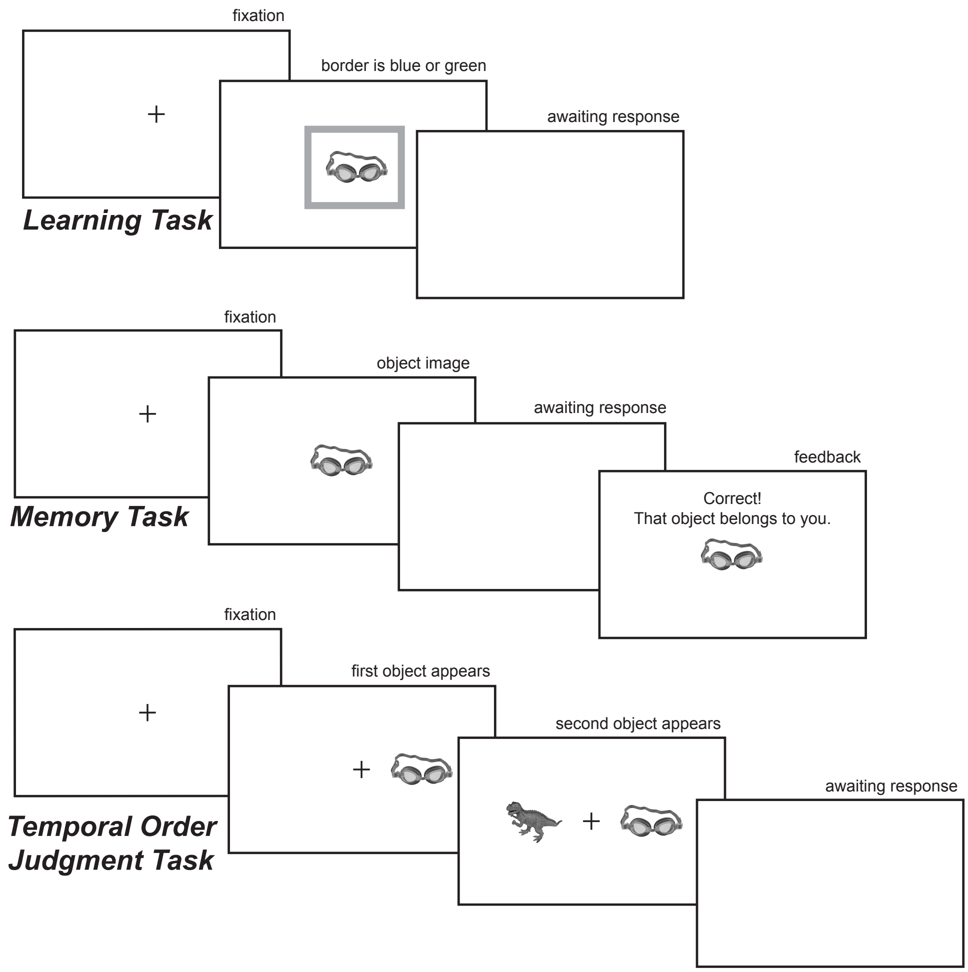

Figure 3.1. Typical trial sequences for the learning task, memory task, and temporal order judgment task. In Experiments 1 and 2, the colored border in the learning task signified “self” or “other”. In Experiment 3, the colored border signified “Group S” or “Group T”.

Results

For the following analyses, participants were excluded if they showed abnormal psychometric functions during the temporal order judgment task. Specifically, a subset of participants frequently reported the second stimulus as appearing first even at the largest (and therefore easiest) SOAs. This resulted in response curves (slopes) that were flat (i.e., insensitive to temporal order) or negative (i.e., reverse of normal responding). These participants may have been unable to perceive temporal order or they may have been responding pseudo-randomly during the TOJ task.

Memory task. On average, participants performed at ceiling on the memory task, with 74.00% of participants achieving perfect accuracy on the first attempt, 15.10% achieving ceiling on the second attempt, and only 10.9% needing more than two attempts. When there was an incorrect response during the first attempt, it was equally likely to be a “self-owned” trial as an “other-owned” trial, $t(72) = 0.34$, $p = .73$.

Temporal order judgment task. For each participant, trials in which participants pressed an irrelevant key (e.g., “M”) and trials in which reaction time was greater than three standard deviations greater than the participant’s own mean reaction time were excluded from analysis (on average, 2.05% per participant).

To determine whether there was a bias in responding during the TOJ task, a multi-level logistic regression was run using R’s *lme4* package (*R* Development Core Team, 2009; Bates, Sarkar, Bates, & Matrix, 2007) under restricted maximum likelihood. Using multi-level modeling enabled the estimation of a PSS bias for the “average” participant, while accounting for different numbers of trials, variability of slopes, and variability of intercepts across participants. The specific equations for the (logged, for ease of interpretation) model are as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1j}SOA_{ij} + \varepsilon_{ij}$$

$$\beta_{0j} = \beta_{00} + u_{0j}$$

$$\beta_{1j} = \beta_{10} + u_{1j}$$

Here Y_{ij} represents a participant’s (*j)* binary response in a given trial (*i*) as to which object in the stimulus pair appeared first according to their subject perception. SOA_{ij} refers to the stimulus offset asynchrony, the sole predictor in the model. The coefficients of interest are the model intercept (β_{00}) and the predictor slope (β_{10}), both of which were allowed to vary across participants (modeled by u_{0j} and u_{1j}, respectively).

On average, participants had a strong and expected relationship between SOA and perceived order (see β_{10} above), *B* = 0.021, *z* = 16.01, *p* < .001, confirming that participants had normal psychometric functions and were sensitive to the stimulus onset asynchronies. (Note: Due to the exclusion of participants who showed flat or negative slopes (see above for reasoning), the significance of the slope was inevitable and therefore not of key interest.) More importantly, the regression model also revealed that participants were significantly more likely to report that the self-owned object appeared first when the objects were presented simultaneously (model-implied SOA = 0, see β_{00} above), *B* = 0.11, *z* = 4.35, *p* < .001. Using the method proposed by Raudenbush & Bryk (2002), the model also revealed that this intercept value varied significantly between individuals, $\chi^2(71) = 26978.18$, *p* < .001. In order to correlate the TOJ bias with our measures of self-construal, I calculated the point of subjective simultaneity (PSS) for each participant using individually estimated logistic regressions. The PSS represents the effect size of the experiment as it quantifies the offset at which stimuli are perceived as appearing simultaneously. The average PSS derived from individually estimated logistic regressions was 5.72 ms (SD = 14.77 ms). In other words, this meant an other-owned object would need to be presented approximately 5.7 ms before a self-owned object in order to be perceived as appearing at the same time. Similarly, the average PSS derived from the multi-level model was 5.38 ms. (The difference between the two average PSS values arises from the weighting of participants by number of trials in the multi-level model.) Thus, as predicted, participants showed an overall prior-entry effect for self-owned objects (see Figure 3.2).

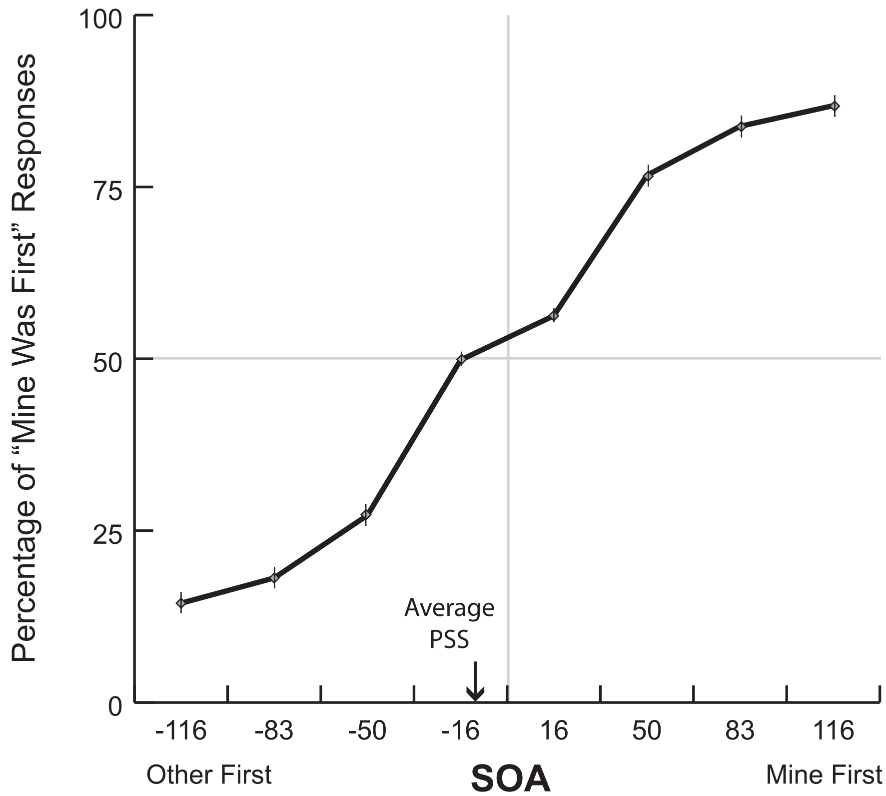

Figure 3.2. The average percentage of "My object appeared first" responses as a function of stimulus onset asynchrony (SOA) in Experiment 1. Error bars represent 1 standard error. The arrow represents the model-implied average point of subjective simultaneity (PSS). The average PSS reflects the average amount of time (according to the logistic regression analysis) that one object needs to be presented before another object in order to be perceived simultaneously. In Experiment 1, an other-owned object needed to be presented approximately 5.38 ms before a self-owned object in order to be perceived as appearing at the same time.

Self-construal and PSS. To control for the possibility that the prior-entry effect for self-owned objects was driven by individuals with a more individualistic self-construal, I examined the correlations between individuals' independent self-construal, interdependent self-construal, and prior-entry effect. Of the 73 participants included in the TOJ task analysis, two did not complete the measure of self-construal and were not included in the correlations between self-construal and PSS. For these correlations, a separate PSS was computed for each participant (see TOJ task results above for analytic approach). The correlation between independent self-construal and PSS was not significant, $r(69) = -0.037$, $p = .76$ (see Figure 3.3a). The correlation between interdependent self-construal and PSS was also not significant, $r(69) = 0.009$, $p = .94$ (see Figure 3.3b). Finally, the correlation between independent and interdependent self-construal was not significant, $r(69) = 0.088$, $p = .47$. Therefore, although there was substantial variation in the prior-entry bias for self-owned objects, the degree of bias was not associated with either dimension of self-construal.

In summary, results showed a reliable effect of prior entry for images of objects participants had learned to consider they owned, showing evidence of creation of a habitual attentional set previously observed only for arousing evolutionarily relevant stimuli. There was no evidence that individual differences were related to self-construal as independent or interdependent. Enactive approaches to self distinguish the investigation of the self as a third-person object of evaluation (self-as-object) from investigation of self as the first-person situated and embodied self we experience in daily life (self-as-subject) (Christoff et al., 2011). One possible interpretation of this null finding is that self-construal engages *explicit* evaluation of the self as object. In contrast, it has been proposed that ownership entails *implicit* incorporation of an object as an extension the first person self, or self- as subject. The goal of Experiment 2 was to replicate the primary finding while investigating additional explanatory variables.

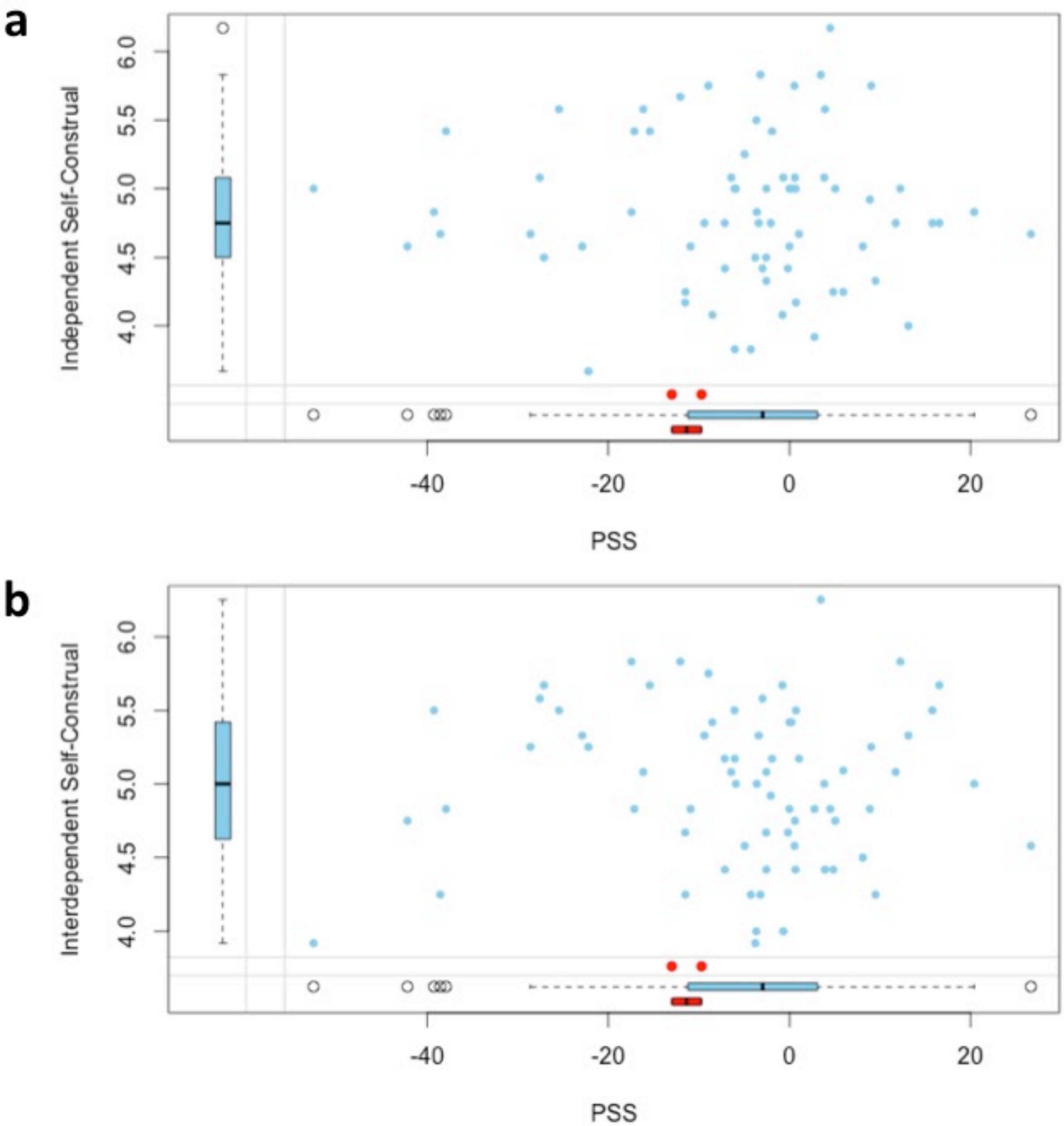

Figure 3.3. (a) Scatterplot of independent self-construal (SC) scores against individually-estimated PSS values in Experiment 1. The upper boxplot on the horizontal axis represents the distribution of PSS values, the boxplot on the vertical axis represents the distribution of SC scores, and the lower boxplot on the horizontal axis and data points outside of the plot margins represent the distribution of PSS scores for which there is no corresponding SC score. (b) Scatterplot of interdependent self-construal (SC) scores against individually-

estimated PSS values in Experiment 1. The upper boxplot on the horizontal axis represents the distribution of PSS values, the boxplot on the vertical axis represents the distribution of SC scores, and the lower boxplot on the horizontal axis and data points outside of the plot margins represent the distribution of PSS scores for which there is no corresponding SC score. For both plots, negative PSS values signify a participant was more likely to report that a self-owned object appeared first when simultaneously presented with an other-owned object (and vice versa for positive values).

Discussion

According to the enactive perspective of the self, a minimal first-person self-awareness distinguishes one's own body from its environment, making the fundamental distinction between self and not self central to the experience of owning an acting and perceiving body (Gallagher, 2000; Legrand & Ruby, 2009). This implicit first-person sense of self has been described as *self-as-subject,* in contrast with consideration of the self from the third person, or *self-as-object* (Christoff et al., 2011). Such a core self is also associated with internal somatically-based feeling states (e.g., Parvizi & Damasio, 2001). Moreover, it has been suggested that the first person perspective of self-as-subject can be extended to elements of the environment such as things that you own (e.g., Belk, 1988). For example, one's own objects are better remembered, and can elicit positive attitudes, even in the minimal context of experimentally defined ownership (Beggan, 1992; Belk, 1988, 1991; Cunningham et al., 2008; Huang et al., 2009; Van den Bos, Cunningham, Conway, & Turk, 2010). It has thus been suggested that we extend the cognitive and affective biases we feel for our selves to the objects that we own (Belk, 1988).

Whereas self-construals primarily reflect third person evaluation of the self-as-object, I reasoned that individual differences in attentional prioritization of self-owned objects better reflect ownership as an extension of self-as-subject. As such, they may be linked to individual differences in patterns of decision making such as loss aversion (the tendency to be avoidant of loss of what one already possesses, (Kahneman & Tversky, 1979)) associated with the sense of core self. Recent research by Charpentier and colleagues (Charpentier et al., 2016) indicates that individual differences in loss aversion are characterized by greater weighting of affective feelings in the case of losses than gains, which the authors speculate may reflect greater attention to feelings during losses. Here I wondered if individual differences in selective attention to one's own items would similarly translate into patterns of loss aversion in decision-making.

Experiment 2

In Experiment 2, in addition to the memory and TOJ tasks employed in Experiment 1, I did the following: (1) I measured *ownership-positivity* through an implicit associations test, indexing the degree of association between self-owned objects and positively-valenced words; (2) I measured loss aversion through a loss aversion task, which specifically indexes the degree to which participants weight losses as more important than gains. Unlike self-construal, implicit ownership-positivity and loss aversion involve affective and experiential dimensions of self, which may be more directly related to implicit attentional sets for owned objects.

Methods

Participants. 98 healthy undergraduate participants were initially recruited to participate in the experiment. Exclusions were as follows: seven participants were removed due to data recording errors related to software malfunction, seven were outliers with respect to their points of subjective simultaneity (PSS), and six demonstrated abnormal psychometric functions (see Results). In the end, 78 undergraduates (63 women, Age: *M* = 20.76 years, *SD* = 3.42) completed the experiment in exchange for course credit. Participants had normal or corrected-to-normal vision, and provided written informed consent.

Stimuli and measures.

Object images. The object images used for the training task, memory task, and temporal order judgment task were the same as Experiment 1. The stimulus onset asynchronies, counterbalances, and number of trials were also the same.

Implicit associations test. If the prior-entry effect for self-relevant objects is driven by an underlying bias for positively-valenced stimuli, reflecting a higher value assigned to self-owned objects, individual differences in the TOJ effect may be correlated with differences in the degree to which self-related items are implicitly considered to be positive. To index the degree of association between self-ownership and positive valence, participants completed a computer-based version of the Implicit Associations Test (IAT) adapted from Sriram and Greenwald (2009) and implemented through Inquisit (Version 4; Millisecond Software, 2014). Because greater priority was allocated to the TOJ task, participants always completed the IAT and the loss aversion task (see below) after the TOJ task. The object images were taken directly from the stimulus sets used in the temporal order judgment task and the participants were told that the owner-based categorizations for the objects were the same. The valenced words (12 positive, 12 negative) were chosen from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999). The group of positive words were not significantly different from the group of negative words based on absolute deviation from the valence scale midpoint, $t(22) = 1.30$, $p = .21$, word frequency, $t(22) = 0.43$, $p = .67$, number of syllables, $t(22) = 0.78$, $p = .44$, or arousal rating, $t(22) = 1.86$, $p = .08$. For the full list of valenced words, see Table 3.2.

The first block consisted of 24 my stuff/research assistant's stuff practice trials, and the second block consisted of 24 good/bad practice trials. The next two blocks had 24 test trials each of (my objects OR good) versus (research assistant's objects OR bad). The fifth block consisted of 24 (my objects OR bad) versus (research assistant's objects OR good) practice trials, and lastly, the sixth and seventh blocks each consisted of 48 test trials of those same trial configurations. Using the test trials, I calculated a D-score (Greenwald, Nosek, & Banaji, 2003) for each participant with positive D-scores coded as self-ownership-positivity and negative D-scores coded as other-ownership-positivity.

Loss aversion task. As reviewed above, the often-observed tendency to place greater weight in losses relative to gains (Kahneman & Tversky, 1979) may reflect a bias towards self-owned objects linked to attentional prioritization. I predicted that greater loss aversion would be associated with greater self-bias in temporal order judgment.

Participants completed a computer-based loss aversion task adapted from (Sokol-Hessner et al., 2009) and implemented through Inquisit (Version 4; Millisecond Software, 2014). In this task, participants made 140 hypothetical choices between two monetary amounts. Each choice consisted of a guaranteed amount and a binary gamble (P = 0.50). Of the 140 trials, 120 featured a guaranteed amount of $0 versus a gamble between a positive amount and a negative amount. The remaining 20 trials featured a guaranteed positive amount versus a gamble between a positive amount and $0. After each choice, the participant's decision was immediately enacted and an updated running total of "winnings" was displayed on screen. All 140 trials were later incorporated into a participant-specific choice model measuring loss aversion, also known as the degree to which losses are valued as greater than wins. For a full list of choices, see Table 3.3.

Table 3.2. Positively and negatively valenced words used for implicit associations test for Experiment 2.

IAT Valence Words	
Positive	Negative
Cheer	Useless
Friendly	Hostile
Excellence	Toxic
Success	Agony
Pleasure	Terrible
Delight	Misery
Joyful	Pain
Kindness	Ugly
Adorable	Tragedy
Honest	Disaster
Happy	Nightmare
Wise	Failure

Table 3.3. Monetary amounts in loss aversion task for Experiment 2.

Monetary amounts in loss aversion task	
Certain	Gamble
0	{2, 4, 5, 6, 8, 9, 10, 12} versus each multiplied by {-0.25, -0.375, -0.5, -0.625, -0.75, -0.875, -1.0, -1.125, -1.25, -1.375, -1.5, -1.625, -.175, -1.875, -2.0}
1	{2, 3} vs. 0
2	{4, 5} vs. 0
3	{7, 8} vs. 0
4	12 vs. 0
5	{12, 13} vs. 0
6	{12, 13} vs. 0
8	19 vs. 0
9	25 vs. 0
10	{22, 23, 25, 26} vs. 0
12	{26, 30} vs. 0
13	28 vs. 0

Results

For the following analyses, participants were excluded if they showed abnormal psychometric functions during the temporal order judgment task. Specifically, a subset of participants frequently reported the second stimulus as appearing first even at the largest (and therefore easiest) SOAs. This resulted in response curves (slopes) that were flat (i.e., insensitive to temporal order) or negative (i.e., reverse of normal responding). These participants may have been unable to perceive temporal order or they may have been responding pseudo-randomly during the TOJ task.

Memory task. On average, participants performed adequately on the memory task, with 52.56% of participants achieving perfect accuracy on the first attempt, 15.38% achieving ceiling on the second attempt, and 32.06% needing more than two attempts. When there was an incorrect response during the first attempt, it was equally likely to be a "self-owned" trial as an "other-owned" trial, $t(77) = 1.48$, $p = .14$.

Temporal order judgment task. For each participant, trials in which participants pressed an irrelevant key (e.g., "M") and trials in which reaction time was more than three standard deviations greater than the participant's own mean reaction time were excluded from analysis (on average, 8.04% per participant).

To determine whether there was a bias in responding during the TOJ task, a multi-level logistic regression was run using R's *lme4* package (*R* Development Core Team, 2009; Bates et al., 2007) under restricted maximum likelihood. On average, participants had a strong and expected relationship between SOA and perceived order, $B = 0.017$, $z = 14.10$, $p < .001$, confirming that participants had normal psychometric functions and were sensitive to the stimulus onset asynchronies. Again, the regression model also revealed that participants were significantly more likely to report that the self-owned object appeared first when the objects were presented simultaneously (model-implied SOA = 0), $B = 0.078$, $z = 3.45$, $p < .001$, thus replicating the prior-entry effect reported in Study 1. Using the method proposed by Raudenbush and Bryk (2001), the model also revealed that this intercept value varied significantly between individuals, $\chi^2(76) = 29067.97$, $p < .001$. In order to correlate the TOJ bias with our measures of loss aversion and our IAT measure, I calculated the point of subjective simultaneity (PSS) for each participant using individually estimated logistic regressions. The PSS represents the effect size of the experiment as it quantifies the offset at which stimuli are perceived as appearing simultaneously. The average PSS derived from individually estimated logistic regressions was 4.66 ms (SD = 19.47 ms). In other words, this meant an other-owned object would need to be presented approximately 4.6 ms before a self-owned object in order to be perceived as appearing at the same time. Similarly, the average PSS derived from the multi-level model was 4.56 ms. (The difference between the two average PSS values arises from the weighting of participants by number of trials in the multi-level model.) Critically, participants showed an overall prior-entry effect for self-owned objects, thus replicating the result from Experiment 1 (see Figure 3.4).

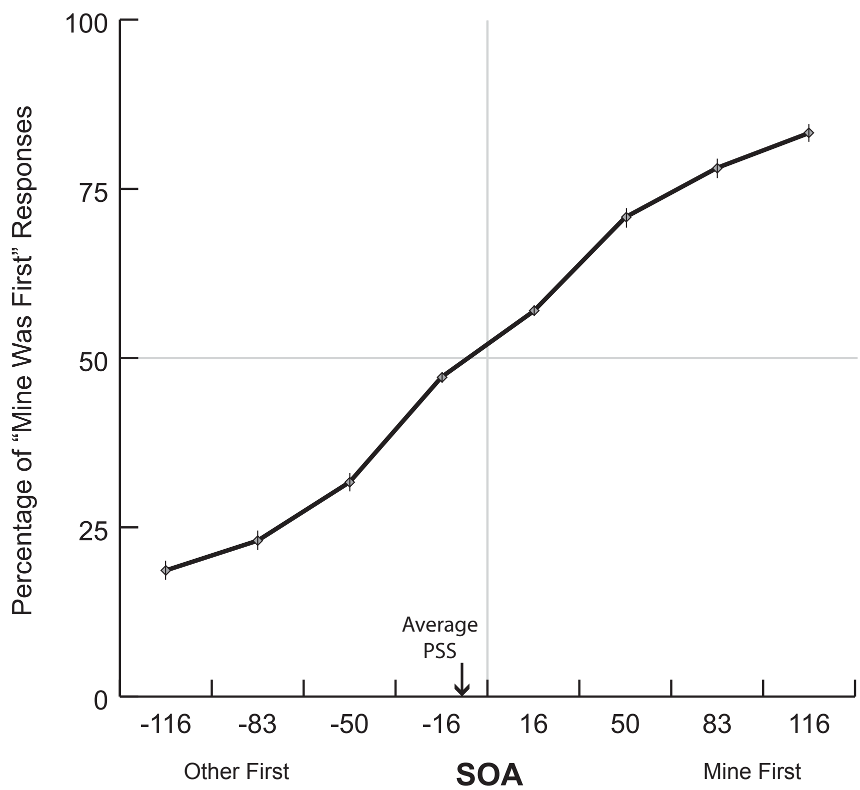

Figure 3.4. The average percentage of “My object appeared first” responses as a function of stimulus onset asynchrony (SOA) in Experiment 2. Error bars represent 1 standard error. The arrow represents the model-implied average point of subjective simultaneity (PSS). The average PSS reflects the average amount of time (according to the logistic regression analysis) that one object needs to be presented before another object in order to be perceived simultaneously. In Experiment 2, an other-owned object needed to be presented

approximately 4.56 ms before a self-owned object in order to be perceived as appearing at the same time.

Additional TOJ analyses. To assess the reliability of the prior entry effect, a split half correlation was computed for the PSS values from Experiments 1 and 2. Each participant's data was split into two halves through random assignment and a PSS value was computed for each half. There was a large and significant correlation between the halves, $r(149) = 0.76$, $p < .001$, suggesting strong internal reliability. Although the test for the intercept would be functionally equivalent to the test for "PSS = 0" due to the positive slopes constraint (see introduction to Results section), a secondary analysis examining the latter was done via a single sample *t*-test was conducted on the PSS values from Experiments 1 and 2. As expected, the average PSS was significantly different from zero, $t(150) = 3.67$, $p < .001$, 95% CI = [2.39, 7.96]. Separate *t*-tests for each experiment yielded the similar results ($t(72) = 3.31$, $p = .001$ and $t(78) = 2.36$, $p = .021$ for Experiments 1 and 2, respectively).

IAT and PSS. To measure the strength of association between self-owned objects and positive words, a D-score (Greenwald et al., 2003) was computed for each participant. Positive D-scores signified participants were more likely to associate positive words with self-owned objects, whereas negative D-scores signified participants were more likely to associate positive words with other-owned objects. Of the 78 participants included in the temporal order judgment task analysis, three did not complete the IAT and were not included in the correlation computations between implicit association of self and PSS. On average, participants had a moderate and significant association between self-owned objects and positive words (IAT D-score: $M = 0.60$, $SD = 0.37$, $t(74) = 13.98$, $p < .001$). The correlation between D-score and PSS was not significant, $r(73) = -0.033$, $p = 0.78$ (see Figure 3.5a).

Thus, although in general participants tended to implicitly associate their own objects with positive value, I did not observe a relationship between positive bias for self-owned objects and temporal bias for self-owned objects.

Loss aversion and PSS. A non-linear stochastic choice model (100 iterations) was conducted for each participant to estimate the degree of loss aversion during the loss aversion task, using the same parameter constraints as Sokol-Hessner et al. (2009). Although parameter estimates for risk aversion (ρ) and choice consistency (μ) were also estimated in the model, the key estimate extracted was that for loss aversion (λ).

Of the 78 participants included in the TOJ task analysis, nine did not complete the loss aversion task due to time constraints (e.g., participants arrived late) and were not included in this analysis. Furthermore, estimates of loss aversion for ten participants were extremely imprecise (i.e., standard errors greater than 1, compared to the remaining participants who had standard errors below 0.5) and were also excluded from analysis. On average, participants were loss averse such that the log-transformed λ (M = 0.11, SD = 0.20) was significantly different from zero, $t(58) = 4.32$, $p < .001$. Consistent with Sokol-Hessner et al. (2009), there was substantial individual variation in the degree of loss aversion (range of λ was 0.50 to 3.49). However, this variation did not correlate with PSS, $r(57) = 0.14$, $p = .29$ (see Figure 3.5b) for lambda and PSS, $r(57) = 0.10$, $p = .44$ for log-lambda and PSS. Thus, although participants were typically loss averse, as with the IAT I failed to observe a relationship between individual differences in loss aversion and the prior-entry effect for self-owned objects. However, it is important to note that while the correlational analyses revealed near-zero non-significant relationships, null correlations cannot unequivocally demonstrate orthogonality between the prior entry effect and psychological variables.

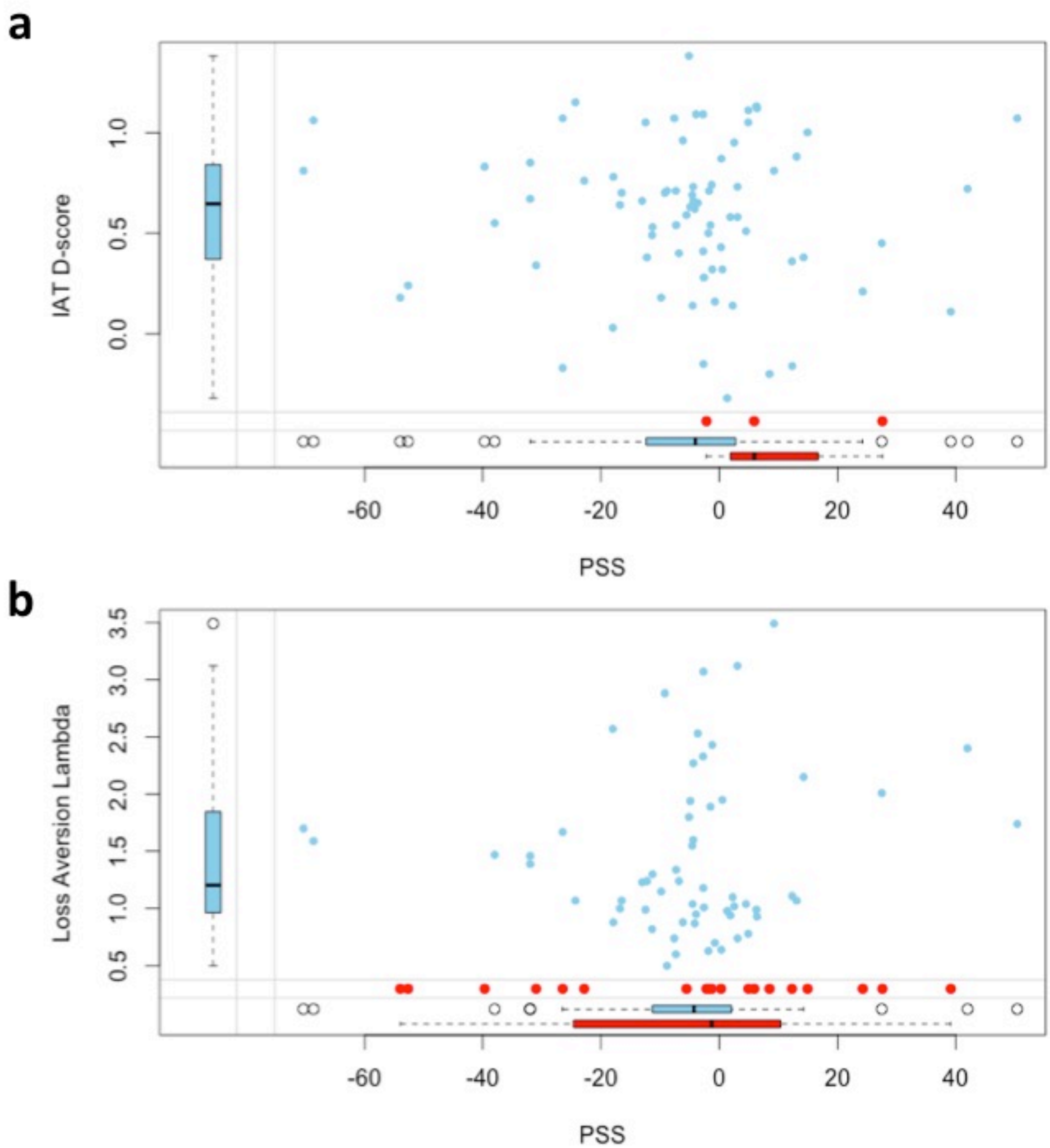

Figure 3.5. (a) Scatterplot of IAT d-scores score against individually-estimated PSS values in Experiment 2. The upper boxplot on the horizontal axis represents the distribution of PSS values, the boxplot on the vertical axis represents the distribution of IAT scores, and the lower boxplot on the horizontal axis and data points outside of the plot margins represent the distribution of PSS scores for which there is no corresponding IAT score. (b) Scatterplot of

lambda value from loss aversion task against individually-estimated PSS values in Experiment 2. The upper boxplot on the horizontal axis represents the distribution of PSS values, the boxplot on the vertical axis represents the distribution of lambda values, and the lower boxplot on the horizontal axis and data points outside of the plot margins represent the distribution of PSS scores for which there is no corresponding lambda value. For both plots, negative PSS values signify a participant was more likely to report that a self-owned object appeared first when simultaneously presented with an other-owned object (and vice versa for positive values).

Experiment 3

In Experiments 1 and 2 I replicated the prior-entry effect in both magnitude and direction, indicating that participants typically can develop an attentional set that prioritizes awareness of what they own. However, it is possible that the bias was observed for reasons not related to the self/other object categorizations. For instance, simply presenting a dichotomy may have caused participants to select one and give objects in one grouping greater attentional prioritization. To explore this possibility, in Experiment 3 participants were given the same learning, memory, and TOJ tasks as the previous experiments but with one exception: Instead of learning that the objects belonged to self or other, these participants were told that the objects belonged to Group S or Group T. Since the letters “S” and “T” do no have differential value in this experimental context, I predicted no prior-entry effect for either category.

Methods

Participants. 95 healthy undergraduate participants were initially recruited to participate in the experiment. Exclusions were as follows: six participants were removed due to data recording errors related to software malfunction, four were outliers with respect to their points of subjective simultaneity (PSS), and five demonstrated abnormal psychometric functions (see Results). In the end, 80 undergraduates (65 women, Age: *M* = 21.28 years, *SD* = 5.33) completed the experiment in exchange for course credit. Participants had normal or corrected-to-normal vision, and provided written informed consent.

Stimuli and measures. The object images used for the training task, memory task, and temporal order judgment task were the same as Experiments 1 and 2. The stimulus onset asynchronies, counterbalances, and number of trials were also the same.

Procedure.

Learning task, memory task, and temporal order judgment task. In order to examine the prior-entry effect in the absence of a self/other ownership distinction, the instructions for the learning task were altered. Instead of objects belonging to the participant or to the research assistant, the objects now belonged to “Group S” or “Group T” and were the same green and blue borders as the previous experiments (counterbalanced across participants). Participants were given the same amount of time as before to memorize the object categorizations. The visual and temporal parameters of the task remained unchanged. The instructions for the memory task also contained references to “Group S” and “Group T” and the instructions for the TOJ task did not require changes and therefore did not change.

Results

For the following analyses, participants were excluded if they showed abnormal psychometric functions during the temporal order judgment task. Specifically, a subset of participants frequently reported the second stimulus as appearing first even at the largest (and therefore easiest) SOAs. This resulted in response curves (slopes) that were flat (i.e., insensitive to temporal order) or negative (i.e., reverse of normal responding). These participants may have been unable to perceive temporal order or they may have been responding pseudo-randomly during the TOJ task.

Memory task. On average, participants performed adequately on the memory task, with 21.25% of participants achieving perfect accuracy on the first attempt, 16.25% achieving ceiling on the second attempt, and 62.50% needing more than two attempts.

Temporal order judgment task For each participant, trials in which participants pressed an irrelevant key (e.g., “M”) and trials in which reaction time was greater than three standard deviations greater than the participant’s own mean reaction time were excluded from analysis (on average, 9.09% per participant).

To determine whether there was a bias in responding during the TOJ task, a multi-level logistic regression was run using R’s *lme4* package (*R* Development Core Team, 2009; Bates et al., 2007) under restricted maximum likelihood. On average, participants had a strong and expected relationship between SOA and perceived order, $B = 0.016$, $z = 16.89$, $p < .001$, confirming that participants had normal psychometric functions and were sensitive to the stimulus onset asynchronies. More importantly, the regression model also revealed that participants were not significantly more likely to report that the Group S object appeared first (relative to Group T objects) when the objects were presented simultaneously (model-implied SOA = 0), $B = 0.02$, $z = 1.60$, $p = .11$. Using the method proposed by Raudenbush & Bryk (2002), the model also revealed that this intercept value varied significantly between individuals, $\chi^2(78) = 27951.54$, $p < .001$. Although I did not correlate the PSSs from Experiment 3 with any secondary measures, I calculated each participant’s point of subjective simultaneity in order to compute an effect size measure as well as for ease of comparison across experiments. The average PSS derived from individually estimated logistic regressions was 0.22 ms (SD = 11.07 ms), and the model-implied PSS was 1.40 ms. Thus, participants did not show an overall prior-entry effect for either Group S objects or Group T objects, suggesting the prior-entry effect for self-owned objects was not an artifact of a dichotomous choice (see Figure 3.6).

Lastly, as a cross-experiment comparison, I examined whether the PSSs significantly differed. Given that Experiments 1 and 2 were exact replications of each other, participants from these two experiments were combined into the same group. After adjusting for heterogeneity of variances (Levene's test: $F(1, 229) = 9.502$, $p = .002$), a t-test revealed that PSSs were significantly larger in Experiments 1 and 2 (and biased in the direction of self being perceived first) relative to Experiment 3, $t(220.949) = 2.64$, $p = .009$.

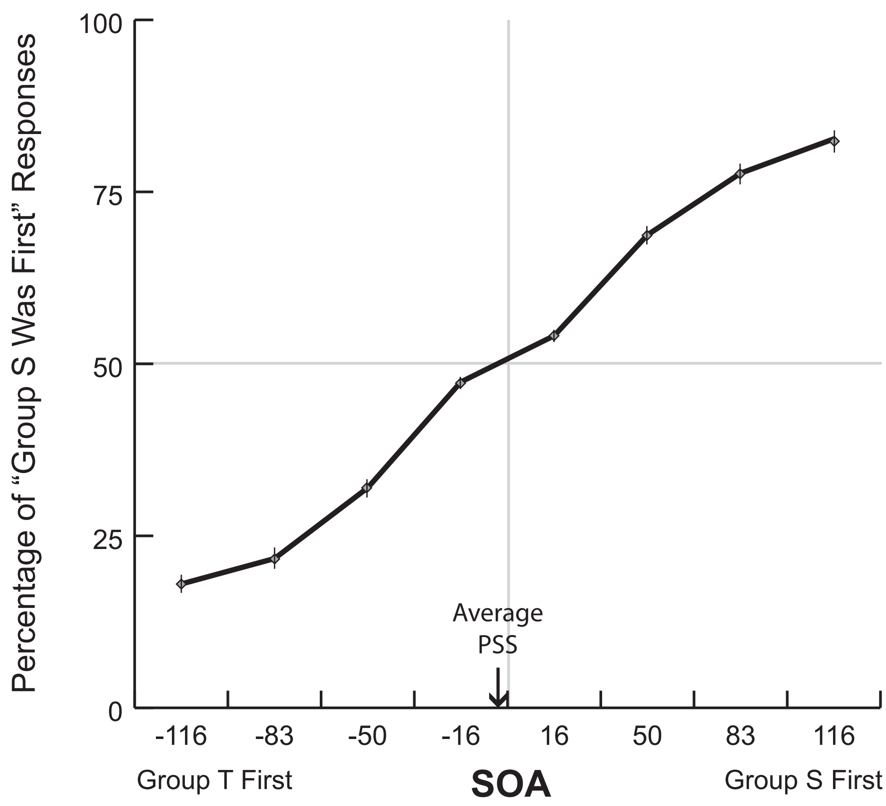

Figure 3.6. The average percentage of "The Group S object appeared first" responses as a function of stimulus onset asynchrony (SOA) in Experiment 3. Error bars represent 1 standard error. The arrow represents the model-implied average point of subjective simultaneity (PSS).

The average PSS reflects the average amount of time (according to the logistic regression analysis) that one object needs to be presented before another object in order to be perceived simultaneously.

General Discussion

In the present study, I employed a TOJ task to investigate whether people spontaneously engage implicit attentional sets for objects made personally relevant by ownership. Experiment 1 revealed that self-owned items elicit a prior-entry effect such that they are more likely to be perceived first when presented simultaneously with an other-owned item. Critically, since the sets of self-relevant stimuli were experimentally manipulated, this self-bias could not be explained by differences in low-level visual features or prior history with the items. I replicated the prior-entry effect in Experiment 2. Finally, in Experiment 3 I removed all mention of self and other and found no measurable bias, indicating that the prior-entry effect is not simply an artifact of our TOJ paradigm. Whereas previous studies have found prior-entry effects for more universally salient angry and fearful faces (West et al., 2009, 2010), I provide novel evidence indicating that implicit attentional sets for self-owned objects can be established rapidly in the lab. Building on previous findings that associations with self relevance are learned rapidly and durably, and elicit enhanced attention and memory *following* stimulus presentation (for review see Sui & Humphreys, 2015a; Humphreys & Sui, 2015b), the present findings suggest that ownership prioritizes attention in a manner similar to established sources of goals that modulate attentional sets so that we are more likely to perceive them in the first place. These include sources such as task relevance (Corbetta & Schulman, 2002) and emotional salience (Markovic et al., 2013; Todd et al., 2012). Although the average PSS was quite small (~5.2 ms), reported TOJ effects for emotionally arousing and universally salient stimuli such as schematic angry faces have also quite modest (~ 7.9 ms) (West et al., 2009). Indeed, the comparison between our self-relevant objects and angry faces is especially interesting and informative. Emotional faces are considered among the most universal of salient stimuli, possess featural regularity, and accumulate thousands of exposures over the lifetime. In contrast, the current stimuli were assigned self-relevance in the lab through minimal manipulation and with no reward conditioning and yet we still see a reliable average effect. Given the relatively low survival value of recently "acquired" images of objects compared to threats encountered in real life, the reliability of this twice-replicated finding is striking.

I propose that such prior entry effects for self-owned objects may be observed because items that are affectively salient are affectively salient precisely because they are by definition self-relevant. According to the enactive view of the self, a fundamental structure of sensorimotor and cognitive processing is the self/world distinction (Christoff et al., 2011; Legrand & Ruby, 2009). According to this view, the distinction is intrinsically motivational and affective, such that things perceived as beneficial to self and things perceived as detrimental to self are attentionally prioritized. Thus, as a source of prioritization, self-relevance may be superordinate to affect-biased attention. Future research can test this proposition by using computational modeling to disembed hierarchically embedded sources of prioritization.

The SAN model proposed by Humphreys & Sui (2015) would predict a key role for the vmPFC and parietal nodes of the ventral attention networks in establishing and maintaining attentional sets for self-relevant items. Future research can investigate whether the prior entry effect for self-relevant items is predicted by enhanced activity in this network prior to stimulus onset. Such predictions are also consistent with evidence that parietally-mediated priority maps that guide spatial attention are modulated by reward (Chelazzi et al., 2014) as well as evidence of biased activation patterns for stimuli with recently-learned reward value in sensory cortices (Pooresmaeili et al., 2014). In Experiment 2, while I did not pair self-owned objects with any type of reward, most participants demonstrated a positive association between their objects and positively-valenced words. This suggests that rapid acquisition of attentional sets for self-owned objects may be partly explained by their reward value. With the emergence of more theories positing integration between self-relevance and reward (e.g., de Greck et al., 2008; d'Argembeau, 2013), the characteristics of this relationship is in need of greater investigation.

The current work departs from much of the previous research on self-related cognition. Much work has focused on how relatively constant objective aspects of the self, such as viewing one's own face (Tong & Nakayama, 1999) or one's own name (Tacikowski et al., 2011) shape the orientation of attention. In contrast, building on previous work indicating self-relevance can be rapidly established (e.g., Sui & Humphreys, 2015), the present study examines an aspect of subjective self-relevance that changes over time. In other words, there is an element of continuity over time for one's name and face, but the sum of what objects are personally relevant at any given time can fluctuate widely. I sought to reflect this state of affairs by assigning self-relevance online to highly common objects. This design controlled for stimulus-related confounds traditionally associated with research on self-referential processing such as familiarity, pre-existing affective content, and elaboration. Furthermore, this methodological approach more closely mirrored real world situations in which what is significant to one person may be immaterial to another. In the end, the results suggest that attentional biases for self-relevant stimuli are not confined to longstanding representations of one's self as an object but can (quickly) incorporate any objects that are relevant to the self as a subject. Thus such self-related biases are flexible and context-specific.

Careful consideration was paid to the possibility that participants may have wanted to use behavioral "short cuts" during subjectively difficult trials. I took steps to combat this possibility such as equalizing the number of “self” and “other” objects to preclude differential base rates, strictly asking for whether the left or right object appeared first (as opposed to whether the self-owned or other owned object appeared first), and counterbalancing which objects were in each category on top of ensuring the categories did not differ on low-level properties. Moreover, other researchers have also examined this same issue and do not find that response biases can account for their effects. For example, West et al. (2009) did both “Which came first?” (Experiment 5) and “Which came second?” (Experiment 6) versions of their emotional face prior entry experiment. If participants were systematically choosing the angry face (over the neutral face) due to strategy rather than perception, one would expect a flip in the direction of the bias between the two experiments. In other words, choosing angry faces as a response bias would lead to a neutral face bias in the “Which came second?” experiment. However, the authors observed a PSS effect that still temporally favored angry faces. All things considered, the attentional bias in the present study is unlikely to have arisen from strategic responding.

The additional measures revealed that the prior-entry effect I observed was not driven by individual differences in explicit self-construal of oneself as independent versus interdependent. Although self-construal has previously been found to moderate the endowment effect (Maddux et al., 2010), it did not account for TOJ variability in Experiment 1. One possible explanation for the orthogonality between the prior-entry effect and self-construal may be that they are measuring different distinct dimensions of self (e.g., Christoff et al., 2011). Whereas the prior entry effect observed in the TOJ task reflected engagement of self as an active subject in cognition and action, the self-construal reflected self as object of perception and self-attribution. Consequently, they need not have been necessarily correlated and were in fact unrelated. In Experiment 2, although participants rated self-owned objects as overall more positive than other-owned objects, individual differences in implicit associations between self and positive value were unrelated to the prior-entry effect. This may be because associations for self-owned objects measured in our IAT task were too restricted in range to be sensitive to individual differences in the prior-entry effect. In Experiment 2, I also observed that measures of loss aversion were unrelated to the TOJ effect. Here, it is important to note that participants were making hypothetical monetary choices and were not paid at the end of the experiment. This may have skewed the loss aversion estimates since there is evidence that making choices that do not directly and monetarily impact oneself can alter one's behavior (e.g., Polman, 2012). Furthermore, the loss aversion task and the IAT were always completed after the TOJ task, therefore any potential additional biasing of one ownership category over the other caused by the TOJ task may have affected the results. In summary, the mechanisms that drive the prior-entry effect for self-relevant items remain an open and interesting question.

Future research can build on the present findings and examine the independent and interactive influences of self-relevance on the allocation of attention. As with self-relevance and reward (e.g., Sui & Humphreys, 2015a), there may be unique patterns of attention distribution when varying degrees of self-relevance are combined with stimulus properties such as differential valence, goal relevance, and featural complexity. In addition, stable and/or transient personological factors such as cognitive load (e.g., Turk et al., 2013), mood, and psychopathology (e.g., compulsive hoarding) may also augment or attenuate the attentional self-bias. Lastly, continued research on self-relevance expressed through objects will contribute to a comprehensive understanding of psychological ownership, which at present remains a pervasive yet poorly understood construct.

Whether at baggage claim or in a lab, we are constantly filtering information from the environment through the deployment of attention. The present research has shown that prior-entry effects hasten the perception of self-relevant objects even when self-relevance is recently established. These results suggest that implicit attentional prioritization is shaped both by what is vital for the species and what is vital for us personally, and that it can be rapidly developed in response to a changing environment. In the next chapter, I explore how changes in self-relevance affect attention to objects.

Chapter 4: Post-stimulus temporal effects of self

Introduction

Despite the ubiquity of changes in ownership in daily life, there is a gap in knowledge surrounding attention towards objects following changes in ownership. Specifically, it is unclear how attention to self-owned objects changes when such objects are no longer self-owned. The goal of the present study was to investigate whether self-relevance in the form of ownership exerts a temporal effect through its potential to “stick” to stimuli. In Experiment 1, participants first learned the ownership status of a set of everyday objects randomly assigned to belonging to the participant (i.e., self) or to the research assistant (i.e., other) in a “learning” task. In the second (“feedback”) task, participants were tested for recall on these categories until ceiling performance or a maximum of six attempts. Lastly, participants were told that the object ownership statuses had “switched” from self to other and vice versa. Participants had to report the “new owner” of each object in the third (“switch”) task. I hypothesized that participants would respond more quickly to objects they originally owned and the results from Experiment 1, as described below, supported this hypothesis.

Experiment 1

Methods

Participants. Prior to data collection, a power analysis was performed to determine the necessary number of subjects. Assuming a moderate effect size (Cohen’s $d = 0.35$), moderate power ($1 - \beta = 0.80$), and a two-tailed paired samples *t*-test, approximately 70 participants were required. Data collection ceased at the end of the academic term in which this minimum number was reached. This approach was applied to all three experiments.

A group of 84 University of British Columbia undergraduates was initially recruited to participate in the experiment in exchange for course credit. Exclusions were as follows: seven participants were run with a different number of objects in the stimulus set, two were removed due to software malfunction, and one participant left after realizing he or she was in the wrong experiment (after having completed the learning task). In the end, 74 participants (59 women, Age: *M* = 20.80 years, *SD* = 4.18) completed the experiment. Participants had normal or corrected-to-normal vision, and provided written informed consent. This study was conducted with approval from the research ethics board of the University of British Columbia and in accordance with the provisions of the World Medical Association Declaration of Helsinki.

Stimuli. The stimulus set included 24 digital images of frequently purchased everyday items (e.g., can opener, bananas, bagel). Each image was 250 × 250 pixels and contained a photograph of the item on a white background. For the learning task, a colored border around each image was used to cue ownership category. The borders were 25 pixels wide and were blue and red, and the assignment of color to ownership category (self, other) was counterbalanced across participants. Half of the objects were randomly assigned to be self-owned and the remaining objects were assigned to be other-owned. For the feedback and switch tasks, the same images were presented without colored borders. All images were presented centrally on a computer monitor.

Procedure.

Learning task. Participants were asked to imagine that they and the experimenter had just gone on a shopping trip together and that it was time to “sort” through the items based on owner. They were told that a colored border surrounding each image would signify the owner of each item and that they would need to sort each item via game controller button press. The button press/owner configuration was counterbalanced across participants. Participants were told ahead of time that they would be subsequently tested for their memory of the object categorizations and were encouraged to proceed through the task at a slightly slower place and deeply encode every object/owner pairing. Participants were verbally quizzed about the task demands before beginning the task. On each trial, a single object image was presented onscreen for a variable interval of 400-600 ms, at which point a colored border signifying the owner appeared around the image. The bordered image remained onscreen until the participant made a response or for a maximum of four seconds. Between trials, a fixation cross was presented in the center of the screen. Accuracy feedback was not provided during this task.

Feedback task. For this second task, participants' memory for the object owner categorizations was tested and reinforced. For each trial, an object image from the learning task was presented without a border in a randomized order, and participants responded via game controller button press indicating to whom they thought the object belonged. Participants were told to prioritize accuracy over speed; five seconds (per trial) was allotted for responding. After responding, participants received onscreen accuracy feedback ("Correct!/Incorrect! This object belongs to you/the experimenter!" for 500 ms) regardless of the correctness of their response. If participants achieved 100% accuracy on the task in the first pass through the stimulus set, the feedback task was terminated and participants proceeded to the switch task. If participants did not achieve 100% accuracy on the task in the first pass, a second pass through the stimulus set was administered, and so on until 100% accuracy was achieved or six passes (144 trials) through the stimulus set had been completed. Participants were informed of the ceiling performance requirement prior to beginning the feedback task and were encouraged to use the feedback to increase the chances of achieving ceiling performance in a fewer number of attempts/passes.

Switch task. In this last task, participants were told that all of the object owners had "switched" such that all of the objects that originally belonged to the participant were now owned by the experimenter, and vice versa. For each trial, participants saw an object image from the previous tasks and responded via game controller button press who currently owned the object. The button/owner assignments remained the same for this task as the previous tasks. That is, if the left trigger was assigned for "self-owned" previously, it was still assigned to "self-owned" for the switch task despite the objects themselves changing owners. Participants were given a maximum of five seconds to respond (per trial), were allowed to guess if they were uncertain, were instructed to prioritize accuracy over speed, did not receive feedback about their response, and only saw each stimulus images once.

Results

Reaction time. A paired samples *t*-test revealed that mean reaction times for correct trials in the switch task were significantly shorter for objects that were originally self-owned relative to objects that were originally other-owned, $t(73) = 2.74$, $p = .008$, mean difference = 136.03 ms (see Figure 4.1).

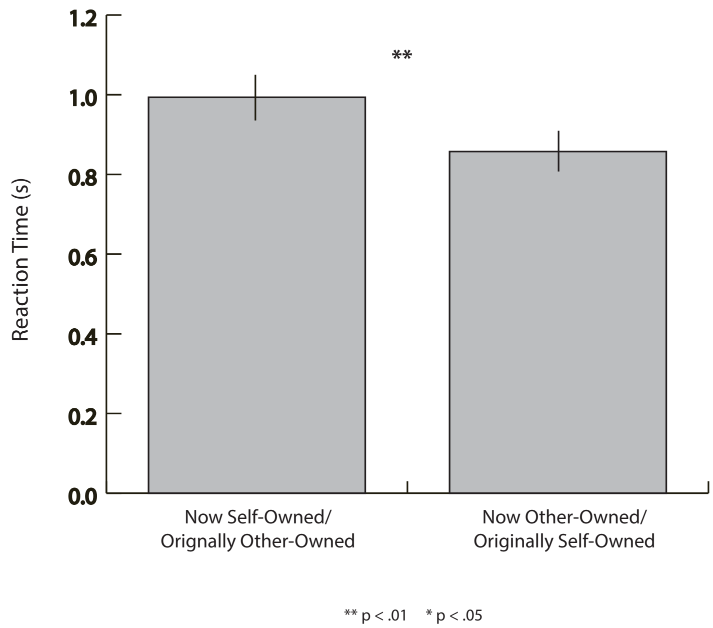

Figure 4.1. Mean reaction times of correct trials as a function of owner for Experiment 1.

Discussion

In Experiment 1, participants were significantly faster to correctly report the “new” owner of an object when they originally owned the object compared to when the experimenter originally owned the object. The present findings thus suggest that ownership as a form of self-relevance may act to tag stimuli as salient, which subsequently leads to faster responding to said stimuli when they are encountered at a later time. This interpretation would be consistent with the findings from Chapter 3 that suggest we can quickly and flexibly form attentional sets for self-relevant stimuli. Interestingly, these results would suggest that ownership can lead to faster responding regardless of what actual response is needed, given that the response required in the switch task was to report that objects that were originally self-owned were no longer self-owned. In this way, self-relevance is “sticky” in that attentional prioritization is maintained for an object despite a change in ownership status.

However, one potential confound arising from Experiment 1 was the issue of differential encoding. Although participants were told that they needed to memorize all of the object-owner pairings, some participants may have engaged in attentional shortcuts that could explain why items that were originally self-owned were associated with faster reaction times in the switch task. Specifically, some participants may have decided to only attend to stimuli that were self-owned during the learning task, potentially realizing that the presence of only two ownership categories meant whichever objects they did not attend had to be owned by the experimenter. A potential consequence of such a strategy would be differences in depth of encoding across ownership categories and, in turn, differences in responding during the switch task. Therefore, to better control for differences in initial encoding, I ran a second experiment in which I manipulated participants' encoding strategy. Specifically, participants were explicitly instructed to focus on either solely their objects or solely the experimenter's object during the learning task. If differential attention towards (originally) self-owned objects during the learning task could explain the results of Experiment 1, I would anticipate that overt instructions to attend to other-owned objects would yield a bias towards (originally) other-owned objects. However, if attention were not the main mechanism for the observed effect, I would predict a preserved self bias.

Experiment 2

Methods

Participants. 113 healthy undergraduate participants were initially recruited to participate in the experiment in exchange for course credit. Exclusions were as follows: one participant was removed due to the wrong set of instructions being given, one was removed due to software malfunction, and one participant was removed due to very poor performance (less than 10% accurate) in the switch task. In the end, 110 participants (81 women, Age: *M* = 20.61 years, *SD* = 2.51) completed the experiment.

Stimuli. The object images used for the learning task, feedback task, and switch task were the same as Experiment 1.

Procedure. The procedures for the learning task, feedback task, and switch task were the same as Experiment 1 with the exception of the instructions given prior to the learning task. After receiving instructions about the colored borders and the button responses, participants were given one of two sets of instructions about how to encode the objects. Participants in the "self focus" condition were told that, to make memorizing the object categorizations easier and more efficient, they should only focus on memorizing half of the objects – namely the objects they owned and that by default the objects that they did not focus on would be of the other-owned category. Participants in the "other focus" condition were told to focus on memorizing the objects the experimenter owned (for the same reasons as the self focus condition). Participants were verbally quizzed about these instructions prior to starting the learning task.

Results

Reaction time. A two-way between-within subjects ANOVA with instructions as a between-subjects factor and owner as a within subjects factor was conducted on the mean reaction time data for correct trials in the switch task. There was a significant main effect of owner, $F(1, 108) = 4.29$, $p = .041$, such that reaction times for correct trials in the switch task were significantly shorter for objects that were originally self-owned relative to objects that were originally other-owned (see Figure 4.2). The main effect of instructions was not significant, $F(1, 108) = 0.001$, $p = .98$, and the owner by instructions interaction was also not significant, $F(1, 108) = 0.016$, $p = .90$.

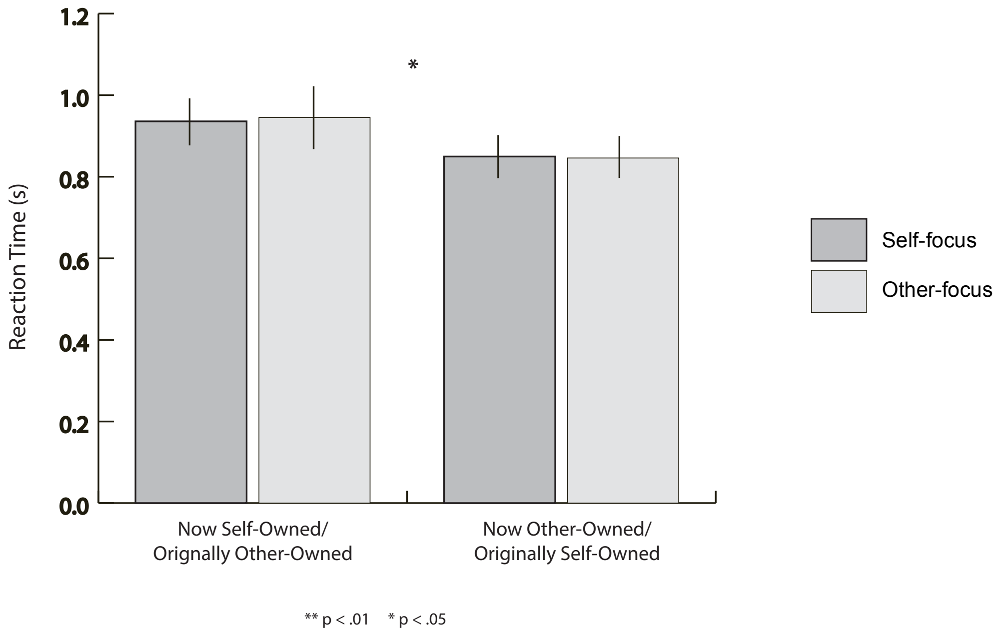

Figure 4.2. Mean reaction times of correct trials as a function of owner and instruction for Experiment 2.

As manipulation check of the instructions, data from the feedback task was analyzed. Specifically, trials from participants' first (and sometimes only) pass through the stimulus set were extracted since they best represented participants' encoding of the data prior to any recurrent feedback (i.e., feedback from having to do a second pass through the stimulus set). If participants' encoding of the objects was affected by the instructions, it would be reasonable to expect this to be evident in the feedback task data. For example, a participant who was instructed to focus solely on the other-owned objects would be expected to be faster to correctly respond to other-owned objects following encoding.

Reaction time during feedback task. A two-way between-within subjects ANOVA with instructions as a between-subjects factor and owner as a within subjects factor was conducted on reaction time during correct trials during the first pass of the stimulus set. There was no main effect of owner, $F(1, 108) = 0.002$, $p = .97$. Furthermore, there was no main effect of instructions, $F(1, 108) = 0.62$, $p = .43$. There was a significant owner by instructions interaction, $F(1, 108) = 15.41$, $p < .001$. Simple main effects analysis revealed that when participants were instructed to focus on self-owned objects, they were significantly faster to respond to self-owned objects compared to other-owned objects ($p = .007$). When participants were instructed to focus on other-owned objects, they were significantly faster to respond to other-owned objects compared to self-owned objects ($p = .006$). To the extent that speed of response during correct trials reflects a successful manipulation, the reaction time data were consistent with the intent of the instructions.

Discussion

In Experiment 2, participants were significantly faster to correctly report the “new” owner of an object when they originally owned the object compared to when the experimenter originally owned the object. This result replicated the “sticky” effect of the first experiment. There was no effect of instructions on reaction times in the switch task. To ensure that the instructions did influence initial participant behavior, a manipulation check was performed on the data from the first round of the feedback task. Participants were significantly faster at correctly responding to stimuli when the stimuli were the instructed focus of attention during encoding (e.g., faster for self-owned objects when in the focus-on-self condition).

The results of Experiment 2 were thus consistent with Experiment 1 and reveal that the self-other difference observed in Experiment 1 cannot be fully attributed to attentional strategy at time of encoding. Given these results, I asked how long this effect might last. In a third and final experiment, I investigated the temporal decay (or conversely, potential robustness) of the self bias observed in the previous two experiments. Specifically, much of the literature on ownership, self-relevance, and attention, including the studies described in Chapters 2 and 3, has examined the immediate effects of ascribing self-relevance to various stimuli (e.g., Cunningham et al., 2008; Constable et al., 2011; Sui et al., 2012; Ye & Gawronski, 2016). What remains relatively unknown is how stable those effects are. There is some evidence to suggest that the biases towards self-related items change over time. A meta-analysis by Symons and Johnson (1997) revealed that the self-reference effect increases as time between encoding and memory test increases, potentially as a result of consolidation. Likewise, studies on the endowment effect found that the value of a self-owned object increased as duration of ownership increased (Strahilevitz & Loewenstein, 1998; Ashby, Dickert, & Glockner, 2012). In contrast, however, a study comparing the strength of self-object associations (as measured by an implicit associations test) for already-owned and newly-owned objects found no difference in reaction times as a function of duration of ownership (LeBarr & Shedden, 2017).

In Experiment 3, participants were given the same learning and feedback tasks as the previous experiments and then either proceeded directly to the switch task or completed a ten-minute filler task and then completed the switch task. I examined whether performance changed for self-owned and other-owned objects across delay conditions, and specifically, I examined whether the difference between the self and other ownership categories changed across delay conditions. A second manipulation, switch condition, was also incorporated into Experiment 3. Half of the participants were instructed to switch object ownership for the last task, thus following the same general procedure as Experiments 1 and 2. The remaining half of participants was instructed to simply recall object ownership for the last task. By manipulating the required responses of the last task, I were able to investigate two important things. First, including a switch-absent condition yielded a “control” self-other difference, allowing for a comparison between decay of memory for static ownership status and dynamic ownership status. Second, including a switch-absent condition enabled us to determine whether the faster responding to objects that originally belonged to the self was more likely due to the object being initially associated with the self or more likely due to participants being faster to report that an object did not belong to them. If association with the self is the mechanism, then participants will be faster to respond to items that originally belonged to the self for both the switch condition (in which the response to those items would be “This object now belongs to the experimenter”) and the switch-absent condition (in which the response to those items would be “This object still belongs to me”). If quicker responding is the mechanism, then participants will be faster to respond to items that originally belonged to the self if in the switch condition (in which the response to those items would be “This object now belongs to the experimenter”) but faster to respond to items the originally belonged to the experimenter if in the switch-absent condition (in which the response to those items would be “This object still belongs to the experimenter”).

Experiment 3

Methods

Participants. 138 healthy undergraduate participants were initially recruited to participate in the experiment in exchange for course credit. Exclusions were as follows: three were removed due to software malfunction, and three were removed for very poor performance in the last task. In the end, 132 participants (111 women, Age: *M* = 20.58 years, *SD* = 2.45) completed the experiment.

Stimuli. The object images used for the learning task, feedback task, and switch task were the same as Experiment 1. The math filler task was a worksheet comprised of 126 basic math problems (involving addition, subtraction, multiplication, and division; see Appendix A).

Procedure. Participants were assigned to a time delay condition (delay present, delay absent) and a switch condition (switch present, switch absent). In the delay absent/switch present condition, participants completed the learning, feedback, and switch tasks exactly the same as in Experiment 1. The delay manipulation involved a ten-minute delay period that was inserted between the feedback task and the switch task. The selection of specifically ten minutes as the length of delay was based on a meta-analysis of the self-reference effect (Symons & Johnson, 1997) that examined changes in the magnitude of the self-reference effect as a function of time between period of encoding and memory test (TET). Given the modest effect size found (β = 0.21), ten minutes was chosen as it was approximately two standard deviations above the mean TET and represented a strong manipulation of delay. During the delay period, participants completed the math filler task. (They were not instructed to do the worksheet as quickly as possible.) If they finished the math task before the end of the ten-minute period, they were instructed to sit quietly for the remainder of the delay period. The switch manipulation involved participants reporting the “new” owners of the objects (like in Experiments 1 and 2) or reporting the original owners of the objects.

Results

The following data analyses are reported with labels referring to the original object owners (i.e., ownership as assigned during the learning task) and not to the final object owners (i.e., ownership during the switch task).

Reaction time. A three-way between-within subjects ANOVA with delay and switch as between-subjects factors and owner as a within-subjects factor was conducted on the mean reaction time data for correct trials in the third ("switch") task. There was a significant main effect of owner, $F(1, 128) = 22.34$, $p < .001$, such that reaction times for correct trials in the switch task were significantly shorter for objects that were originally self-owned relative to objects that were originally other-owned (see Figure 4.3). There was also a significant main effect of switch condition, $F(1, 128) = 67.60$, $p = < .001$, such that reaction times for correct trials in the switch task were significantly shorter for participants in the switch-absent condition relative to the switch condition. The main effect of delay was not significant, $F(1, 128) = 0.01$, $p = .95$. Furthermore, the owner by switch condition interaction was not significant, $F(1, 128) = 0.08$, $p = .78$, the owner by delay condition interaction was not significant, $F(1, 128) = 0.002$, $p = .96$, and the switch condition by delay condition interaction was not significant, $F(1, 128) = 0.12$, $p = .73$. The three-way interaction between owner, switch condition, and delay condition was also not significant, $F(1, 128) = 0.43$, $p = .52$.

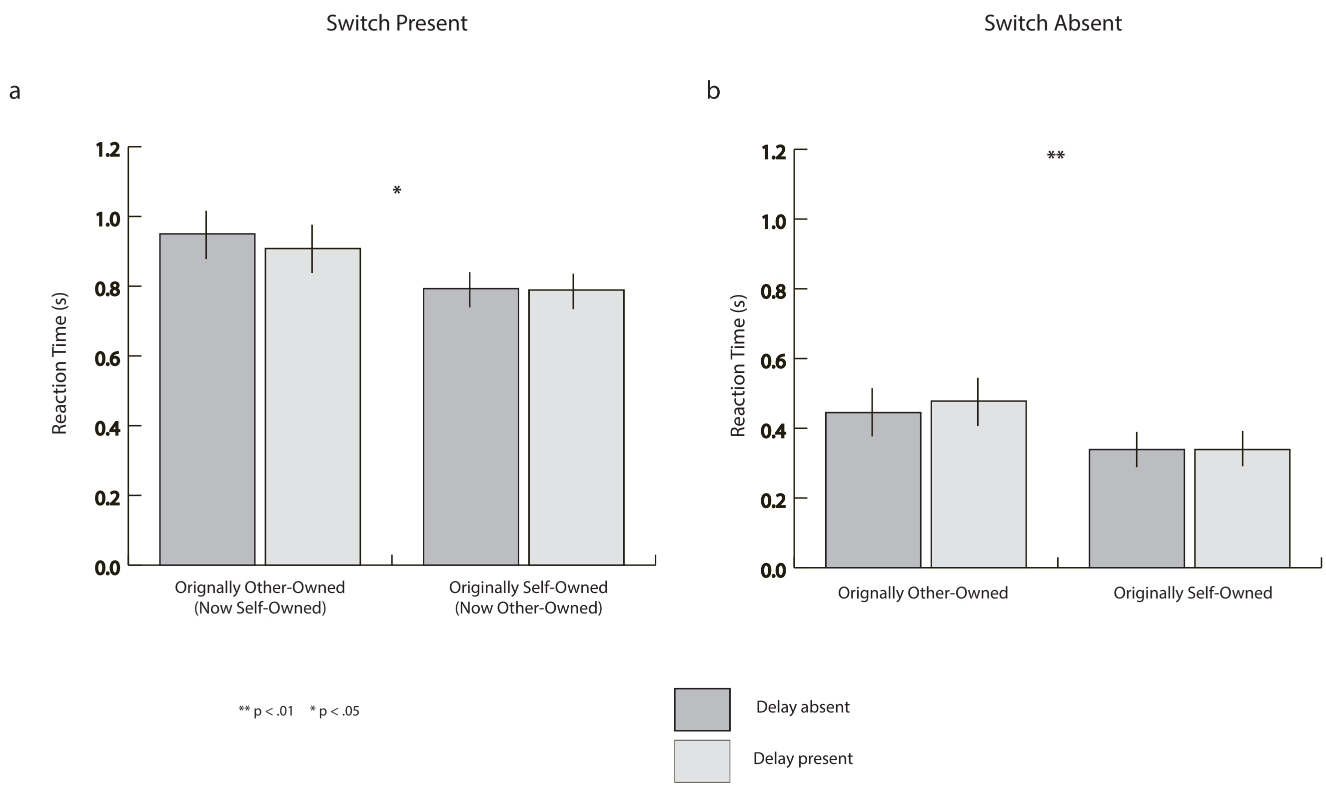

Figure 4.3. Mean reaction times for correct trials as a function of owner, delay condition, and switch condition for Experiment 3.

Discussion

In Experiment 3, participants were significantly faster to correctly report the owner of an object when they originally owned the object compared to when the experimenter originally owned the object. Furthermore, this effect was not moderated by switch condition, which means the effect was not dependent on the specific required response in the final task (i.e., responding "I own this object" versus "The experimenter owns this object"). This effect is consistent with the reaction times results of the previous two experiments and the implications of it are examined below in the General Discussion.

Participants were significantly faster to correctly respond in the third ("switch") task when they were in the switch-absent condition. This result was not surprising as the switch-absent condition meant participants only had to repeat what they had already learned and did not need to cognitively alter any object-owner knowledge. The switch manipulation affected accuracy in a parallel way, with accuracy being significantly higher for the switch absent condition relative to the switch condition.

There was no effect of delay on accuracy or on reaction times for correct trials. Moreover, the delay manipulation was not moderated by ownership or switch condition. This suggests that a ten-minute interval between learning/feedback and test was not sufficient to affect the pre-existing difference between self-ownership and other-ownership (or performance overall). Although the ten-minute delay was longer in duration than most delays in previous self-reference effect experiments (the closest analogue to the sticky effect, see Symons & Johnson, 1997 for a meta-analysis), it neither augmented nor diminished the reaction time difference between objects that were originally self-owned and objects that were originally other-owned. Future research could employ longer delay periods in order to determine the threshold for changes to the presently observed effects.

One potential reason for why the delay period failed to strengthen the reaction time difference between self-owned and other-owned objects may have been the inclusion of the filler task during the delay. Findings from a study by Turk and colleagues (2013) suggest that the ownership effect may depend on attentional resource availability. Using a similar paradigm to Cunningham et al (2008), participants in this study completed encoding phase trials in which they saw an image of an everyday item with a colored border around the image to denote the owner (the participant or a fictitious other student). A single digit number presented at the bottom of the screen accompanied each image. Participants responded to each object image by “sorting” the object into an appropriate onscreen “shopping basket” via keyboard press. Interspersed amongst the encoding trials were divided attention trials in which participants had to report either the number of even numbers presented (easy condition) or the complete sequence of preceding numbers in the order presented (hard condition). Participants in a full attention (control) condition were instructed to ignore the presented numbers.

During the test phase of the experiment, participants completed a two-step recognition memory test. For each trial, participants first indicated whether they recognized a given item from the encoding phase, then selected either “remember” if there was conscious recollection of seeing the object, “know” if there was a feeling of familiarity to the object, or “guess” if their response was a total guess. Participants in the full attention condition demonstrated greater recognition for self-owned objects relative to other-owned objects for “remember” responses but not “know” responses. In contrast, no such difference between self and other was found in either of the divided attention conditions. Notably, memory for other-owned objects did not differ by attention condition. The authors concluded that the ownership effect requires a threshold degree of attentional resources. With respect to the present work, the inclusion of a filler task may have created a divided attention situation that precluded the strengthening of the ownership/self-relevance effect. Future research could examine the effect of a time delay under undivided attention conditions.

General Discussion

In the present study, I examined whether the attentional biases afforded to self-owned objects hold or “stick” to stimuli when they are no longer self-owned. Experiment 1 showed that participants are faster to correctly respond that a self-owned object now belongs to someone else than to respond that an other-owned object now belongs to the self. Experiment 2 showed that the effect observed in Experiment 1 could not be fully explained by initial encoding strategy. Lastly, Experiment 3 showed that the difference between self and other was stable over a ten-minute delay and was more likely driven by stimulus self-relevance rather than response bias towards other-ownership. Taking these findings together, the data suggests that ownership can impart an attentional “stickiness” to objects such that objects that are initially self-owned receive greater attention (compared to objects that are initially other-owned) even when they are no longer self-owned. The current findings provide novel evidence that not only do self-owned objects receive more attention initially, they also retain an attentional advantage over other-owned objects after they are no longer self-owned. Furthermore, the retained (“sticky”) advantage holds for at least ten minutes and cannot be fully explained by strategic encoding. These findings suggest that the effects of ownership on attention are not limited to the instant at which “it” becomes “mine” but extend through time and also affect how objects are cognitively processed after they become another person’s possessions. Based on the results of these experiments, attention allocation appears to lag factual ownership.

One limitation of the present work lies in participants’ internal schema during the experiment. In the instructions for the switch task, participants were instructed to mentally switch the ownership categorizations of all of the objects so that objects that were originally self-owned were subsequently other-owned and vice versa. This ownership switch occurred without the response buttons also switching, which meant that an object that was originally self-owned may have required a “left trigger” response in the learning and feedback tasks and a “right trigger” response in the switch. It is possible that some participants did not mentally switch ownership categories at all and instead made a response switch. For example, they may have made self-left/other-right mappings during the first task and self-right/other-left for the switch task. Though the extent to which response switching occurred could not be ascertained, it is still noteworthy that participants who may have engaged in response switching (rather than ownership switching) were better able to make a response switch for objects that were originally self-owned.

Future research can build on the present findings by exploring the temporal limits of the observed “sticky” effect. For example, in Experiment 3 the time delay was inserted between the feedback task and the switch task. Critically, the filler task was completed before participants were informed about the ownership switch. This was done to investigate whether increasing the duration of ownership could potentially augment the original effect. However, in a potential follow-up experiment the participants could be informed of the switch before completing a filler task. This would enable us to gauge how long a participant would need to know an object was no longer self-owned in order to treat it as if it were not theirs. Relatedly, a second avenue for further research would be examining the electrophysiological signature of the sticky effect. Previous research shows the P3 event-related potential (ERP) component is greater in mean amplitude for self-referenced stimuli relative to other-referenced stimuli (Berlad & Pratt, 1995; Gray et al., 2004; Esslen et al., 2008; Turk et al., 2011; Truong et al., 2013). I would hypothesize that the amplitude of the P3 in response to seeing an object during the switch would be larger for objects that were originally self-owned compared to objects that were originally other-owned. However, one might expect that the difference in P3 components would attenuate if participants were given informed of the ownership switch long before beginning the switch task.

The ubiquity of the marketplace in western societies has produced millions of transactions and with that millions of changes in ownership. Whereas previous research has focused on the impact of acquiring self-relevance through ownership, the present work examined how the initial attentional bias towards self-owned objects is affected by a change in ownership status. These results suggest that objects originally owned by the self are still responded to more quickly than objects originally owned by another person. Moving forward, further research should investigate the cognitive dynamics of ownership across time and across owners.

Chapter 5: General discussion

My dissertation aimed to examine how the heightened attentional saliency that objects receive through psychological ownership is manifested or altered by broadening the scope of the self to include the body and the persistence of self-relevance across time. In Chapter 2, I investigated how the physical body moderates the previously observed ownership effect in which self-owned objects are recognized more than other-owned objects. I found that pulling a self-owned object towards the self (i.e., one's physical body) significantly increased subsequent recognition relative to both pushing/pulling on other-owned objects and pushing a self-owned object away from the self. Crucially, simply having a self-owned object near the self was not sufficient to generate this interaction. This suggests that the spatial/bodily component of the self does impact attention to owned objects but that this impact depends on the body's ability to act on objects in space. In Chapter 3, I investigated how self-relevance can influence temporal perception through attentional prioritization due to affective salience. Using a temporal order judgment task, I found that self-owned objects elicit a prior entry effect such that they are more likely to be perceived first when simultaneously presented with an other-owned object. Individual differences in the magnitude of the prior entry effect were unrelated to self-construal, implicit ownership positivity, and loss aversion. These findings suggest that self-relevant stimuli such as objects we own can engage an attentional set that biases attention deployment and, in turn, subjective perception. In Chapter 4, I investigated how changes in ownership affect subsequent responding to owned objects. I found that when ownership categorizations are changed, objects that were originally self-owned maintained a reaction time advantage over objects that were originally other-owned. The "stickiness" of initial ownership could not be fully accounted for by strategic encoding and persisted over a ten-minute delay. This suggests that the effect of ownership as form of self-relevance is moderately robust over time as well as changes to self-relevance that can occur across time. In the next section, I will examine how the current findings fit into extant understandings of self-related attention.

Support For and Extension of Existing Models of Self-Related Attention

Recently, Humphreys and Sui (2015) proposed the Self Attention Network (SAN) as a neural substrate of self-biased attention. Drawing from their own previous work (Sui, Rothstein, & Humphreys, 2013; Sui, Liu, Mevorach, & Humphreys, 2013; Mevorach, Hodsoll, Allen, Shalev, & Humphreys, 2010) as well as that of others (e.g., Bar et al., 2006; Gronau, Cohen, & Ben-Shakhar, 2003), Humphreys and Sui proposed that the vmPFC is a node for self-representation that biases attention towards self-relevant stimuli via excitatory connectivity with the posterior superior temporal sulcus (pSTS). In situations where deployment of attention towards self-related stimuli is not called for (e.g., when the correct response is to ignore the self-representational stimulus), the attentional control network inhibits self-representations in a top-down manner (though this would not preclude *all* self-related information from being processed and perceived). Sui and Humphreys also claim that individual and group differences in self-related processing are instantiated via modulation of the SAN through experience, culture, and social context.

The SAN's inclusion of the VMPFC as a node for self-representation is consistent with the aforementioned body of work examining the neural correlates of self, and has been received positively by other researchers in the field (Conway, Pothos, & Turk, 2015). Nevertheless, it may not be a complete model for understanding how self-relatedness or self-relevance modulates attention. The studies cited by Humphreys and Sui (2015) involved recognition of an identifiable representation of self. Specifically, these studies utilized faces (e.g., Tao, Zhang, Li, & Geng, 2012), names (e.g., Harris, Pashler, & Coburn, 2004), and shapes (see Sui et al., 2012 above) in various contexts. These works and related works are undoubtedly important in understanding how the self biases attention, but they utilize solely non-agentic characterizations of self (i.e., self as object, as mentioned in Chapter 3). As the experiments in Chapters 2 and 3 demonstrated, the bodily/agentic self has independent and modulatory influence over attention to objects and thus should be included a comprehensive model of how the self biases attention. I propose that an alternative perspective for understanding how ownership (as a form of self-relevance) affects attention to objects should include mechanisms that involve both self as object and self as subject. As previously established by others, ownership can exert an influence on one's perspective on self-as-object, which in turn can tune attention and generate prioritization effects. Such effects can operate either over the long term or be rapidly acquired. In addition to these effects, some of the potency of rapidly acquired ownership may be because ownership fundamentally changes the salience of a given object – arguably increasing its value by altering the set of potential actions the object affords. The agentic self that perceives and acts on the environment wields a distinct impact on attention, adding increased salience to items that can be acted upon (e.g., Handy, Grafton, Shroff, Ketay, & Gazzaniga, 2003). In this way, ownership acts to stratify the salience of objects that have otherwise equal action affordances. To this end, the self as subject can impact attention to the immediate environment ("What can I act on now?") and more broadly across contexts ("What can I act on in general?"). Ownership through permission to act may serve to constrain action selection to specific actions that meet short-term goals. If it is mine I can eat it or drink it for survival and/or pleasure, I can wear it for warmth and to attract love and attention, or I can use it as a tool for any number of short-term goals in the service of motivational goals of surviving and thriving. Over the long term the two aspects of self (subject and object) may demonstrate a bidirectional relationship in which one aspect of self can influence how the other orients itself to objects in the world. For example, it may be that repeated interactions with an unowned object leads to increased feelings of ownership over the object and increased identification of said object with one's concept of self-as-object. Finally, the two aspects of self elicited by ownership are not equally represented or equally influential in all situations. Situations in which action-oriented cognitive processing is emphasized may lean more heavily on self as subject than self as object. Future research can test these proposals directly.

Points of Consideration

In the following sections, I now turn to several key questions and issues that arise from my thesis that were not addressed within any of the specific data chapters, but warrant examination as overarching points of consideration regarding the methods I have employed and the findings I have reported.

Stimulus choice and ownership manipulation

Across all experiments, the stimuli used were photographic images of everyday objects and not actual physically present ("real") objects. The choice to use photographs of images was driven by two main reasons. First, the use of photographs allowed for greater control over stimulus properties like size (i.e., subtended visual angle), and visual consistency. (Many items were perishable foods that would have deteriorated over the course of data collection). Stimulus onscreen time was a particular crucial variable for the temporal order judgment tasks of Chapter 3 and would not have been sufficiently controlled without the use of computer-based stimulus presentation. Second, presenting photographs allowed for many more trials in a given period of time because there was no need to physically remove and replace items between trials or instruct the participant to look at different spatial locations from trial to trial. Despite the advantages of using photographs and the existence of non-physical possessions (e.g., ownership of online-only items), the stimuli lacked ecological validity.

The use of object images over real objects may matter for two reasons. Several studies on attention for or encoding of objects have used real objects as stimuli (e.g., Dirks & Neisser, 1977; Mandler, Seegmiller, & Day, 1977; Pezdek, Roman, & Sobolik, 1986; Droll & Eckstein, 2009), with some comparing real objects to two-dimensional photographs (Riddoch & Humphreys, 1987; Snow et al., 2011). In experiments comparing real objects to two-dimensional pictures, real objects were more likely to be recognized than objects in picture form by patients with visual agnosia (Young & Ellis, 1989; Chainay & Humphreys, 2001). In a study involving neurotypical subjects, participants viewed either real objects, photographs of objects, or line drawing of objects, and were given a surprise memory test following stimulus presentation (Snow, Skiba, Coleman, & Berryhill, 2014). Participants recalled significantly more real objects relative to photographs and line drawings, even after controlling for viewing distance and this effect held for different stimulus types (i.e., tools, non-tools, natural kinds, etc.). Given the experimental design similarities between this study and the experiments in Chapter 2, this finding would suggest that recognition memory would be higher overall if real objects were used in place of photographs. However, since there was no ownership manipulation, Snow et al.'s (2014) results cannot speak to whether the use of real objects would differentially affect self-owned/other-owned stimuli.

The use of photographs instead of real objects as stimuli may have also affected the way participants physically acted on the stimuli in Chapter 2. The results of those experiments mostly showed no differences across conditions in how the participants acted on the objects, at least in terms of movement onset latency and how long movements lasted. This may have been in part due to the artificiality of the stimuli. A study by Constable et al. (2011; later replicated in Constable, Kritikos, Lipp, & Bayliss, 2014) found that when participants moved mugs that were theirs (given to them by the experimenters), they moved their own mugs closer to their body and did so with more force than with mugs that were not their own. Had the present work employed real objects instead of photographs, participants may have acted on the stimuli differently and in turn shown different patterns of subsequent recognition. Furthermore, research in the fields of marketing and consumer behavior has shown that physical interaction with products (relative to descriptions and images of products) leads to differences in ownership-related outcomes such as willingness to pay (Reb & Connolly, 2007; Bushong et al., 2010), purchase intentions (Schlosser, 2003), and consumer preference (McCabe & Nowlis, 2003). Moreover, work by Peck and Shu (2009) has found that touching (real) objects can increase the sense of perceived ownership of said objects. Had participants in Chapter 2 moved real objects, the ownership effect may have been even stronger.

Across all experiments, the manipulation of object ownership was imagined. Participants only imagined that objects belonged to themselves or to the experimenters and did not actually take home any of the items that were ostensibly self-owned. While some studies on the psychological effects of ownership have utilized “real” ownership (e.g., Strahilevitz & Loewenstein, 1998; Reb & Conolly, 2007; Constable et al., 2011; Ye & Gawronski, 2016), the use of imagined ownership is not an uncommon choice (e.g., Cunningham et al., 2008; Huang et al., 2009; Krigolson, et al., 2013; Englert & Wentura, 2016; Gregg, Mahadevan & Sedikides, 2017). However, there may be the question of whether it would be reasonable to expect different results had participants experienced real ownership rather than imagined ownership. It is important to recall that the ownership effect investigated in the current work is an extension of the more general self-reference effect, a phenomenon that was first studied using trait adjectives. Unlike objects, trait adjectives and the personality traits they reference cannot be owned in any particular sense and yet still show a robust self-reference effect, suggesting that there only needs to be some form of linking between the self and a stimulus in order to produce a self-bias. In this regard, imagined ownership appears to a sufficient method of linkage. If the relationship between real and imagined ownership parallels the relationship between real and imagined/visualized objects, any effects arising from imagined ownership would likely be enhanced but not fundamentally altered by the use of real ownership.

Concerns regarding similarity to self and self-construal

The current studies used the research assistant in the room as a specific non-fictional "other" for participants to think about when imagining owning or not owning the stimulus objects. As briefly mentioned in Chapter 2, using the experimenter as the "other" is a common choice but it is far from the only choice employed in self-referencing and ownership research. (For a more comprehensive sampling of "others" used in neuroimaging studies on the self, see Appendix B.) For example, Kelley et al. (2002) asked participants to judge whether certain personality traits were descriptive of themselves, and whether these traits were descriptive of President George Bush. D'Argembeau et al. (2005) chose three famous people for the "other" condition: French president Jacques Chirac, French singer Johnny Hallyday, and the Belgian princess Mathilde. By choosing prominent individuals for their non-self conditions, these researchers effectively "level the playing field", roughly equalizing the degree of familiarity and intimacy the participants have for the comparator. Although electing to use a famous person eliminates some differences across participants, it allows for potentially huge differences within participants, with the self condition having far richer pools of experiences, memories and connections from which to draw during referencing or reflection. As such, others researchers have opted instead to have participants reference close others (e.g., Schmitz, Kawahara-Baccus, & Johnson, 2004; Devue et al., 2007; Raposo, Vicens, Clithero, Dobbins, & Huettel, 2010; Wang et al., 2012).

The issue with choosing a particular “other” as a comparator when conducting research on self-referential processing is that the difference between (“self” and “other”) conditions may vary based on the particular “other” chosen as well as the self-conceptualizations of the participants. In the present work, the research assistants who represented the “other” across all of the experiments were undergraduate students and may have had many similarities to the participants, who were also predominantly undergraduate students at the same institution. Previous research suggests that similarity between the self and an “other” may moderate self-biases. In a study by Allan, Morson, Dixon, Martin, and Cunningham (2017), participants made judgments about objects that hypothetically either belonged to them, to a similar person, or to a dissimilar person. When asked to recall the objects later, participants’ memory was better for objects that belonged to the similar person relative to the dissimilar person. Findings from neuroimaging research also support similarity as a modulatory factor. Mitchell, Banaji, and Macrae (2005) had participants judge others’ mental and non-mental qualities and rated how similar they perceived the others to be. They found that activity in the MPFC positively correlated with perceived similarity during mental judgments, and concluded that inferring the mental states of similar others involves referencing one’s own mental state. A subsequent study by Mitchell, Macrae, and Banaji (2006) involved participants mentalizing about (fictional) politically similar and dissimilar others. The ventromedial prefrontal cortex (VMPFC) was more active during mentalizing about similar others and the DMPFC was more active during mentalizing about dissimilar others. Other cortical midline structures such as the dorsal anterior cingulate cortex also show correlations between activity and degree of similarity to self (Leshikar, Cassidy, & Gutchess, 2015). If participants in the present work had perceived a high degree of similarity between themselves and the research assistant, the difference between the self and other conditions may have been attenuated.

Self-construal is a competing explanation for differences in degree of self-bias. Cultural models present the difference from self as the degree to which others are incorporated to the self-concept; one end of the continuum contains solely the individual and the other end of the continuum contains solely the individual's relationship with others (Markus & Kitayama, 1991). The main prediction coming out of these models is that samples with high independent self-construal (i.e., Western samples) will show greater bias towards the self relative to an "other" compared to samples with high interdependent self-construal (i.e., Asian samples). A more direct comparison to the present work comes from Sparks, Cunningham, & Kritikos (2016) who conducted an object ownership experiment using Western and Asian participants. Across two experiments, the Western participants replicated the ownership effect while the Asian participants showed no difference on recognition memory between self-owned and other-owned objects (Experiment 1) and even a reversal of the effect when the "other" was imagined to be the participant's mother (Experiment 2). The attenuation or reversal of the classic (i.e., trait adjectives) self-reference effect in Asian samples has also been observed (Huff, Ligouri, & Gutchess, 2015; Zhu, & Zhang, 2002). As mentioned in Chapter 2, the endowment effect is attenuated in some Asian samples (Maddux et al., 2010). Interestingly, it has also been found to *extend* to close others (Zhao, Feng, & Kazinka, 2014) such that willingness to accept is higher for items that belong to a close other. Cross-cultural differences between self-referencing and other-referencing is particular evident in neuroimaging studies. Zhu, Zhang, Fan, & Han (2007) found that although the medial prefrontal cortex (MPFC) was activated during trait judgments regarding the self for Western participants, it was activated during self- *and* mother-trait judgments in Chinese participants, concluding that the Chinese participants' inclusion of their mother in their self representation was reflected in their MPFC activity. At the individual level, Sul, Choi, and Kang (2012) showed that a person's score on a collectivism versus individualism scale significantly predicted peak activation in various regions of interest during a self-referencing paradigm, with collectivists showing greater activity in the temporo-parietal junction (TPJ) and individualists showing greater activity in MPFC. Even simply priming self-construal also has been found to modulate responses in a gambling task (Varnum, Shi, Chen, Qiu, & Han, 2014) and alter the neural activity of the default mode network (Wang, Oyserman, Liu, Li, & Han, 2013).

Collectively, these aforementioned studies suggest that interdependent or collectivist self-construal may dampen self-biases. However, when examined in Chapter 3, self-construal did not correlate with participants' points of subjective simultaneity (PSSs). As argued in Chapter 3, self-construal may index self-as-object and prior entry effects for self-relevant objects may index self-as-subject. If these aspects of self exist orthogonally to each other then measurements of each aspect should be uncorrelated. Though self-construal was not measured in Chapter 2, the current argument about the two aspects of self could be speculatively applied. In Chapter 2, active pulling of a self-owned object towards the body yielded the highest levels of subsequent recognition. If acting on objects activates self-as-subject, the self-construal would likely be uncorrelated with the degree to which pulling objects towards the self augmented the ownership effect.

The necessity of the self in ownership effects

One question relevant to the present work is whether there can be "mine" without "me." In other words, though the present work has explored ownership from the perspective of how objects are related to the self, it is important to examine whether ownership effects can exist independently of self-referencing. To assess this, one can look at subjects who may not show evidence of self-referencing (insofar as human researchers have measured it) but who can show evidence of ownership such as animals. In her review of property in non-human primates, Brosnan (2011) made the distinction between possession and ownership such that possession refers to property that is in one's possession (i.e., currently within one's physical control) and ownership refers to a state that is maintained even when the owner is not around to physically control the destiny of the object. There are some studies that suggest animals, specifically primates, respect possession of food such that a primate may inhibit himself from taking food away from a fellow primate even when the former is dominant to the latter (Perry, 1997; Sigg & Falett, 1985). Interestingly, the results from a study on long-tailed macaques by Kummer and Cords (1990) speak to the concept of peripersonal space and action. Rival macaques were less like to rob owner macaques of a tube of raisins when the owner could carry the tube around compared to when the tube was tethered to the floor, suggesting that acting on an object can signal ownership. Furthermore, there was more robbing when the owned object was partially outside of the owner's immediate vicinity and the rival macaque was more dominant. This suggests that proximity to body may interact with social factors to determine ownership. With respect to whether non-human animals show ownership in the outside-of-immediate-control sense, chimpanzees can learn to not request (of an experimenter) foods from a trading partner's storage space (Brosnan & Beran, 2009). Moreover, chimpanzees (Brosnan, Jones, Mareno, Richardson, Shapiro et al., 2007), orangutans (Flemming, Jones, Stoinski, Mayo, & Brosnan, 2012), and capuchin monkeys (Lakshminarayanan, Chen, & Santos, 2008) show the endowment effect. Together, research in animals suggests that various primates do show some ownership-like behaviors. However, this does not necessarily mean that ownership does not require links to the self. The extant animal literature is wholly reliant on concrete survival-related (i.e., food) items as stimuli. In comparison, research on ownership in humans has used a wide variety of stimuli ranging from food (Reb & Connolly, 2007) to mugs (Ong & Tan, 2015), and even ideas (Shaw, Li, & Olson, 2012). That ownership can extend onto non-primary reinforcers and abstract things suggests ownership can exist as a symbolic or abstract relationship between a person and a stimulus. As such, it may be that the self-concept may be needed to bootstrap understanding of ownership onto non-present or non-concrete items. Future research can test whether non-human animals can show ownership-like behaviors towards non-tangible stimuli.

Future Directions

Presence and actions of others in peripersonal space

Going forward, future research can examine the effects of another person interacting with self-owned and other-owned objects in one's peripersonal space. Whereas in the current work the "other" was in the room but outside of the experimental actionable areas, follow-up research can investigate the extent to which the active involvement of a second (or third) person alters attention allocation to owned objects. Changes in attention due to the presence of others is supported by both behavioral and neuroimaging research. At the physiological level, there are neurons in the monkey ventral intraparietal area (Ishida, Nakajima, Inase, & Murata, 2010) and human ventral premotor cortex (Brozzoli, Gentile, Bergouigan, & Ehrsson, 2013) that respond to both the receptive fields (on the body or in nearby space) of the self and the corresponding area on a nearby person. Furthermore, a shared multisensory experience with another person can elicit a change in the representation of peripersonal space (Teneggi, Canzoneri, de Pellegrino, & Serino 2013; Maister, Cardini, Zamariola, Serino, & Tsakiris, 2015). At the behavioral level, emphasis has been placed on the impacts of a second person when they are a co-actor (e.g., Sun & Thomas, 2013), an emphasis that is in line with the findings of Chapter 2. For example, in one study participants viewed various objects that varied in their proximity to either the participant's hands or a co-actor's hands (Constable, Pratt, Gozli, & Welsh, 2015). In subsequent recognition test trials, reaction times in a later visual recognition task were not affected by the object proximity to hands. Follow-up experiments found that active participation of a second person in a task and not merely the presence of another person modulated performance. Relatedly, Tversky and Hard (2009) had participants describe spatial relationships between various objects in a scene when there was or was not another person sitting near the objects. When the experimenters framed their questions in terms of action, participants were significantly more likely to take the other person's perspective. With these findings in mind, if self-owned objects in one's immediate environment are subject to manipulation by another person, it would be reasonable to hypothesize that they may receive a different level of attention than if they were only subject to manipulation by the self.

Pathological hoarding

A second way the current findings could be extended is through exploring their potential malfunctioning in neurocognitive pathologies. One plausible test case is hoarding. Compulsive hoarding is a mental disorder characterized by the excessive accumulation of possessions (Greenberg, Witzum, & Levy, 1990) and the clutter arising from hoarding can pose significant health and safety risks as well as psychological distress and stigma (Tolin, Frost, Steketee, & Fitch, 2008). Existing research on hoarding suggests that hoarders show intense emotional attachment to objects they own (Frost, Hartl, Christian, & Williams, 1995) but little is known about what elicits and maintains this attachment. It is possible that atypically high and sustained attention to the different aspects of self through ownership may be implicated. Research in the 1970s explored the nature of ownership through interviews with a large cross-cultural sample of children and adults (Furby, 1978). Content analysis of the interviews revealed that self-owned objects were high in sense of self, perceived control (i.e., control over use or permission to allow other to use) and instrumental value (i.e., the ability to perform tasks). These themes echo this dissertation's finding on action as a modulator of the ownership effect and are consistent with the general idea that ownership is an expression of the self-concept. Thus, it may be that compulsive hoarding involves hyper-responsiveness to ownership-related signals. Though there may be multiple etiologies contributing to hoarding behavior, abnormal patterns of ownership-mediated attention are consistent with two specific hoarding findings.

First, my proposed alternative perspective (presented above) states that ownership taps into the self as object and increases the salience of objects that reflect one's self-concept or identity. Previous research suggests that self-ambivalence is positively correlated with compulsive hoarding (Frost, Kyrios, McCarthy, & Matthews, 2007). As defined by Guidano and Liotti (1983), self-ambivalence manifests as vigilant searching for signs in the environment that can reveal one's self-worth. This particular characterization of hoarding as related to vigilance suggests a maladaptive attentional set for representations of self-identity. From this perspective, objects that would otherwise go unnoticed by persons not exhibiting compulsive hoarding would now possess abnormally high salience. In particular, my perspective would predict attentional prioritization to self-relevant objects in the environment to the extent they could inform the self-concept. The act of hoarding such objects could temporarily reduce levels of self-ambivalence and allow for attentional disengagement from the objects. Subsequent returns to the original maladaptive attentional patterns would result in the gradual accumulation of objects to potentially pathological levels.

Second, my proposed alternative perspective claims that the action-oriented contexts tap into the self as subject and increase the salience of objects that can be acted upon. One facet of compulsive hoarding is the finding that hoarders tend to accumulate items that are seen by others as having little to no value such old newspapers and damaged items (Frost & Gross, 1993). Despite the low utility of the hoarded items, persons with hoarding disorder sometimes cite *potential* uses for such items as reasons not to discard them (Steketee & Frost, 2010). If the salience of an object were abnormally high due to prioritization via systems mediating self as subject, it would be unsurprising to observe contorted conscious action-related rationalizations for keeping the object. For example, a bucket with a large rip or hole in its side is unlikely to retain most of its original uses and affordances: it can no longer be used to hold and transport substances and might not even be able to be picked up depending on the type of damage. To a person without hoarding symptoms, the bucket has lost much of its self-as-subject forms of salience and fails to draw attention. However, a person with compulsive hoarding might still observe many of the original affordances of the bucket (even though they are no longer valid) and thus attend to it much more and perhaps for much longer than a typical person. When later probed about the failure to discard the bucket, a hoarder may make an affordance-based argument by insisting that there are multiple potential ways of acting on or using it. Future research can test these proposals directly.

Interaction of ownership and reward

An important issue regarding the effects of self-relevance and ownership on attention for objects concerns whether other constructs can account for the observed effects. To be more specific, the concept of reward has been connected by various researchers to the concept of self-relevance. In their review of neuroimaging evidence on the overlap between self and reward, Northoff and Hayes (2011) identified three potential relationships between self and reward: integration, segregation, and parallel processing. Proponents of self-reward integration claim that self-processing and reward- processing are more or less structurally and functionally indistinguishable. Specifically, some have argued that the self-relevance of any stimulus arises from the value the stimulus holds to the organism, and therefore judgments of self-relatedness are a special subset of value/reward judgments. Support for the self-is-reward position comes from de Greck et al. (2008). In their study, participants first completed a gambling task in which they viewed a series of stimulus images and had to choose between two response options, with one option paired with a reward and the other option paired with a loss. Following this task, participants judged the self-relatedness of the same series of stimuli. The authors found that, as expected, the win/lose contrast in BOLD activity showed differences in regions of the valuation system such as the NACC, VMPFC, and the VTA. More importantly, these same regions were equally active in the high-self/low-self contrast during the early signal changes. The authors concluded that the reward system is recruited during evaluations of self-relatedness. It must be noted, however, that this study focused on very specific regions of interest and did not examine whether non-reward-related areas of the brain were active during the self- relatedness judgments nor did it probe for a reward-by-self interaction.

One offshoot related to the main integration theories of reward and self is the valuation hypothesis by D'Argembeau (2013). Citing work showing that activation of the vmPFC tracks participants' subjective reward valuations for stimuli (Peters & Buchel, 2010; Chib, Rangel, Shimojo, & O'Doherty, 2009), including social valuations (Lin, Adolphs, & Rangel, 2012), D'Argembeau proposed that the vmPFC assigns "personal value" to stimuli that can change as context changes. The valuation hypothesis has a more general definition of value that included self as a dimension of reward with higher degrees of closeness to self being associated with higher personal value. Accordingly, activity in the vmPFC is greater when considering present self versus future self (akin to reward-like temporal discounting; Ersner-

Hershfield, Wimmer, & Knutson, 2009; Mitchell, Schirmer, Ames, & Gilbert, 2011), greater when thinking about traits that are important to oneself (Andrews-Hanna et al., 2010, D'Argembeau et al., 2011), and greater when viewing self- owned objects versus other-owned objects (Kim & Johnson, 2013). These findings have particular relevance to the temporal aspects of self. Although the valuation hypothesis is consistent with many findings regarding self and reward, it has not yet specified whether traditional (economic) reward values are coded independently from self-relatedness (Brosch et al., 2012; Nicolle et al., 2012).

If self-relevance is a form of reward then it may be of interest to assess the degree to which attending to self-owned objects is more rewarding than attending to other-owned objects. One way of measuring this type of self/other difference would be to impose a differential reward structure to encoding self-owned and other-owned objects. For example, instituting a 10% larger reward (announced at the time encoding) for later recall of other-owned objects relative to recall of self-owned objects may or may not be sufficient to equalize recall between the two categories. Alternatively, one could also institute a greater reward for self-owned objects and determine whether the effects of self-relevance and reward on attention are additive or modulatory. Conversely, it may also be of interest to investigate how self-relevance/ownership and reward are unrelated and whether the effects of these two factors change as a function of temporal or spatial context. Sui and Humphreys (2015a) examined a version of this question by assessing the redundancy gains associated with self-related and reward-related stimuli. Redundancy gains occur when performance is enhanced due to redundant information during stimulus presentation. The authors found that redundancy gains were greater when the stimuli were associated with the self (relative to when they were associated with another person) at both perceptual and conceptual levels of representation whereas reward only had an effect on the conceptual level of representation

(Sui & Humphreys, 2015a). These results suggested that self is separable from reward. Future research can extend from these findings to examine how attentional prioritization for self-owned objects when explicit instantiations of reward are introduced.

Conclusion

When we come into possession of something, when we learn that we own something, our cognitive relationship with that something changes even though nothing about the item has changed at all. In this way, ownership is a powerful mechanism for influencing attention. Because many explanations for the influence of ownership involve relating objects to the self, it is important to consider that the scope of the self is not limited to the immediate perception of psychological ownership. Rather, contexts like the presence of an active body or the previous establishment/removal of ownership over an object can also affect the allocation of attention to owned objects. The findings from my dissertation demonstrate that the effects of ownership (as a form of self-relevance) on attention to objects do not function in a vacuum. Rather, they can be modulated through the actions we take, the hierarchy of goals we seek to achieve, and the changes to self-relevance that can occur over time. Moving forward, it is crucial for future studies on ownership and attention to take into account the living, acting self. In other words, a deeper understanding of ownership depends on a deeper understanding of the self.

References

Allan, K., Morson, S., Dixon, S., Martin, D., & Cunningham, S. J. (2017). Simulation-based mentalizing generates a “proxy” self-reference effect in memory. *The Quarterly Journal of Experimental Psychology*, *70*(6), 1074-1084.

Anderson, A.K. (2005). Affective influences on the attentional dynamics supporting awareness. Journal of Experimental Psychology: General, 134, 258-281.

Anderson, A. K., Yamaguchi, Y., Grabski, W., & Lacka, D. (2006). Emotional memories are not all created equal: evidence for selective memory enhancement. *Learning & Memory*, *13*(6), 711-718.

Anderson, B. A., Laurent, P. A., & Yantis, S. (2011). Value-driven attentional capture. *Proceedings of the National Academy of Sciences*, *108*(25), 10367-10371.

Andrews-Hanna, J. R., Reidler, J. S., Sepulcre, J., Poulin, R., & Buckner, R. L. (2010). Functional-anatomic fractionation of the brain's default network. *Neuron*, *65*(4), 550-562.

Ashby, N. J., Dickert, S., & Glöckner, A. (2012). Focusing on what you own: Biased information uptake due to ownership. *Judgment and Decision Making*, *7*(3), 254-267.

Awh, E., Belopolsky, A. V., & Theeuwes, J. (2012). Top-down versus bottom-up attentional control: a failed theoretical dichotomy. *Trends in cognitive sciences*, *16*(8), 437-443.

Bar, M., Kassam, K. S., Ghuman, A. S., Boshyan, J., Schmid, A. M., Dale, A. M., ... & Halgren, E. (2006). Top-down facilitation of visual recognition. *Proceedings of the National Academy of Sciences of the United States of America*, *103*(2), 449-454.

Baruni, J. K., Lau, B., & Salzman, C. D. (2015). Reward expectation differentially modulates attentional behavior and activity in visual area V4. *Nature neuroscience. 18*(11), 1656.

Bates, D., Sarkar, D., Bates, M. D., & Matrix, L. (2007). The lme4 Package. *October*, *2*(1), 1–6. Retrieved from http://ftp.auckland.ac.nz/software/CRAN/doc/packages/lme4.pdf

Becker, S. I., Folk, C. L., & Remington, R. W. (2013). Attentional capture does not depend on feature similarity, but on target-nontarget relations. *Psychological science*, *24*(5), 634-647.

Becker S.I., Folk, C.L., & Remington, R.W. (2010). The role of relational information in contingent capture. *Journal of Experimental Psychology: Human Perception and Performance, 36,* 1460-1476.

Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology*, *62*(2), 229.

Bekkering, H., & Neggers, S. F. (2002). Visual search is modulated by action intentions. *Psychological science*, *13*(4), 370-374.

Belk, R. (1988). Possessions and the extended self. *Journal of Consumer Research, 15*, 139-168.

Belk, R. (1991). The ineluctable mysteries of possessions. *Journal of Social Behaviour and Personality*, 6, 17-55.

Berlad, I., & Pratt, H. (1995). P300 in response to the subject's own name. *Electroencephalography and Clinical Neurophysiology/Evoked Potentials Section*, *96*(5), 472-474.

Bloesch, E. K., Davoli, C. C., Roth, N., Brockmole, J. R., & Abrams, R. A. (2012). Watch this! Observed tool use affects perceived distance. *Psychonomic Bulletin & Review*, *19*(2), 177-183.

Boenke, L. T., Deliano, M., & Ohl, F. W. (2009). Stimulus duration influences perceived simultaneity in audiovisual temporal-order judgment. *Experimental brain research*, *198*(2-3), 233-244.

Bower, G. H., & Gilligan, S. G. (1979). Remembering information related to one's self. *Journal of Research in Personality*, *13*(4), 420-432.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW): Instruction manual and affective ratings* (pp. 1-45). Technical Report C-1, The Center for Research in Psychophysiology, University of Florida.

Brainard, D. H. (1997). The psychophysics toolbox. *Spatial vision*, *10*(4), 433-436.

Brédart, S., Delchambre, M., & Laureys, S. (2006). Short article one's own face is hard to ignore. *The Quarterly Journal of Experimental Psychology*, *59*(1), 46-52.

Breveglieri, R., Galletti, C., Bosco, A., Gamberini, M., & Fattori, P. (2015). Object affordance modulates visual responses in the macaque medial posterior parietal cortex. *Journal of cognitive neuroscience*. Retrieved from http://www.mitpressjournals.org/doi/abs/10.1162/jocn_a_00793

Brockmole, J. R., Davoli, C. C., Abrams, R. A., & Witt, J. K. (2013). The world within reach: effects of hand posture and tool use on visual cognition. *Current Directions in Psychological Science*, 22(1), 38.44.

Brodeur, M. B., Dionne-Dostie, E., Montreuil, T., & Lepage, M. (2010). The Bank of Standardized Stimuli (BOSS), a new set of 480 normative photos of objects to be used as visual stimuli in cognitive research. *PloS one*, *5*(5), e10773. https://doi.org/10.1371/journal.pone.0010773

Brosch, T., Coppin, G., Schwartz, S., & Sander, D. (2012). The importance of actions and the worth of an object: dissociable neural systems representing core value and economic value. *Social cognitive and affective neuroscience*, *7*(5), 497-505.

Brosnan, S. F. (2011). Property in nonhuman primates. *New directions for child and adolescent development*, *2011*(132), 9-22.

Brosnan, S. F., & Beran, M. J. (2009). Trading behavior between conspecifics in chimpanzees, Pan troglodytes. *Journal of Comparative Psychology*, *123*(2), 181.

Brosnan, S. F., Jones, O. D., Mareno, M. C., Richardson, A. S., Lambeth, S. P., & Schapiro, S. J. (2007). Endowment Effects in Chimpanzees. *Current Biology, 17*, 1-4.

Brozzoli, C., Gentile, G., Bergouignan, L., & Ehrsson, H. H. (2013). A shared representation of the space near oneself and others in the human premotor cortex. *Current Biology*, *23*(18), 1764-1768.

Bushong, B., King, L. M., Camerer, C. F., & Rangel, A. (2010). Pavlovian processes in consumer choice: The physical presence of a good increases willingness-to-pay. *The American economic review*, *100*(4), 1556-1571.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of personality and social psychology*, *65*(1), 5.

Carmon, Z., & Ariely, D. (2000). Focusing on the forgone: How value can appear so different to buyers and sellers. *Journal of consumer research*, *27*(3), 360-370.

Chainay, H., & Humphreys, G. W. (2001). The real-object advantage in agnosia: Evidence for a role of surface and depth information in object recognition. *Cognitive neuropsychology*, *18*(2), 175-191.

Chapman, C. S., Gallivan, J. P., Wood, D. K., Milne, J. L., Ansari, D., Culham, J. C., & Goodale, M. A. (2014). Counting on the motor system: Rapid action planning reveals the format-and magnitude-dependent extraction of numerical quantity. *Journal of Vision*, *14*(3):30, 1-19.

Charpentier, C. J., De Neve, J. E., Li, X., Roiser, J. P., & Sharot, T. (2016). Models of Affective Decision Making: How Do Feelings Predict Choice?. *Psychological science*, *27*(6), 763-775.

Chelazzi, L., Eštočinová, J., Calletti, R., Lo Gerfo, E., Sani, I., Della Libera, C., & Santandrea, E. (2014). Altering Spatial Priority Maps via Reward-Based Learning. *The Journal of Neuroscience*, *34*(25), 8594-604.

Chelazzi, L., Perlato, A., Santandrea, E., & Della Libera, C. (2013). Rewards teach visual selective attention. *Vision Research*, *85*, 58-72.

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and social psychology bulletin*, *25*(2), 215-224.

Cherry, E. C. (1953). Some experiments on the recognition of speech, with one and with two ears. *The Journal of the acoustical society of America*, *25*(5), 975-979.

Chiao, J. Y., Harada, T., Komeda, H., Li, Z., Mano, Y., Saito, D., ... & Iidaka, T. (2009). Neural basis of individualistic and collectivistic views of self. *Human brain mapping*, *30*(9), 2813-2820.

Chib, V. S., Rangel, A., Shimojo, S., & O'Doherty, J. P. (2009). Evidence for a common representation of decision values for dissimilar goods in human ventromedial prefrontal cortex. *The Journal of neuroscience*, *29*(39), 12315-12320.

Christoff, K., Cosmelli, D., Legrand, D., & Thompson, E. (2011). Specifying the self for cognitive neuroscience. *Trends in Cognitive Sciences*, *15*(3), 104-112.

Cisek, P. (2007). Cortical mechanisms of action selection: the affordance competition hypothesis. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *362*(1485), 1585-1599.

Colby, C. L. (1998). Action-oriented spatial reference frames in cortex. *Neuron*, *20*(1), 15-24.

Coluccia, E., Mammarella, I. C., De Beni, R., Ittyerah, M., & Cornoldi, C. (2007). Remembering object position in the absence of vision: Egocentric, allocentric, and egocentric decentred frames of reference. *Perception*, *36*(6), 850-864.

Constable, M. D., Kritikos, A., Bayliss, A. P. (2011). Grasping the concept of personal property. *Cognition*, 119, 430-437.

Constable, M. D., Kritikos, A., Lipp, O. V., & Bayliss, A. P. (2014). Object ownership and action: the influence of social context and choice on the physical manipulation of personal property. *Experimental brain research*, *232*(12), 3749-3761.

Constable, M. D., Pratt, J., Gozli, D. G., & Welsh, T. N. (2015). Do you see what I see? Co-actor posture modulates visual processing in joint tasks. *Visual Cognition*, *23*(6), 699-719.

Conway, M. A., & Dewhurst, S. A. (1995). The self and recollective experience. *Applied Cognitive Psychology*, *9*(1), 1-19.

Conway, M. A., Pothos, E. M., & Turk, D. J. (2016). The self-relevance system?. *Cognitive neuroscience*, *7*(1-4), 20-21.

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature reviews neuroscience*, *3*(3), 201-215.

Correa, Á., & Nobre, A. C. (2008). Spatial and temporal acuity of visual perception can be enhanced selectively by attentional set. *Experimental brain research*, *189*(3), 339-344.

Costantini, M., Ambrosini, E., Tieri, G., Sinigaglia, C., & Committeri, G. (2010). Where does an object trigger an action? An investigation about affordances in space. *Experimental brain research*, *207*(1-2), 95-103.

Coventry, K. R., Griffiths, D., & Hamilton, C. J. (2014). Spatial demonstratives and perceptual space: Describing and remembering object location. *Cognitive psychology*, *69*, 46-70.

Craik, F. I. (1979). Human memory. *Annual review of psychology*, *30*(1), 63-102.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of verbal learning and verbal behavior*, *11*(6), 671-684.

Cunningham, W. A., Van Bavel, J. J., & Johnsen, I. R. (2008). Affective flexibility evaluative processing goals shape amygdala activity. *Psychological Science*, *19*(2), 152-160.

Cunningham, S. J., Turk, D. J., Macdonald, L. M., & Macrae, C. N. (2008). Yours or mine? Ownership and memory. *Consciousness and cognition*, *17*(1), 312-318.

Cunningham, S. J., Vergunst, F., Macrae, C. N., & Turk, D. J. (2013). Exploring early self-referential memory effects through ownership. *British Journal of Developmental Psychology*, *31*(3), 289-301.

De Greck, M., Rotte, M., Paus, R., Moritz, D., Thiemann, R., Proesch, U., ... & Northoff, G. (2008). Is our self based on reward? Self-relatedness recruits neural activity in the reward system. *Neuroimage*, *39*(4), 2066-2075.

D’Argembeau, A. (2013). On the role of the ventromedial prefrontal cortex in self-processing: the valuation hypothesis. *Frontiers in human neuroscience*, *7*. doi: 10.3389/fnhum.2013.00372

D'Argembeau, A., Collette, F., Van der Linden, M., Laureys, S., Del Fiore, G., Degueldre, C., ... & Salmon, E. (2005). Self-referential reflective activity and its relationship with rest: a PET study. *Neuroimage*, *25*(2), 616-624.

D'Argembeau, A., Jedidi, H., Balteau, E., Bahri, M., Phillips, C., & Salmon, E. (2011). Valuing one's self: medial prefrontal involvement in epistemic and emotive investments in self-views. *Cerebral Cortex*, bhr144.

D’Argembeau, A., & Salmon, E. (2012). The neural basis of semantic and episodic forms of self-knowledge: insights from functional neuroimaging. In *Sensing in nature* (pp. 276-290). Springer US.

Davoli, C. C., Brockmole, J. R., Du, F., & Abrams, R. A. (2012). Switching between global and local scopes of attention is resisted near the hands. *Visual Cognition*, *20*(6), 659-668.

Della Libera, C., & Chelazzi, L. (2009). Learning to attend and to ignore is a matter of gains and losses. *Psychological Science*, *20*(6), 778-784.

Devue, C. Collette, F., Balteau, E., Degueldre, C., Luxen, A., Maquet, P., & Bredart, S. (2007). Here I am: The cortical correlates of visual self-recognition. *Brain Research*, 1143, 169-182.

Devue, C., Van der Stigchel, S., Brédart, S., & Theeuwes, J. (2009). You do not find your own face faster; you just look at it longer. *Cognition*, *111*(1), 114-122.

Dirks, J., & Neisser, U. (1977). Memory for objects in real scenes: The development of recognition and recall. *Journal of Experimental Child Psychology*, *23*(2), 315-328.

Dommer, S. L., & Swaminathan, V. (2013). Explaining the endowment effect through ownership: The role of identity, gender, and self-threat. *Journal of Consumer Research*, *39*(5), 1034-1050.

Droll, J. A., & Eckstein, M. P. (2009). Gaze control and memory for objects while walking in a real world environment. *Visual Cognition*, *17*(6-7), 1159-1184.

Englert, J., & Wentura, D. (2016). How “mere” is the mere ownership effect in memory? Evidence for semantic organization processes. *Consciousness and cognition*, *46*, 71-88.

Epley, N., Morewedge, C. K., & Keysar, B. (2004). Perspective taking in children and adults: Equivalent egocentrism but differential correction. *Journal of Experimental Social Psychology*, *40*(6), 760-768.

Ersner-Hershfield, H., Wimmer, G. E., & Knutson, B. (2009). Saving for the future self: Neural measures of future self-continuity predict temporal discounting. *Social cognitive and affective neuroscience*, *4*(1), 85-92.

Eskes, G. A., Klein, R. M., Dove, M. B., Coolican, J., & Shore, D. I. (2007). Comparing temporal order judgments and choice reaction time tasks as indices of exogenous spatial cuing. *Journal of neuroscience methods*, *166*(2), 259-265.

Esslen, M., Metzler, S., Pascual-Marqui, R., & Jancke, L. (2008). Pre-reflective and reflective self-reference: a spatiotemporal EEG analysis. *Neuroimage*, *42*(1), 437-449.

Fagioli, S., Hommel, B., & Schubotz, R. I. (2007). Intentional control of attention: action planning primes action-related stimulus dimensions. *Psychological research*, *71*(1), 22-29.

Fecica, A. M., & Stolz, J. A. (2008). Facial affect and temporal order judgments: emotions turn back the clock. *Experimental psychology*, *55*(1), 3-8.

Feng, T., Zhao, W., & Donnay, G. F. (2013). The endowment effect can extend from self to mother: Evidence from an fMRI study. *Behavioural brain research*, *248*, 74-79.

Flemming, T. M., Jones, O. D., Mayo, L., Stoinski, T., & Brosnan, S. F. (2012). The endowment effect in orangutans.

Flindall, J. W., & Gonzalez, C. L. (2014). Eating interrupted: the effect of intent on hand-to-mouth actions. *Journal of neurophysiology*, *112*(8), 2019-2025.

Folk, C. L., & Remington, R. (1999). Can new objects override attentional control settings?. *Perception & Psychophysics*, *61*(4), 727-739.

Folk, C. L., Remington, R. W., & Johnston, J. C. (1992). Involuntary covert orienting is contingent on attentional control settings. *Journal of Experimental Psychology: Human perception and performance*, *18*(4), 1030.

Fossati, P., Hevenor, S. J., Lepage, M., Graham, S. J., Grady, C., Keightley, M. L., ... & Mayberg, H. (2004). Distributed self in episodic memory: neural correlates of successful retrieval of self-encoded positive and negative personality traits. *Neuroimage*, *22*(4), 1596-1604.

Freedman, D. J., & Assad, J. A. (2006). Experience-dependent representation of visual categories in parietal cortex. *Nature, 443,* 85–88.

Frost, R. O., Hartl, T. L., Christian, R., & Williams, N. (1995). The value of possessions in compulsive hoarding: patterns of use and attachment. *Behaviour research and therapy*, *33*(8), 897-902.

Frost, R. O., Kyrios, M., McCarthy, K. D., & Matthews, Y. (2007). Self-ambivalence and attachment to possessions. *Journal of Cognitive Psychotherapy*, *21*(3), 232-242.

Furby, L. (1978). Possession in humans: An exploratory study of its meaning and motivation. *Social Behavior and Personality: an international journal*, *6*(1), 49-65.

Gallagher, S. (2000). Philosophical conceptions of the self: implications for cognitive science. *Trends in cognitive sciences*, *4*(1), 14-21.

Gallivan, J.P., Cavina-Pratesi, C., & Culham, J. C. (2009). Is that within reach? fMRI reveals that the human superior parieto-occiptal cortex encodes objects reachable by the hand. *Journal of Neuroscience*, 29(14), 4381-4391.

Gallivan, J. P., & Chapman, C. S. (2014). Three-dimensional reach trajectories as a probe of real-time decision-making between multiple competing targets. *Frontiers in Neuroscience*, 8(15), 1-19.

Gawronski, B., Bodenhausen, G. V., & Becker, A. P. (2007). I like it, because I like myself: Associative self-anchoring and post-decisional change of implicit evaluations. *Journal of Experimental Social Psychology*, *43*(2), 221-232.

Gibson, J. J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

Glenberg, A. M. (2010). Embodiment as a unifying perspective for psychology. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*(4), 586-596.

Golledge, R. G. (1992). Place recognition and wayfinding: Making sense of space. *Geoforum*, *23*(2), 199-214.

Gray, H. M., Ambady, N., Lowenthal, W. T., & Deldin, P. (2004). P300 as an index of attention to self-relevant stimuli. *Journal of experimental social psychology*, *40*(2), 216-224.

Graziano, M. S., & Cooke, D. F. (2006). Parieto-frontal interactions, personal space, and defensive behavior. *Neuropsychologia*, *44*(6), 845-859.

Graziano, M. S., & Gross, C. G. (1998). Spatial maps for the control of movement. *Current opinion in neurobiology*, *8*(2), 195-201.

Greenberg, D., Witztum, E., & Levy, A. (1990). Hoarding as a psychiatric symptom. *The Journal of clinical psychiatry*, *51*(10), 417-421.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of personality and social psychology*, *85*(2), 197.

Gregg, A. P., Mahadevan, N., & Sedikides, C. (2017). The SPOT effect: People spontaneously prefer their own theories. *The Quarterly Journal of Experimental Psychology*, *70*(6), 996-1010.

Griffiths, D., & Tipper, S. P. (2012). When far becomes near: shared environments activate action simulation. *The Quarterly Journal of Experimental Psychology*, *65*(7), 1241-1249.

Gronau, N., Cohen, A., & Ben-Shakhar, G. (2003). Dissociations of personally significant and task-relevant distractors inside and outside the focus of attention: a combined behavioral and psychophysiological study. *Journal of Experimental Psychology: General*, *132*(4), 512.

Guidano, V. F., Liotti, G., & Guidano, V. F. (1983). *Cognitive processes and emotional disorders: A structural approach to psychotherapy*. New York: Guilford Press.

Handy, T.C., Grafton, S.T., Shroff, N. M., Ketay, S., & Gazzaniga, M.S. (2003). Graspable objects grab attention when the potential for action is recognized. *Nature Neuroscience, 6*, 421-427.

Harris, C. R., Pashler, H. E., & Coburn, P. (2004). Moray revisited: High-priority affective stimuli and visual search. *Quarterly Journal of Experimental Psychology Section A*, *57*(1), 1-31.

Hart, R. A., & Moore, G. T. (1973). *The development of spatial cognition: A review*. Aldine Transaction.

Hickey, C., Chelazzi, L., & Theeuwes, J. (2010). Reward changes salience in human vision via the anterior cingulate. *The Journal of Neuroscience*, *30*(33), 11096-11103.

Hickey, C., & van Zoest, W. (2012). Reward creates oculomotor salience. *Current Biology*, *22*(7), R219-R220. https://doi.org/10.1016/j.cub.2012.02.007

Holmes, N. P., & Spence, C. (2004). The body schema and multisensory representation(s) of peripersonal space. *Cognitive processing*, *5*(2), 94-105.

Huang, Y., Wang, L., & Shi, J. (2009). When do objects become more attractive? The individual and interactive effects of choice and ownership on object evaluation. *Personality and Social Psychology Bulletin*, *35*(6), 713-722.

Huff, S., Ligouri, L., & Gutchess, A. (2015). Cultural influences on social and self-relevant memory. In *Neuroscience in Intercultural Contexts* (pp. 215-241). Springer New York.

Humphreys, G. W., & Sui, J. (2015). Attentional control and the self: the Self-Attention Network (SAN). *Cognitive neuroscience*, *7*(1-4), 5-17.

Inquisit 4.0.8.0 [Computer software]. (2014). Seattle, WA: Millisecond Software.

Iriki, A., Tanaka, M., & Iwamura, Y. (1996). Coding of modified body schema during tool use by macaque postcentral neurones. *Neuroreport*, *7*(14), 2325-2330.

Ishida, H., Nakajima, K., Inase, M., & Murata, A. (2010). Shared mapping of own and others' bodies in visuotactile bimodal area of monkey parietal cortex. *Journal of Cognitive Neuroscience*, *22*(1), 83-96.

Jaśkowski, P. (1992). Temporal-order judgment and reaction time for short and long stimuli. *Psychological Research*, *54*(3), 141-145.

Jaskowski, P., & Verleger, R. (2000). Attentional bias toward low-intensity stimuli: an explanation for the intensity dissociation between reaction time and temporal order judgment?. *Consciousness and cognition*, *9*(3), 435-456.

Johnson, E. J., Häubl, G., & Keinan, A. (2007). Aspects of endowment: a query theory of value construction. *Journal of experimental psychology: Learning, memory, and cognition*, *33*(3), 461.

Jostmann, N. B., Lakens, D., & Schubert, T. W. (2009). Weight as an embodiment of importance. *Psychological Science*, 1169-1174.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of political Economy*, *98*(6), 1325-1348.

Kanai, K., Ikeda, K., & Tayama, T. (2007). The effect of exogenous spatial attention on auditory information processing. *Psychological research*, *71*(4), 418-426.

Kasai, T. (2008). Early visual selection in near and far space: an event-related potential study. *NeuroReport*, 19(9), 961-964.

Keil, A., & Ihssen, N. (2004). Identification facilitation for emotionally arousing verbs during the attentional blink. *Emotion*, *4*(1), 23.

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An event-related fMRI study. *Journal of cognitive neuroscience*, *14*(5), 785-794.

Kim, K., & Johnson, M. K. (2013). Extended self: spontaneous activation of medial prefrontal cortex by objects that are 'mine'. *Social cognitive and affective neuroscience*, *9*(7), 1006-1012.

Kiss, M., Driver, J., & Eimer, M. (2009). Reward priority of visual target singletons modulates event-related potential signatures of attentional selection. *Psychological Science*, *20*(2), 245-251.

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organization, and the self-reference effect in memory. *Journal of Experimental Psychology: General*, *115*(1), 26.

Klein, S. B., & Loftus, J. (1988). The nature of self-referent encoding: The contributions of elaborative and organizational processes. *Journal of Personality and Social Psychology*, *55*(1), 5.

Kleiner, M., Brainard, D., Pelli, D., Ingling, A., Murray, R., & Broussard, C. (2007). What's new in Psychtoolbox-3. *Perception*, *36*(14), 1-1.

Krigolson, O. E., Hassall, C. D., Balcom, L., & Turk, D. (2013). Perceived ownership impacts reward evaluation within medial-frontal cortex. *Cognitive, Affective, & Behavioral Neuroscience*, *13*(2), 262-269.

Kristjánsson, Á., & Campana, G. (2010). Where perception meets memory: A review of repetition priming in visual search tasks. *Attention, Perception, & Psychophysics*, *72*(1), 5-18.

Kuiper, N. A., & Rogers, T. B. (1979). Encoding of personal information: Self–other differences. *Journal of Personality and Social Psychology*, *37*(4), 499.

Kummer, H., & Cords, M. (1990). Cues of ownership in long-tailed macaques, *Macaca* *fascicularis*. *Animal Behavior, 42*, 529-549.

Làdavas, E. (2002). Functional and dynamic properties of visual peripersonal space. *Trends in Cognitive Sciences*, *6*(1), 17-22.

Ladavas, E., Pavani, F., & Farne, A. (2001). Auditory peripersonal space in humans: a case of auditory-tactile extinction. *Neurocase*, *7*(2), 97-103.

Lakshminaryanan, V., Chen, M. K., & Santos, L. R. (2008). Endowment effect in capuchin monkeys. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1511), 3837-3844.

LeBarr, A. N., & Shedden, J. M. (2017). Psychological ownership: The implicit association between self and already-owned versus newly-owned objects. *Consciousness and Cognition*, *48*, 190-197.

Legrand, D., & Ruby, P. (2009). What is self-specific? Theoretical investigation and critical review of neuroimaging results. *Psychological review*, *116*(1), 252-282.

Lerner, J. S., Small, D. A., & Loewenstein, G. (2004). Heart strings and purse strings carryover effects of emotions on economic decisions. *Psychological science*, *15*(5), 337-341.

Leshikar, E. D., Cassidy, B. S., & Gutchess, A. H. (2015). Similarity to the self influences cortical recruitment during impression formation. *Cognitive, Affective, & Behavioral Neuroscience*, 1-13.

Lester, B. D., Hecht, L. N., & Vecera, S. P. (2009). Visual prior entry for foreground figures. *Psychonomic Bulletin & Review*, *16*(4), 654-659.

Lim, S. L., Padmala, S., & Pessoa, L. (2009). Segregating the significant from the mundane on a moment-to-moment basis via direct and indirect amygdala contributions. *Proceedings of the National Academy of Sciences*, *106*(39), 16841-16846.

Lin, A., Adolphs, R., & Rangel, A. (2012). Social and monetary reward learning engage overlapping neural substrates. *Social cognitive and affective neuroscience*, *7*(3), 274-281.

Lugli, L., Baroni, G., Gianelli, C., Borghi, A. M., & Nicoletter, R. (2012). Self, others, objects: How this triadic interaction modulates our behavior. *Memory & Cognition, 40*, 1373-1386.

Macrae, C. N., Moran, J. M., Heatherton, T. F., Banfield, J. F., & Kelley, W. M. (2004). Medial prefrontal activity predicts memory for self. *Cerebral Cortex*, *14*(6), 647-654.

Maddux, W. W., Yang, H., Falk, C., Adam, H., Adair, W., Endo, Y., ... & Heine, S. J. (2010). For whom is parting with possessions more painful? Cultural differences in the endowment effect. *Psychological Science*, *21*(12), 1910-1917.

Maister, L., Cardini, F., Zamariola, G., Serino, A., & Tsakiris, M. (2015). Your place or mine: Shared sensory experiences elicit a remapping of peripersonal space. *Neuropsychologia*, *70*, 455-461.

Mandel, D. R. (2002). Beyond mere ownership: Transaction demand as a moderator of the endowment effect. *Organizational Behavior and Human Decision Processes*, *88*(2), 737-747.

Mandler, J. M., Seegmiller, D., & Day, J. (1977). On the coding of spatial information. *Memory & Cognition*, *5*(1), 10-16.

Maravita, A., Spence, C., & Driver, J. (2003). Multisensory integration and the body schema: close to hand and within reach. *Current Biology*, *13*(13), 531-539.

Markman, A. B., & Brendl, C. M. (2005). Constraining theories of embodied cognition. *Psychological Science*, *16*(1), 6-10.

Markovic, J., Anderson, A. K., & Todd, R. M. (2014). Tuning to the significant: Neural and genetic processes underlying affective enhancement of visual perception and memory. *Behavioural Brain Research*, *259*, 229-241.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological review*, *98*(2), 224.

Martinelli, P., Sperduti, M., & Piolino, P. (2013). Neural substrates of the self-memory system: New insights from a meta-analysis. *Human brain mapping*, *34*(7), 1515-1529.

McCabe, D. B., & Nowlis, S. M. (2003). The effect of examining actual products or product descriptions on consumer preference. *Journal of Consumer Psychology*, *13*(4), 431-439.

McClelland, D. (1951). *Personality*, New York: Holt, Rinehart, & Winston.

Mevorach, C., Hodsoll, J., Allen, H., Shalev, L., & Humphreys, G. (2010). Ignoring the elephant in the room: a neural circuit to downregulate salience. *Journal of Neuroscience*, *30*(17), 6072-6079.

Milne, J. L., Chapman, C. S., Gallivan, J. P., Wood, D. K., Culham, J. C., & Goodale, M. A. (2013). Connecting the dots: object connectedness deceives perception but not movement planning. *Psychological Science*, 465.

Miskovic, V., & Keil, A. (2012). Acquired fears reflected in cortical sensory processing: a review of electrophysiological studies of human classical conditioning. *Psychophysiology*, *49*(9), 1230-1241.

Mitchell, J. P., Banaji, M. R., & MacRae, C. N. (2005). The link between social cognition and self-referential thought in the medial prefrontal cortex. *Journal of Cognitive Neuroscience*, *17*(8), 1306-1315.

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron*, *50*(4), 655-663.

Mitchell, J. P., Schirmer, J., Ames, D. L., & Gilbert, D. T. (2011). Medial prefrontal cortex predicts intertemporal choice. *Journal of cognitive neuroscience*, *23*(4), 857-866.

Moores, E., Laiti, L., & Chelazzi, L. (2003). Associative knowledge controls deployment of visual selective attention. *Nature neuroscience*, *6*(2), 182-189.

Morewedge, C. K., Shu, L. L., Gilbert, D. T., & Wilson, T. D. (2009). Bad riddance or good rubbish? Ownership and not loss aversion causes the endowment effect. *Journal of Experimental Social Psychology*, *45*(4), 947-951.

Nayakankuppam, D., & Mishra, H. (2005). The endowment effect: Rose-tinted and dark-tinted glasses. *Journal of Consumer Research*, *32*(3), 390-395.

Neisser, U. (1988). Five kinds of self-knowledge. *Philosophical psychology*, *1*(1), 35-59.

Nicolle, A., Klein-Flügge, M. C., Hunt, L. T., Vlaev, I., Dolan, R. J., & Behrens, T. E. (2012). An agent independent axis for executed and modeled choice in medial prefrontal cortex. *Neuron*, *75*(6), 1114-1121.

Niedenthal, P. M. (2007). Embodying emotion. *Science*, 1002–1005.

Niu, Y., Todd, R. M., Kyan, M., & Anderson, A. K. (2012). Visual and emotional salience influence eye movements. *ACM Transactions on Applied Perception*, *9*(3), 1-18.

Northoff, G., & Hayes, D. J. (2011). Is our self nothing but reward?. *Biological Psychiatry*, *69*(11), 1019-1025.

Northoff, G., Heinzel, A., De Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain—a meta-analysis of imaging studies on the self. *Neuroimage*, *31*(1), 440-457.

Northoff, G., Schneider, F., Rotte, M., Matthiae, C., Tempelmann, C., Wiebking, C., ... & Panksepp, J. (2009). Differential parametric modulation of self-relatedness and emotions in different brain regions. *Human brain mapping*, *30*(2), 369-382.

Nuttin, J. M. (1985). Narcissism beyond Gestalt and awareness: The name letter effect. *European Journal of Social Psychology*, *15*(3), 353-361.

Öhman, A. (2002). Automaticity and the amygdala: Nonconscious responses to emotional faces. *Current directions in psychological science*, *11*(2), 62-66.

Ong, L. S., & Tan, J. H. (2015). Sense and sensibility of ownership: Type of ownership experience and valuation of goods. *Journal of Behavioral and Experimental Economics*, *58*, 171-177.

Parvizi, J., & Damasio, A. (2001). Consciousness and the brainstem. *Cognition*, *79*(1), 135-160.

Peck, J., & Shu, S. B. (2009). The effect of mere touch on perceived ownership. *Journal of Consumer Research*, *36*(3), 434-447.

Pelli, D. G. (1997). The VideoToolbox software for visual psychophysics: Transforming numbers into movies. *Spatial vision*, *10*(4), 437-442.

Perry, S. (1997). Male-female social relationships in wild white-faced capuchin monkeys, *Cebus capucinus*. *Behavior, 134*, 477-510.

Peters, J., & Büchel, C. (2010). Neural representations of subjective reward value. *Behavioural brain research*, *213*(2), 135-141.

Pezdek, K., Roman, Z., & Sobolik, K. G. (1986). Spatial memory for objects and words. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(4), 530.

Pick Jr, H. L., & Lockman, J. J. (1981). From frames of reference to spatial representations. *Spatial representation and behavior across the life span: theory and application/edited by LS Liben, AH Patterson, N. Newcombe*.

Pooresmaeili, A., FitzGerald, T. H., Bach, D. R., Toelch, U., Ostendorf, F., & Dolan, R. J. (2014). Cross-modal effects of value on perceptual acuity and stimulus encoding. *Proceedings of the National Academy of Sciences*, *111*(42), 15244-15249.

Pourtois, G., Schettino, A., & Vuilleumier, P. (2013). Brain mechanisms for emotional influences on perception and attention: what is magic and what is not. *Biological psychology*, *92*(3), 492-512.

Prebble, S. C., Addis, D. R., & Tippett, L. J. (2013). Autobiographical memory and sense of self. *Psychological bulletin*, *139*(4), 815.

Previc, F. H. (1998). The neuropsychology of 3-D space. *Psychological bulletin*, *124*(2), 123.

Proffitt, D. R. (2006). Embodied perception and the economy of action. *Perspectives on Psychological Science*, 110–122.

Proverbio, A. M., Adorni, R., & D'Aniello, G. E. (2011). 250ms to code for action affordance during observation of manipulable objects. *Neuropsychologia*, *49*(9), 2711-2717.

R Development Core Team. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, 2008. Available from: http://www.R-project.org.

Raposo, A., Vicens, L., Clithero, J. A., Dobbins, I. G., & Huettel, S. A. (2010). Contributions of frontopolar cortex to judgments about self, others and relations. *Social Cognitive and Affective Neuroscience*, nsq033.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.

Raymond, J. E., & O'Brien, J. L. (2009). Selective visual attention and motivation the consequences of value learning in an attentional blink task. *Psychological Science*, *20*(8), 981-988.

Reb, J., & Connolly, T. (2007). Possession, feelings of ownership and the endowment effect. *Judgment and Decision Making*, *2*(2), 107.

Riddoch, M. J., & Humphreys, G. W. (1987). A case of integrative visual agnosia. *Brain*, *110*(6), 1431-1462.

Riggio, L., Iani, C., Gherri, E., Benatti, F., Rubichi, S., & Nicoletti, R. (2008). The role of attention in the occurrence of the affordance effect. *Acta Psychologica*, *127*(2), 449-458.

Rizzolatti, G., Fadiga, L., Fogassi, L., & Gallese, V. (1997). The space around us. *Science*, *277* (5323), 190-191.

Roberts, K. L., & Humphreys, G. W. (2010). The one that does, leads: action relations influence the perceived temporal order of graspable objects. *Journal of Experimental Psychology: Human Perception and Performance*, *36*(3), 776.

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of personality and social psychology*, *35*(9), 677.

Ruggiero, G., Ruotolo, F., & Iachini, T. (2009). The role of vision in egocentric and allocentric spatial frames of reference. *Cognitive processing*, *10*(2), 283-285.

Rushworth, M. F., Passingham, R. E., & Nobre, A. C. (2005). Components of attentional set-switching. *Experimental psychology*, *52*(2), 83-98.

Schlosser, A. E. (2003). Experiencing products in the virtual world: the role of goal and imagery in influencing attitudes versus purchase intentions. *Journal of consumer research*, *30*(2), 184-198.

Schmitz, T. W., & Johnson, S. C. (2006). Self-appraisal decisions evoke dissociated dorsal—ventral aMPFC networks. *Neuroimage*, *30*(3), 1050-1058.

Schneider, K. A., & Bavelier, D. (2003). Components of visual prior entry. *Cognitive psychology*, *47*(4), 333-366.

Seibt, B., Neumann, R., Nussinson, R., & Strack, F. (2008). Movement direction or change in distance? Self-and object-related approach–avoidance motions. *Journal of Experimental Social Psychology*, *44*(3), 713-720.

Serences, J. T., & Saproo, S. (2010). Population response profiles in early visual cortex are biased in favor of more valuable stimuli. *Journal of Neurophysiology*, *104*(1), 76-87.

Shaw, A., Li, V., & Olson, K. R. (2012). Children apply principles of physical ownership to ideas. *Cognitive Science*, *36*(8), 1383-1403.

Shore, D. I., Spence, C., & Klein, R. M. (2001). Visual prior-entry. *Psychological Science*, *12*(3), 205-212.

Sigg, H., & Falett, J. (1985). Experiments on the respect of possession and property inhamadryas baboons (*Papio hamadryas*). *Animal Behavior, 33*, 978-984.

Singelis, T. M. (1994). The measurement of independent and interdependent self-construals. *Personality and Social Psychology Bulletin*, *20*(5), 580-591.

Snow, J. C., Pettypiece, C. E., McAdam, T. D., McLean, A. D., Stroman, P. W., Goodale, M. A., & Culham, J. C. (2011). Bringing the real world into the fMRI scanner: Repetition effects for pictures versus real objects. *Scientific reports*, *1*, 130. doi:10.1038/srep00130

Snow, J. C., Skiba, R. M., Coleman, T. L., & Berryhill, M. E. (2014). Real-world objects are more memorable than photographs of objects. *Frontiers in human neuroscience*, *8*. doi: 10.3389/fnhum.2014.00837

Sokol-Hessner, P., Hsu, M., Curley, N. G., Delgado, M. R., Camerer, C. F., & Phelps, E. A. (2009). Thinking like a trader selectively reduces individuals' loss aversion. *Proceedings of the National Academy of Sciences*, *106*(13), 5035-5040.

Sparks, S., Cunningham, S. J., & Kritikos, A. (2016). Culture modulates implicit ownership-induced self-bias in memory. *Cognition*, *153*, 89-98.

Spence, C., & Parise, C. (2010). Prior-entry: A review. *Consciousness and cognition*, *19*(1), 364-379.

SR Research Experiment Builder (2007). [Computer software]. Mississauga: SR Research Ltd.

Sriram, N., & Greenwald, A. G. (2009). The brief implicit association test. *Experimental psychology*, *56*(4), 283-294.

Stelmach, L. B., & Herdman, C. M. (1991). Directed attention and perception of temporal order. *Journal of Experimental Psychology: Human Perception and Performance*, *17*(2), 539.

Steketee, G., & Frost, R. (2010). *Stuff: Compulsive hoarding and the meaning of things*. Houghton Mifflin Harcourt.

Sternberg, S., Knoll, R. L., & Gates, B. A. (1971, November). Prior entry reexamined: Effect of attentional bias on order perception. In *meeting of the Psychonomic Society, St. Louis, Missouri*.

Strahilevitz, M. A., & Loewenstein, G. (1998). The effect of ownership history on the valuation of objects. *Journal of Consumer Research*, *25*(3), 276-289.

Suh, J., & Abrams, R. A. (2015). Reduced object-based perception in the near-hand space. *Experimental brain research*, *233*(12), 3403-3412.

Sui, J., & Humphreys, G. W. (2015a). The interaction between self-bias and reward: Evidence for common and distinct processes. *The Quarterly Journal of Experimental Psychology*, *68*(10), 1952-1964.

Sui, J., & Humphreys, G. W. (2015b). The Integrative Self: How Self-Reference Integrates Perception and Memory. *Trends in cognitive sciences*, *19*(12), 719-728.

Sui, J., He, X., & Humphreys, G. W. (2012). Perceptual effects of social salience: evidence from self-prioritization effects on perceptual matching. *Journal of Experimental Psychology: Human Perception and Performance*, *38*(5), 1105.

Sui, J., Liu, M., Mevorach, C., & Humphreys, G. W. (2015). The salient self: The left intraparietal sulcus responds to social as well as perceptual-salience after self-association. *Cerebral Cortex*, *25*(4), 1060-1068.

Sui, J., Rothstein, P., & Humphreys, G. W. (2013). Coupling social attention to the self forms a network for personal significance. *Proceedings of the National Academy of Sciences*, 110(19), 7607-7612.

Sul, S., Choi, I., & Kang, P. (2012). Cultural modulation of self-referential brain activity for personality traits and social identities. *Social Neuroscience*, *7*(3), 280-291.

Sun, H. M., & Thomas, L. E. (2013). Biased attention near another's hand following joint action. *Frontiers in Psychology*, 4. doi: 10.3389/fpsyg.2013.00443

Symes, E., Tucker, M., Ellis, R., Vainio, L., & Ottoboni, G. (2008). Grasp preparation improves change detection for congruent objects. *Journal of Experimental Psychology: Human Perception and Performance*, *34*(4), 854.

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: a meta-analysis. *Psychological bulletin*, *121*(3), 371.

Tacikowski, P., Brechmann, A., Marchewka, A., Jednoróg, K., Dobrowolny, M., & Nowicka, A. (2011). Is it about the self or the significance? An fMRI study of self-name recognition. *Social Neuroscience*, *6*(1), 98-107.

Tao, R., Zhang, S., Li, Q., & Geng, H. (2012). Modulation of self-esteem in self-and other-evaluations primed by subliminal and supraliminal faces. *PloS one*, *7*(10), e47103. https://doi.org/10.1371/journal.pone.0047103

Teneggi, C., Canzoneri, E., di Pellegrino, G., & Serino, A. (2013). Social modulation of peripersonal space boundaries. *Current biology*, *23*(5), 406-411.

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization*, *1*(1), 39-60.

Todd, R. M., Cunningham, W. A., Anderson, A. K., & Thompson, E. (2012). Affect-biased attention as emotion regulation. *Trends in cognitive sciences*, *16*(7), 365-372.

Tolin, D. F., Frost, R. O., Steketee, G., & Fitch, K. E. (2008). Family burden of compulsive hoarding: results of an internet survey. *Behaviour research and therapy*, *46*(3), 334-344.

Tong, F., & Nakayama, K. (1999). Robust representations for faces: evidence from visual search. *Journal of Experimental Psychology: Human Perception and Performance*, *25*(4), 1016.

Truong, G., Turk, D. J., & Handy, T. C. (2013). An unforgettable apple: Memory and attention for forbidden objects. *Cognitive, Affective, & Behavioral Neuroscience*, *13*(4), 803-813.

Tsakiris, M., Schütz-Bosbach, S., & Gallagher, S. (2007). On agency and body-ownership: phenomenological and neurocognitive reflections. *Consciousness and cognition*, *16*(3), 645-660.

Tseng, P., & Bridgeman, B. (2011). Improved change detection with nearby hands. *Experimental Brain Research*, 209, 257-269.

Tsuchiya, N., Moradi, F., Felsen, C., Yamazaki, M., & Adolphs, R. (2009). Intact rapid detection of fearful faces in the absence of the amygdala. *Nature neuroscience*, *12*(10), 1224-5.

Turatto, M., & Galfano, G. (2000). Color, form and luminance capture attention in visual search. *Vision research*, *40*(13), 1639-1643.

Turk, D. J., Brady-van den Bos, M., Collard, P., Gillespie-Smith, K., Conway, M. A., & Cunningham, S. J. (2013). Divided attention selectively impairs memory for self-relevant information. *Memory & cognition*, *41*(4), 503-510.

Turk, D. J., van Bussel, K., Brebner, J. L., Toma, A. S., Krigolson, O., & Handy, T. C. (2011). When "it" becomes "mine": Attentional biases triggered by object ownership. *Journal of Cognitive Neuroscience*, *23*(12), 3725-3733.

Tversky, B., & Hard, B. M. (2009). Embodied and disembodied cognition: Spatial perspective-taking. *Cognition*, *110*(1), 124-129.

Van Damme, S., Gallace, A., Spence, C., Crombez, G., & Moseley, G. L. (2009). Does the sight of physical threat induce a tactile processing bias? Modality specific facilitation of attention induced by viewing threatening pictures. *Brain Research*, 1253, 100–106.

van den Bos, M., Cunningham, S. J., Conway, M. A., & Turk, D. J. (2010). Mine to remember: The impact of ownership on recollective experience. *The Quarterly Journal of Experimental Psychology*, *63*(6), 1065-1071.

Van Dijk, E., & Van Knippenberg, D. (1998). Trading wine: On the endowment effect, loss aversion, and the comparability of consumer goods. *Journal of Economic Psychology*, *19*(4), 485-495.

Van Dantzig, S., Zeelenberg, R., & Pecher, D. (2009). Unconstraining theories of embodied cognition. *Journal of Experimental Social Psychology*, *45*(2), 345-351.

Varnum, M. E., Shi, Z., Chen, A., Qiu, J., & Han, S. (2014). When "Your" reward is the same as "My" reward: Self-construal priming shifts neural responses to own vs. friends' rewards. *NeuroImage*, *87*, 164-169.

Vibell, J., Klinge, C., Zampini, M., Spence, C., & Nobre, A. C. (2007). Temporal order is coded temporally in the brain: early event-related potential latency shifts underlying prior entry in a cross-modal temporal order judgment task. *Journal of Cognitive Neuroscience*, *19*(1), 109-120.

Vogt, J., De Houwer, J., Crombez, G., & Van Damme, S. (2013). Competing for attentional priority: temporary goals versus threats. *Emotion*, *13*(3), 587.

Wagner, D. D., Haxby, J. V., & Heatherton, T. F. (2012). The representation of self and person knowledge in the medial prefrontal cortex. *Wiley Interdisciplinary Reviews: Cognitive Science*, *3*(4), 451-470.

Wang, C., Oyserman, D., Liu, Q., Li, H., & Han, S. (2013). Accessible cultural mind-set modulates default mode activity: Evidence for the culturally situated brain. *Social neuroscience*, *8*(3), 203-216.

Wang, G., Mao, L. Ma, Y., Yang, X., Cao, J., Liu, X., Wang, J., Wang, X., & Han. S. (2012). Neural representations of close others in collectivistic brains. *Social cognitive affective neuroscience*, 7, 222-229.

West, G. L., Anderson, A. A., Ferber, S., & Pratt, J. (2011). Electrophysiological evidence for biased competition in V1 for fear expressions. *Journal of Cognitive Neuroscience*, *23*(11), 3410-3418.

West, G. L., Anderson, A. A., & Pratt, J. (2009). Motivationally significant stimuli show visual prior entry: evidence for attentional capture. *Journal of Experimental Psychology: Human Perception and Performance*, *35*(4), 1032.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review, 9*(4), 625-636.

Yang, S.-J., Beilock, S. L. (2011). Seeing and doing: Ability to act moderates orientation effects in object perception. *The Quarterly Journal of Experimental Psychology*, 64(4), 639-648.

Yaoi, K., Osaka, N., & Osaka, M. (2009). Is the self special in the dorsomedial prefrontal cortex? An fMRI study. *Social neuroscience*, *4*(5), 455-463.

Ye, Y., & Gawronski, B. (2016). When possessions become part of the self: Ownership and implicit self-object linking. *Journal of Experimental Social Psychology*, *64*, 72-87.

Young, A. W., & Ellis, H. D. (1989). Childhood prosopagnosia. *Brain and cognition*, *9*(1), 16-47.

Yates, M. J., & Nicholls, M. E. (2009). Somatosensory prior entry. *Attention, Perception, & Psychophysics*, *71*(4), 847-859.

Zampini, M., Shore, D. I., & Spence, C. (2005). Audiovisual prior entry. *Neuroscience letters*, *381*(3), 217-222.

Zhang, T., Zhu, Y., & Wu, Y. (2014). Losing oneself upon placement in another's position: The influence of perspective on self-referential processing. *Consciousness and cognition*, *27*, 53-61.

Zhang, Y., & Fishbach, A. (2005). The role of anticipated emotions in the endowment effect. *Journal of Consumer Psychology*, *15*(4), 316-324.

Zhao, K., Wu, Q., Zimmer, H. D., & Fu, X. (2011). Electrophysiological correlates of visually processing subject's own name. *Neuroscience letters*, *491*(2), 143-147.

Zhao, W., Feng, T., & Kazinka, R. (2014). The extensibility of the endowment effect to others is mediated by degree of intimacy. *Asian Journal of Social Psychology*, *17*(4), 296-301.

Zhao, L., Cosman, J. D., Vatterott, D. B., Gupta, P., & Vecera, S. P. (2014). Visual statistical learning can drive object-based attentional selection. *Attention, Perception, & Psychophysics*, *76*(8), 2240-2248.

Zhu, Y., & Han, S. (2008). Cultural differences in the self: From philosophy to psychology and neuroscience. *Social and Personality Psychology Compass*, *2*(5), 1799-1811.

Zhu, Y., & Zhang, L. (2002). An experimental study on the self-reference effect. *Science in China Series C: Life Sciences*, *45*(2), 120-128.

Zhu, Y., Zhang, L., Fan, J., & Han, S. (2007). Neural basis of cultural influence on self-representation. *Neuroimage*, *34*(3), 1310-1316.

Zysset, S., Huber, O., Ferstl, E., von Cramon, D. Y. (2002). The anterior frontomedian cortex and evaluative judgment: an fMRI study. *NeuroImage*, 15, 983-991.

Appendix A. Math worksheet filler task

Math Problems

Subject ID:
Date:

Please complete the following math problems.

-21 - 28 =	9 ÷ 9 =	7 ÷ 7 =
36 – 20 =	6 x 5 =	10 ÷ 1 =
8 x 1 =	2 ÷ 2 =	3 x 4 =
82 + 9 =	5 x 9 =	0 x 56 =
9 x 8 =	63 ÷ 7 =	64 ÷ 8 =
4 x 10 =	76 – 17 =	-55 + 53 =
73 + -23 =	81 – 69 =	7 x 5 =
57 + 23 =	67 + 3 =	4 x 9 =
27 – 46 =	23 x 2 =	2 + 2 =
45 ÷ 9 =	88 – 46 =	-91 – 4 =
6 x 2 =	0 ÷ 9 =	5 ÷ 5 =
65 + 67 =	6 ÷ 2 =	7 x 12 =
5 x 11 =	56 x 2 =	2 + 15 =
42 + 72 =	98 – 99 =	13 x 5 =
98 – 23 =	78 – 98 =	7 ÷ 7 =
26 + 23 =	45 – 27 =	13 – 57 =
44 ÷ 2 =	0 ÷ 6 =	42 ÷ 6 =
50 ÷ 2 =	38 ÷ 38 =	75 x 2 =
45 – 2 =	45 – 65 =	-24 + 4 =
5 x 2 =	3 + 7 =	42 ÷ 42 =
24 x 4 =	26 + 26 =	4 x 1 =
4 x 7 =	22 ÷ 2 =	0 ÷ 33 =
57 – 85 =	-22 + 22 =	-45 – 21 =
65 + -42 =	23 + -14 =	55 – 5 =
27 – 5 =	27 x 5 =	3 x 9 =
4 x 7 =	7 x 12 =	1 + 3 =
32 – 27 =	31 – 11 =	4 x 9 =
50 ÷ 2 =	44 ÷ 4 =	11 ÷ 11 =
49 ÷ 7 =	2 x 41 =	5 – 20 =
5 + -12 =	23 x 1 =	42 + 20 =
35 ÷ 5 =	40 x 4 =	22 – 1 =
6 + 20 =	46 ÷ 23 =	37 + 18 =

Please turn the page over.

Math Problems

Subject ID:
Date:

0 ÷ 31 =	24 x 1 =	2 + 19 =
-21 - 2 =	-12 – 5 =	-11 – 2 =
-31 - 2 =	14 ÷ 7 =	4 x 12 =
4 x 9 =	14 ÷ 1 =	24 – 1 =
32 – 12 =	69 + -11 =	12 + -11 =
41 – 11 =	5 x 5 =	1 x 99 =
99 ÷ 11 =	7 + 3 =	22 – 11 =
0 ÷ 11 =	23 x 3 =	11 x 1 =
-21 + 2 =	-17 + 4 =	0 ÷ 12 =
26 x 6 =	21 x 2 =	45 ÷ 9 =

Appendix B. Contrast conditions across a sampling of neuroimaging studies comparing "self" to "other."

Some papers appear more than once when they include more than one contrast condition.

Authors	Year of Publication	Contrast condition
		Famous Person
Craik, Moroz, Moscovitch, Stuss, Winocur, Tulving, Kapur	1999	Brian Mulroney (politician)
Kelley, Macrae, Wyland, Caglar, Inati, Heatherton	2002	George Bush (politician)
Kjaer, Nowak, Lou	2002	Danish Queen
Lou, Luber, Crupain, Keenan, Nowak, Kjaer, Sakeim, Lisanby	2004	Danish Queen (politician)
Platek, Keenan, Gallup, Mohamed	2004	Famous people (multiple, not specified)
D'Argembeau, Collete, Van der Linden, Laureys, Del Fiore, Degueldre, Luxen, Salmon	2005	French president, French singer, Belgian princess
Zhu, Zhang, Fan, Han	2007	Bill Clinton (politician), Rongji Zhu (Chinese politician)
Gutchess, Kensinger, Schacter	2007	Albert Einstein
Yaoi, Osaka, Osaka	2009	Japanese prime minister
Lombardo, Chakrabarti, Bullmore, Wheelwright, Sadek, Sucklin, Baron-Cohen	2009	Dutch prime minister
van Buuren, Gladwin, Zandbelt, Kahn, Vink	2010	Famous people (multiple, not specified)
Tacikowski, Nowicka	2010	Famous person (not specified)
Tacikowski, Brechmann, Marchewka, Jednorog, Dobrowolny, Nowicka	2011	George Bush (politician)
Jenkins, Mitchell	2011	George Bush (politician)
Ma, Bang, Wang, Allen, Frith, Roepstorff, Han	2012	Gender/nation-matched athlete
Sul, Choi, Kang	2012	Famous Korean entrepreneur
Tamir, Mitchell	2012	George Bush (politician), Obama (politician)

Authors	Year of Publication	Contrast condition
		Close Others
Kircher, Senior, Phillips, Benson, Bullmore, Brammer, Simmnos, Williams, Bartels, David	2000	Female romantic partners (male subjects)
Lou, Luber, Crupain, Keenan, Nowak, Kjaer, Sakeim, Lisanby	2004	Best friend
Seger, Stone, Keenan	2004	Friend
Schmitz, Kawahara-Baccus, Johnson	2004	Close friend or close relative
Heatherton, Wyland, Macrae, Demos, Denny, Kelley	2006	Best friend
Ochsner, Beer, Robertson, Cooper, Gabrieli, Kihsltrom, D'Esposito	2005	Close friend
D'Argembeau, Ruby, Collette, Degueldre, Balteau, Luxen, Maquet, Salmon	2007	Close friend
Zhu, Zhang, Fan, Han	2007	Mother
D'Argembeau, Feyers, Majerus, Collette, Van der Linden, Maquet, Salmon	2008	Close friend
Vanderwal, Hunyadi, Grupe, Connors, Schultz	2008	Mother
Yaoi, Osaka, Osaka	2009	Close friend (gender-matched)
Lou, Luber, Stanford, & Lisanby	2010	Best friend
Ng, Han, Mao, Lai	2010	Mother
Tacikowski, Brechmann, Marchewka, Jednorog, Dobrowolny, Nowicka	2011	Significant other
Ramasubbu, Masalovich, Gaxiola, Peltier, Holtzheimer, Heim, Goodyear, MacQueen, Mayberg	2011	Mother
Wang, Mao, Ma, Yang, Cao, Liu, Wang, Wang, Han	2012	Mother, father, best friend
Sui, Rothstein, Humphreys	2013	Best friend
Sui, Liu, Mevorach, Humphreys	2015	Best friend
		Familiar others
Sui, Han	2007	Familiar person (same gender)
Devue, Collete, Baltrau, Degueldre, Luxen, Maquet, Bredart	2007	Colleague

Authors	Year of Publication	Contrast condition
		Familiar others (continued)
Modinos, Ormel, Aleman	2009	Classmate or teammate (no best friends or romantic partners)
Kang, Hirsch, Chasteen	2010	Friend (present)
Qin, Liu, Shi, Wang, Duncan, Gong, Weng, Northoff	2010	Friend
Ramasubbu, Masalovich, Gaxiola, Peltier, Holtzheimer, Heim, Goodyear, MacQueen, Mayberg	2011	Female friends (gender-matched)
Chen, Zhang, Zhong, Hu, Li	2013	Familiar name (compared to own name)
Moore, Merchant, Kahn, Pfeifer	2014	Similar peers
		Research team
Farrer, Frith	2002	Experimenter
Turk, van Bussel, Brebner, Toma, Krigolson, Handy	2011	Experimenter
Turk, van Bussel, Waiter, Macrae	2011	Experimenter
Kim, Johnson	2012	Alex (not further specified)
Truong, Turk, Handy	2013	Experimenter
		Strangers or Fictional people
Mitchell, Macrae, Banaji	2006	Hypothetical similar other, hypothetical dissimilar other
Miyakoshi, Nomura, Ohira	2007	Other participant (absent)
Ames, Jenkins, Banaji, Mitchell	2008	Fictional individual other
Jenkins, Macrae, Mitchell	2008	Hypothetical similar other, hypothetical dissimilar other
Kang, Hirsch, Chasteen	2010	Stranger (present in lab)
Harada, Li, Chiao	2010	Stranger
Tacikowski, Nowicka	2010	Strangers (multiple)
Chen, Yuan, Feng, Chen, Gu, Li	2011	American (foreign, hypothetical) name
Hu, Wu, Fu	2011	Hypothetical (individual specific) other
Ramasubbu, Masalovich, Gaxiola, Peltier, Holtzheimer, Heim, Goodyear, MacQueen, Mayberg	2011	Strangers

Authors	Year of Publication	Contrast condition
		Strangers or Fictional people (continued)
Fields, Kuperberg	2012	Hypothetical (individual specific) other
Sui, He, Humphreys	2012	Stranger
Tamir, Mitchell	2012	Hypothetical (individual specific) other
Sui, Rothstein, Humphreys	2013	Stranger
Fields, Kuperberg	2015	Hypothetical (individual specific) other
Sui, Humphreys	2015	Stranger