AN INVESTIGATION OF SELF-BIASES IN PERCEPTION AND VISUAL PERSPECTIVE TAKING

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ABSTRACT

This thesis addressed three questions regarding our tendency to prioritise recently learned self-associations. Following an overview of cognitive self-biases in Chapter 1, Chapter 2 explored how novel self-associations impact higher-level social cognition, namely, visual perspective taking (VPT). In Experiments 1–3, we examined how participants respond to third-person perspectives (3PPs) associated with self and other. Participants showed superior performance when explicitly targeting a self-associated (vs. other-associated) 3PP. Chapter 3 extended this line of research by examining whether these self-bias effects are related to social-cognitive ability and executive function. In Experiments 4–5, we found that both individual differences in empathy and putative age-relevant motivations reliably modulated self-bias in third-person VPT. These findings suggest that VPT paradigms draw on domain-specific and domain-general capacities. Chapter 4 examined the extent to which interpersonal dimensions (e.g., day-to-day personal relevance and valence) may explain self-tagging effects. Using behavioural and fMRI methodology, Experiments 6–8 showed that self-processing was largely independent of responses to relevance and valence in others. Finally, Chapter 5 provides a broader discussion of findings from the preceding chapters, offering some possible future research directions.

DEDICATION

I dedicate this thesis to my parents who, long before I ever read the words *Per Ardua Ad Alta*, taught me by example to work diligently and be the best that I can be. I am immensely grateful for their loving support and for their patience with my propensity to live in places very far from home.

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The work reported in this thesis was made possible thanks to the support of many[1]. I would first like to acknowledge my supervisors Drs. Kim Quinn (#kimquinn) and Pia Rotshtein who guided me throughout these three years. Through Kim and Pia, I benefitted greatly from exposure to, and integration of, social psychology and cognitive neuroscience approaches. I also benefitted from Kim's and Pia's evident passion both for research and life in general. Working with them, I learned just how enjoyable the research process can be. (After all, how many social cognition researchers have their own hashtag?) I can't thank Kim and Pia enough for the training I have received here at Birmingham.

Beyond my supervisors, I received key feedback on my work from a number of researchers at Birmingham and beyond. I would like to thank Prof. Ian Apperly for kindly inviting me to attend his lab meetings. Ian and his lab members were very helpful during the initial design and subsequent development of the 3PP-3PP and 1PP-3PP paradigms reported in Chapters 2–3. I would also like to thank Drs. Jie Sui and Dana Samson, whose research on self-tagging and visual perspective taking, respectively, inspired the development of the 3PP-3PP and 1PP-3PP paradigms. I am most grateful for their insightful comments on my findings at various stages. I also thank Dr. Biman Chakraborty at the University of Birmingham for his comments on the sensitivity analyses reported in Experiments 6–7. I would also like to thank the members of the Friday morning cognitive neuroscience breakfast group. I'm grateful both for the feedback I received in those meetings as well as members' patience with my occasional

[1] Because this work is truly a collaborative effort, this is the only section of the thesis where the reader will find the first-person pronoun (notwithstanding the Jamesian "I" in Chapter 1 and incidental item descriptions). I instead use "we" when adopting the active voice in the main text.

badgering of volunteers to give presentations. Finally, I would like to thank my former office mates, in particular Robin Green and Ahmad Abu-Akel, both of whom offered friendly support and thoughtful advice on projects, career development, and life in the UK.

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GLOSSARY

1PP	First-Person Perspective
1PP-3PP Task	First- versus Third-Person Perspective-Taking Task
3PP	Third-Person Perspective
3PP-3PP Task	Third-Person Perspective-Taking Task
AC–PC Axis	Axis from Anterior Commissure to Posterior Commissure
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
BOLD Signal	Blood Oxygenation Level Dependent Signal
DARTEL	Diffeomorphic Anatomical Registration using Exponentiated Lie Algebra
DLPFC	Dorsolateral Prefrontal Cortex
DMPFC	Dorsomedial Prefrontal Cortex
EPI	Echo-Planar Image
fMRI	Functional Magnetic Resonance Imaging
FWE	Family-Wise Error
FWHM	Full-Width Half Maximum
GBP	British Pound Sterling
GLM	General Linear Model
HRF	Haemodynamic Response Function
IFG	Inferior Frontal Gyrus
IPL	Inferior Parietal Lobule
IPS	Intra-Parietal Sulcus
IRI	Interpersonal Reactivity Index
MFG	Middle Frontal Gyrus
MNI	Montreal Neurological Institute
OFC	Orbitofrontal Cortex
PET	Positron Emission Tomography
POS	Parieto-Occipital Sulcus
pSTS	Posterior Superior Temporal Sulcus
RMB	Chinese Yuan
RT	Response Time
SAN	Self-Attention Network
SCM	Stereotype Content Model
SFG	Superior Frontal Gyrus
SMG	Supra-Marginal Gyrus
SPM12	Statistical Parametric Mapping, Version 12
TPJ	Temporo-Parietal Junction
V6	Visual Area 6, Occipital Lobe
VMPFC	Ventral Medial Prefrontal Cortex
VPT	Visual Perspective Taking
Z_{RT}	Z-Transformed Response Time

CHAPTER 1: REVIEW OF COGNITIVE SELF BIASES

Philosophers and psychologists alike have long considered the self to be comprised of at least two components, one that perceives and another that is displayed and seen by others (see Damasio, 1999; Gallagher, 2000; James, 1890). The perceived self (Jamesian "me"), refers to aspects of the self that are externally accessible. Examples of this aspect of the self include one's own face, voice, name, and may even be extended to include one's own belongings (Beggan, 1992). The perceiving self (Jamesian "I") refers to those aspects of the self that are intrinsic to subjective consciousness. Thus, the perceiving self is thought to include phenomena such as interoceptive awareness (Seth, 2013) and the general sense that reality is coherent and fluidly organised around a unitary point (Sass & Parnas, 2003). Although the perceiving self is notoriously difficult to study (S. B. Klein, 2012), the perceived self has generated much research. Consequently, this thesis is primarily concerned with the perceived self. In this chapter, we provide a review of key self biases in memory and attention prior to outlining the programme of research covered in subsequent chapters.

1.1. Self-Priority Effects in Memory

One of the first popular approaches to the perceived self was in the field of memory. Initial reports suggested that perceivers are more likely to remember stimuli processed in reference to the self (Rogers, Kuiper, & Kirker, 1977). Subsequently coined the "self-reference effect", this phenomenon has been replicated numerous times (see Symons & Johnson, 1997, for a meta-analysis). This memory advantage for self-relevant information is thought to be due to the elaborate structure of the self-concept, which facilitates the assimilation of new information into memory (Markus, 1977). Notably, these memory improvements are observed for both explicitly and minimally self-relevant stimuli. In one study on minimal self-relevance (Cloutier & Macrae, 2008), pairs of participants sequentially selected numbers either from a bowl ("selected" condition) or from pre-sorted piles of numbers placed in front of each participant ("assigned" condition). These numbers were paired with trait words that were spoken aloud by the experimenter to both participants. Memory for words selected by the self (versus those chosen by the other dyad member) was better in the "selected" condition relative to the arguably less self-involved "assigned" condition. In summary, it appears that explicit self-related processing is not necessary to obtain a self-reference memory effect.

The phenomenon of superior encoding of self-relevant stimuli also extends to the social domain. Dual-process models of person perception (e.g., Brewer & Feinstein, 1999; Fiske, Lin, & Neuberg, 1999) propose that a social target's personal relevance is a key determinant of the extent to which the perceiver individuates and ultimately remembers that target (see also Quinn & Rosenthal, 2012). In these models, individuation refers to a tendency to encode and elaborate on person-specific information rather than relying on minimal category-based processing. For example, if the social target happens to be from one's own ingroup or a co-worker, that person is likely to be processed in more depth (i.e., individuated) than a stranger belonging to an outgroup, who is summarily processed as non-individuated representative of a relatively non-specific social category (e.g., immigrant). Inspired by classic models of person perception, an extensive literature has demonstrated that perceivers indeed show general processing and memory deficits for low-relevance outgroup members (Hugenberg & Sacco, 2008; Hugenberg, Young, Bernstein, & Sacco, 2010). Notably, this tendency is reduced when outgroup targets become personally relevant either through experience (Hancock & Rhodes, 2008; Rhodes et al., 2009) or the sudden introduction of interdependence (e.g., classification of an otherwise outgroup individual as part of one's ingroup: Bernstein, Young, & Hugenberg, 2007; Cassidy, Boutsen, Humphreys, & Quinn, 2014; Cassidy, Quinn, & Humphreys, 2011; Hehman, Mania, & Gaertner, 2010; Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008).

1.2. Self-Priority Effects in Attention

Beyond memory, the self also appears to guide attention. Despite our ability to hone our attention on one aspect of a perceptually noisy environment (e.g., a quiet conversation, as in the cocktail party effect; Moray, 1959; Wood & Cowan, 1995a), we are especially likely to experience interference from unattended cues if they are self-relevant (e.g., one's own first name; A. R. A. Conway, Cowan, & Bunting, 2001; Moray, 1959; Wood & Cowan, 1995b). Additional work supports the notion that self-relevant information captures attention relative to non-self-relevant information both when it is detrimental to conscious task performance (Geller & Shaver, 1976; Hull & Levy, 1979) and presented outside of conscious awareness (Bargh, 1982). However, attentional effects of self-related stimuli are not limited to words and auditory stimuli. Visual stimuli such as one's own face elicit faster behavioural responses (Keenan et al., 1999; Sui, Zhu, & Han, 2006) and are harder than other faces to ignore (Brédart, Delchambre, & Laureys, 2006; Devue & Brédart, 2008). Moreover, self-face recognition is thought to be supported by different brain regions compared to well-liked and personally familiar faces (Keenan, Wheeler, Gallup, & Pascual-Leone, 2000; Sugiura et al., 2012; Sui, Liu, & Han, 2009).

One difficulty with existing approaches to the self in both memory and attention is that the self is frequently confounded with variables such as familiarity or valence. For example, we are more familiar with our own faces and names than those of others. However, one approach pioneered by Jie Sui and colleagues known as "self-tagging" involves using novel associations with neutral stimuli (e.g., geometric shapes) to study the neurocognitive characteristics of the self. This approach thus bypasses concerns that self-stimuli are somehow more familiar or likeable. Critically, it has revealed that even these novel self-associations with simple geometric shapes can have remarkably robust attentional effects (e.g., Sui, Liu, Wang, & Han, 2009). In an initial study of self-tagging, Sui and colleagues (Sui, He, & Humphreys, 2012), used a simple 60-second procedure in which participants were first given shape–identity associations (e.g., "Mary [the stated best friend of the participant] is a circle; you are a triangle; and a stranger is represented by a square"), and then completed a task in which they were required to indicate the name of the person associated with a given shape presented in written form (e.g., "triangle"). Following this induction, self-tagging effects were assessed in a perceptual-matching task in which each trial presented a geometric shape (e.g., picture of a triangle) and a name label (e.g., "Mary"), and participants indicated whether the shape and label were correctly paired or not. This social-tagging procedure resulted in facilitated performance on self-shape trials relative to other trials (Sui et al., 2012; Sui, Rotshtein, & Humphreys, 2013). Sui and colleagues (2012) also showed that sensitivity to self-associated shapes remained high even after the stimuli were degraded by reducing the contrast; this was not the case for shapes associated with others. Subsequent research provides evidence of a relatively automatic expectancy bias (Sui, Sun, Peng, & Humphreys, 2014) and salience (Sui, Liu, Mevorach, & Humphreys, 2015) associated with self-tagged shapes, but not other-tagged shapes. Attentional biases stemming from such novel self-associations have also been documented in movement (Frings & Wentura, 2014) and social cognition (Mattan, Quinn, Apperly, Sui, & Rotshtein, 2015; Mattan, Rotshtein, & Quinn, in press).

Consistent with the attentional effects of self-tagging in the behavioural literature reviewed above, neuroimaging studies on the perception of novel self-associations highlight regions in the fronto-parietal attentional network (DLPFC, IPS) as well as regions more frequently implicated in self-processing such as the VMPFC and pSTS (see Humphreys & Sui, 2015). Similarly, self-tagged stimuli also facilitate visual selection by altering perceptual salience, with a corresponding increase in left IPS activity (Sui, Liu, et al., 2015). Notably, although it has been proposed that the self is intrinsically tied to reward (Northoff & Hayes, 2011; Tamir & Mitchell, 2012), current findings provide some evidence that self-tagging is partially distinct from reward-tagging (i.e., associating stimuli with financial incentive rather than people). Existing neuroimaging findings have not implicated any primary reward regions in the processing of self-tagged stimuli. A similar conclusion may be warranted from the behavioural literature. Relative to reward (and non-self shapes), self-tagging effects are more resistant to stimulus degradation (Sui et al., 2012), tend to be processed in a more integrated fashion (Sui, Yankouskaya, & Humphreys, 2015), and are more closely tied to motivation (Sui & Humphreys, 2015).

1.3. Overview of Research Programme

This thesis addressed three broad but interconnected questions regarding our tendency to prioritise people and objects associated with the self.

In Chapter 2, we asked whether the robust self-tagging effects reviewed above may extend to higher-level social cognition, namely, visual perspective taking (VPT). Specifically, we examined how participants respond to visual perspectives tagged with self- and other-associations. Critical to this approach is that we presented both self and other as third-person perspectives. True to everyday life, most of the VPT literature (e.g., David et al., 2006; Samson, Apperly, Braithwaite, Andrews, & Bodley Scott, 2010) confounds the self with the first-person perspective (1PP) and others with the third-person perspective (3PP).

We therefore examine what self-biases may be attributable to perspective (1PP vs. 3PP) and what may be attributable to self-relevant versus other-relevant 3PPs.

In Chapter 3, we extended the above research by examining whether the self-bias effects observed in Chapter 2 are related to social-cognitive ability (e.g., empathy, age-relevant motivations) and more domain-general abilities such as executive function. In approaching this question, we draw considerably on work from the empathy and ageing literatures.

In Chapter 4, we explored the extent to which interpersonal dimensions such as day-to-day relevance and valence may explain self-tagging effects, on the assumption that the self is both highly relevant and positive relative to others. Using both behavioural and fMRI methodology, we found evidence for self-effects that were independent of responses to relevance and valence in others. Findings from this line of work touch on work in other-based social cognition and in the study of self-perception. Implications for both literatures are discussed.

Finally, Chapter 5 offers a brief general discussion and some possible future directions based on the research presented in the empirical chapters.

CHAPTER 2: SELF-TAGGING OF VISUAL PERSPECTIVES[2]

2.1. Introduction

2.1.1. Review of Existing Visual-Spatial Perspective-Taking Paradigms

For most, the social world is characterised by multiple perspectives, each competing for attention. From one-to-one conversations to larger group interactions and activities, every participating individual has his or her own perspective on the state of the world, and these perspectives frequently differ. Successful social interaction (e.g., teamwork) thus requires the tracking and management of these perspectives. Indeed, whether and how these perspectives are prioritised is implicated in research ranging from stereotyping (e.g., Galinsky & Moskowitz, 2000) to visual attention (e.g., Keysar, Barr, Balin, & Brauner, 2000; Samson et al., 2010). One means of prioritising amongst perspectives is by their degree of relevance (e.g., self-relevant vs. other-relevant people). To what extent do perceivers prioritise perspectives that are closely tied to their own sense of self? If such perspectives are prioritised, does this occur automatically or is it contingent on some level of effort or intention?

Although much is known about the effects of self-relevant stimuli in basic attention and memory (see Chapter 1), it is unclear how self-associations may affect more complex social processes such as perspective taking. In the perspective-taking literature, the self is often understood as the first-person perspective (Gallagher, 2000; Vogeley & Fink, 2003),

[2] Experiments 2–3 were recently published together as an empirical article in *Journal of Experimental Psychology: Learning, Memory, and Cognition* (Mattan, Quinn, Apperly, Sui, & Rotshtein, 2015). All co-authors contributed to that publication, which also benefitted from the valuable feedback of action editor Prof. Robert Greene, reviewer Prof. Gabriel Radvansky, and an additional anonymous reviewer.

that is, the view held by the research participant. This first-person perspective is most often contrasted with the view of a third-person avatar, which may or may not hold the same view as the research participant (e.g., Aichhorn, Perner, Kronbichler, Staffen, & Ladurner, 2006; Samson et al., 2010; Vogeley et al., 2004). In the director task, for example, observers' gaze is shown to be biased toward their own first-person perspective view when their view is in conflict with the director's third-person perspective (Keysar et al., 2000). This effect is especially pronounced in Western cultures (S. Wu & Keysar, 2007). Nonetheless, it is possible that responses in this paradigm are biased in favour of the first-person perspective due to factors such as stimulus complexity or the mental rotation (see Zacks, Rypma, Gabrieli, Tversky, & Glover, 1999) implicated in adopting the visual perspective of the director.

Unlike the director task, other perspective-taking paradigms do not show consistent self-advantages. One popular paradigm (e.g., Samson et al., 2010) presents participants with a virtual room containing an avatar in the centre facing a wall, with varying numbers of dots appearing on the wall. The avatar's view of the room is partially occluded (i.e., some of the walls are behind her), unlike the view of an outside observer (i.e., the participant) who can see all the walls. Participants are prompted to respond based on the number of dots they see (first-person perspective; hereafter, 1PP) or the avatar sees (third-person perspective; hereafter, 3PP). For congruent trials, the number of dots seen by the avatar is the same number seen by the participant. For incongruent trials, one or more dots appear behind the avatar's head, resulting in the participant seeing more dots than the avatar. Whereas some studies show an advantage for judgements when explicitly adopting 1PP relative to 3PP (e.g., Surtees & Apperly, 2012; Vogeley et al., 2004), several studies report no such advantage (Qureshi, Apperly, & Samson, 2010; Ramsey, Hansen, Apperly, & Samson, 2013; Samson et al., 2010). Furthermore, a series of experiments by Samson and colleagues (Ramsey et al., 2013; Samson et al., 2010) revealed an interaction whereby 3PP judgements were more efficient than judgements for the 1PP, provided both perspectives were congruent. The authors interpret this finding as a computational advantage for 3PP (i.e., the avatar).

Samson and colleagues (2010) speculate that the first-person view may not immediately be considered as a perspective in the same way as the third-person avatar. Specifically, when the two perspectives are congruent and the avatar's perspective is the judgement target, the total dot number can be easily grouped, subitised, and made salient by the avatar's gaze (see discussion of gaze cues below). An additional but unnecessary step would be to attribute the view of the whole scene to a congruent first-person "self" perspective (e.g., "I see the same number of dots as the avatar"). On congruent trials where perspective judgements are based on the 1PP, this further step becomes relevant, resulting in a delayed response time. Thus, Samson and colleagues (2010) propose that the computation of gaze-cued perspectives is distinct from perspective-identity assignment. Nonetheless, it is important to note that not all studies using this paradigm report an advantage of 3PP in the congruent trials (Qureshi et al., 2010; Surtees & Apperly, 2012).

Another important finding from studies using the above VPT paradigm is that neither perspective can be ignored when the two perspectives are incongruent. In other words, there is a reliable interference cost when the contents of the 1PP and 3PP differ. This is reported even when the unattended perspective is made irrelevant to the task (Samson et al., 2010, Experiment 2). However, the perspective that produces the most interference is not always the self-perspective. In some studies, 1PP produced greater interference than did the avatar's 3PP (Ramsey et al., 2013; Samson et al., 2010). However, one study found the opposite (see adult sample error analysis from Surtees & Apperly, 2012), and another found no difference in interference between the perspectives (Qureshi et al., 2010). The inconsistent pattern of interference effects for 1PP versus 3PP in these studies suggests that neither perspective automatically monopolises attention at the implicit level (i.e., as the distractor perspective). Indeed, one fMRI study using the same paradigm as above showed the involvement of the fronto-parietal network in the presence of a conflict between 1PP and 3PP, independent of the perspective that is taken (Ramsey et al., 2013). The authors argue that this finding supports the notion that multiple perspectives in a scene may have equal priority when competing for selection.

In summarising these findings from the VPT literature, we note that there is little evidence to suggest the "self" perspective (i.e., 1PP) is intrinsically prioritised. Paradigms showing a self-advantage (e.g., Keysar et al., 2000; S. Wu & Keysar, 2007) tend to require additional processes for 3PP that are not necessary for the 1PP, such as mental rotation. Relatively simpler perspective-taking paradigms show a computational advantage for the third-person rather than for the first-person (e.g., Samson et al., 2010), although this is not always found (Qureshi et al., 2010; Surtees & Apperly, 2012). Finally, conflicting findings from the same paradigm suggest that neither perspective consistently produces greater interference than the other. This apparent absence of self-prioritisation in VPT stands in contrast to the attention and memory literature reviewed in Chapter 1, which shows that self-relevant stimuli readily capture attention (e.g., Bargh, 1982; Sui et al., 2006) and facilitate memory (e.g., Cloutier & Macrae, 2008; Rogers et al., 1977; Symons & Johnson, 1997).

One explanation for this apparent anomaly is that the avatar's head and body orientation serve as facilitative spatial cues. It is well documented that gaze direction (Friesen & Kingstone, 2003; George, Driver, & Dolan, 2001; Hietanen, 1999; Nummenmaa & Calder, 2009; Schuller & Rossion, 2004) and head orientation (Laube, Kamphuis, Dicke, & Thier, 2011; Nummenmaa & Calder, 2009) trigger attentional shifts. In fact, the use of the head and body as spatial attention cues is prevalent also when interacting with non-humans. Posture cues are known to guide the perspective selection behaviour of gorillas (Bania & Stromberg, 2013), prosimians (Botting, Wiper, & Anderson, 2011), dogs (Gacsi, Miklosi, Varga, Topai, & Csanyi, 2004), and horses (Proops & McComb, 2010). It is therefore possible that posture cues from the avatar may trigger an evolved automatic orientation of attention in a way that is not possible for the first-person perspective.

In the current chapter, we present three studies in which we examined the role of the self in perspective taking while controlling for potential confounds from perceptual cues (e.g., avatar's body posture) and computation confounds (e.g., mental rotation) inherent to 1PP-versus-3PP VPT paradigms (hereafter, 1PP-3PP tasks). In Experiments 1–2, we used a third-person VPT paradigm (hereafter, 3PP-3PP task) to examine the extent to which self-associations facilitate perspective taking at an explicit and implicit level. For the purpose of this chapter, explicit perspective taking is defined as the intentional adoption of a target perspective; implicit perspective taking is defined as the extent of response interference from a distractor perspective. In the research reported in this chapter, attentional cues from head and body orientation as well as differences in computational demands were controlled across perspectives by presenting both Self and Other as avatars (i.e., 3PPs). This approach thus avoided the possibility identified by Samson and colleagues (2010) that the self (i.e., first-person) perspective is not immediately construed as a perspective.

2.1.2. Self in the First- and Third-Person

Although most perspective-taking research characterises the self as a first-person (i.e., egocentric) reference frame (Gallagher, 2000; Vogeley & Fink, 2003), varying degrees of self-association may also be found in third-person perspectives. For example, perceivers show greater self-association with a close family member (e.g., mother) compared to a casual acquaintance (Aron, Aron, & Smollan, 1992). Even in virtual environments (e.g., online multiplayer games), individuals tend to more strongly associate with their own third-person avatars compared to an unknown player's avatar (Ganesh, van Schie, de Lange, Thompson, & Wigboldus, 2012; Yee, Bailenson, & Ducheneaut, 2009). Such self-association tendencies may also influence everyday social interactions: Participants who were assigned taller (vs. shorter) avatars in an immersive virtual environment behaved more aggressively in a subsequent live interaction (Yee et al., 2009). The ability to associate with external avatars (e.g., Corradi-Dell'Acqua et al., 2008; David et al., 2006) can modulate cognitive and perceptual effects, such as reducing hemi-spatial neglect in neuropsychological patients (Becchio, Del Giudice, Dal Monte, Latini-Corazzini, & Pia, 2013). In the symbolic interactionist tradition, the ability to perceive oneself from a third-person perspective is considered integral to the development of the self (Goffman, 1959; Mead, 1934). Indeed, considering oneself from the third-person perspective is linked to future prosocial behaviour (Leary, Estrada, & Allen, 2009; Libby, Shaeffer, Eibach, & Slemmer, 2007) and improved perspective taking (Stephenson & Wicklund, 1983; Zhou et al., 2013), eliciting greater activity in brain regions related to emotion and memory (e.g., Ochsner et al., 2005).

Despite the literature described above, the role of self-associations in more complex processes such as perspective taking remains to be systematically explored. One means of visually presenting a degree of self-relevance is via "self-tagging," which refers to the novel association of the self with a unique shape or colour (see Sui et al., 2012).

2.1.3. Chapter Overview

Through the use of self-tagging, Experiments 1−2 extended previous research by investigating whether self-relevance facilitates perspective taking from a third-person reference frame. Specifically, we presented participants with two 3PPs varying in self-relevance (i.e., a 3PP-3PP task involving avatars for Self and Other). Generally, we anticipated better performance for the self-associated perspective. Particular attention was given to whether such prioritisation occurred as an explicit versus implicit effect in VPT. Recall that the term explicit perspective taking is used here to describe performance for the intended target perspective, whereas implicit perspective taking describes the extent of interference from a distractor perspective.

Experiment 3 (1PP-3PP task) was conducted to test whether the Self avatar (i.e., self-as-3PP) is meaningfully related to phenomenological self (i.e., self-as-1PP). We hypothesised that the perspective of the Self (vs. Other) avatar would interfere more with the 1PP. We further wanted to determine whether the self advantages obtained in Experiments 1–2 remained when the Self and Other avatars were viewed independently of each other and in contrast to the 1PP, as in more conventional perspective-taking paradigms. Finally, Experiment 3 also tested whether the self-prioritisation effects from Experiments 1−2 are replicable.

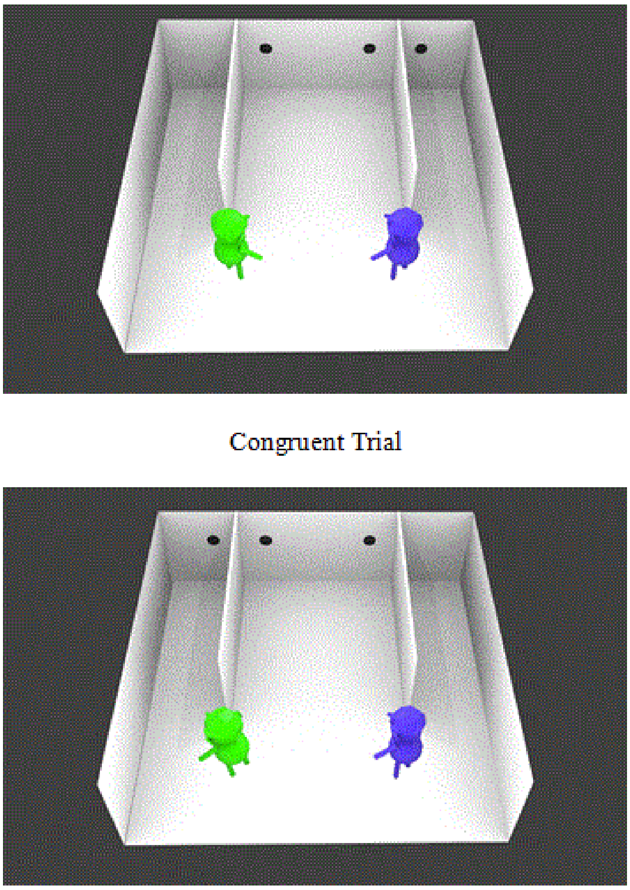
2.2. Experiment 1: 3PP-3PP Task Pilot

2.2.1. Introduction

Paradigm design. This first experiment was conducted to pilot a novel visual 3PP-3PP perspective-taking paradigm. Unlike previous perspective-taking paradigms, this paradigm includes two avatars, one for the self and one for the other. One advantage of this paradigm is that it equates for the effects of attentional cueing from head and body orientation across self and other by presenting Self and Other as third-person perspectives.

The task pilot was divided into two parts. First, participants learned to associate colour-coded avatars to three identities (Self, Friend, and Other) using a perceptual-matching paradigm (Sui et al., 2012; see 2.2.2, for details). Second, participants completed the 3PP-3PP task. In this task, participants viewed the Self and Other avatars from the matching task (the Friend was not used for this task) within a virtual room (Figure 2.1, see Method for details). Participants' overall objective was to adopt the prompted avatar's perspective, which varied randomly between Self and Other across trials.

The primary difference between the current paradigm and previous Level-1 perspective-taking paradigms (i.e., paradigms that ask how many objects are seen) is that a second avatar is included in the visual scene at the same level as the first avatar and the contents of the participant's view (i.e., 1PP) are always incongruent with what each avatar sees, effectively making 1PP irrelevant to the task (cf. Qureshi et al., 2010; Samson et al., 2010; Surtees & Apperly, 2012). Because the avatars are always gazing away from the perceiver toward the far wall, this paradigm also precludes any possible involvement of visual-spatial transformations or mental rotation (Zacks et al., 1999). Furthermore, both perspectives similarly benefit from visual gaze cues. As in the original paradigm (Samson et al., 2010), target identity (Self, Other) and perspective congruence (congruent, incongruent) were varied orthogonally in a 2 × 2 within-participants design. For the 3PP-3PP task, congruency between perspectives was defined as when the Self and Other avatar both faced the same part of the far wall. Incongruent trials resulted when one avatar oriented outward toward one of the peripheral wall areas (Figure 2.1).



Congruent Trial

Incongruent Trial

Figure 2.1. Trial examples from the original 3PP-3PP task used in Experiment 1. In the Congruent Trial (top), both avatars are facing inward and see the same number of dots. In the Incongruent Trial (bottom), one avatar (e.g., green) faces to the outside, such that each avatar has a different perspective. The target avatar always views more dots than the non-target.

Predictions. In line with previous research on self-tagging advantages in attention (Sui et al., 2012, 2013; Sui, Liu, Wang, & Han, 2009) and salience (Sui, Liu, et al., 2015), we tested two predictions. First, we predicted that heightened salience of the self avatar would facilitate the explicit adoption of the self avatar's perspective (i.e., a main effect of target identity). Second, when the self- and other-avatar perspectives were conflicting (i.e., incongruent trials), we anticipated that the Self avatar would produce greater interference than the other avatar. In other words, we predicted a Target Identity × Perspective Congruence interaction, with a greater congruence effect for the other avatar compared to the Self avatar. Such a differential in interference would constitute an implicit perspective-taking bias for the Self avatar.

2.2.2. Method

Participants. Thirty-six students (26 female; M_{age} = 21.9 years, SD_{age} = 5.60) from the University of Birmingham were recruited through an online research participation scheme and received either cash or course credit for their participation. The sample composition was 72.2% White British/Other, 22.3% Asian, and 5.6% Other. In accordance with ethical approval, participants received information on the experimental procedure and gave informed consent prior to participating. Following the completion of all tasks, participants were administered a brief demographic survey, debriefed, and compensated accordingly.

Avatar identity-matching task. Three avatars were created using Blender version 2.64.0 (Blender Foundation, Amsterdam, The Netherlands), an open-source 3D creation software. The avatars were identical in shape, distinguishable only by colour: green, red, or blue. Avatar height was 3 cm (view angle = 2.9°). Each avatar was rendered to create the appearance of facing away from the viewer, with the body angled slightly to the left or to the right, with each rendering having equal representation. The same avatars used in this matching task were later used in the perspective-taking task.

Procedure. The matching task was adapted from a previous perceptual-matching paradigm (Sui et al., 2012). Participants were asked the first name of a close friend, which the experimenter entered into the program. The avatar-identity associations were introduced by simultaneously presenting all three avatar images on the screen, with the appropriate label under each one (e.g., ‘YOU’, ‘OTHER’, [friend’s name]). Self and Other colours were counterbalanced between green and blue across participants. The friend avatar was always assigned the red colour and was used only to make the matching task more challenging. In the matching task, on each trial, participants viewed one avatar image (e.g., blue) above one label (e.g., “YOU”) at the centre of the screen with the instruction to indicate whether the label correctly matched the avatar image. All avatar–label combinations were equally likely to appear.

Each trial started with a fixation cross at the centre of the screen for 500 ms. Then, an avatar image and label was presented for 100 ms followed by a blank screen that remained for 1000 ms, or until response. Participants responded by key press: J for a match and K for a mismatch. Responses longer than 1 s were treated as incorrect. Each trial concluded with a feedback screen that was presented for 500 ms, providing the response state (e.g., correct, incorrect, or no response) with cumulative response time and accuracy statistics. There were altogether 192 trials that were divided into 2 blocks.

Perspective-taking task. The avatars used in the identity-matching task were also used in the perspective-taking task. A virtual room was created using Blender version 2.64.0 (Blender Foundation, Amsterdam, The Netherlands) and GIMP version 2.8.2 (Free Software Foundation, Inc., Boston, MA). Figure 2.1 gives an example of the virtual room display used. This room included three external walls and one or two internal dividing walls parallel to the side walls. The size of the room was 12 cm wide at the far wall (view angle = 11.3°) by 13 cm long from the fore to the far wall (view angle = 12.2°). The internal walls partially divided the room into two or three sections, the size of each peripheral area was 2.9° wide by 12.2° long, and the central area was 6.7° wide by 12.2° long. The avatars were placed facing the far wall of the room in line with the dividing walls, at the bottom of the screen. The room was viewed from above with an angle of 45 degrees, aligned with the overall orientation of the avatars' views; hence the participants saw the avatars from behind. Thus the participant and the avatars faced roughly the same direction but, as opposed to the participant's 1PP, the avatar's view was restricted by the dividing walls and by their head orientation.

Black dots (view angle = 0.5°) were placed on the wall opposite the avatars. There were five possible dot locations at equal distance from one another (distance between potential dots locations 1.9° view angle): one on each peripheral area and three in the central area. On any given trial, 1–4 dots were presented with equal probability. To ensure an incongruent view with the participant's own (first-person) perspective, a dot was always presented in one of the peripheral areas that were partly occluded by a dividing wall. For further information on trial design, see Appendix 2.1.

Participants' task was to indicate whether a preceding prompt predicted the number of dots (e.g., 1, 2, or 3) seen by the target avatar (e.g., Self or Other). The target avatar could see between 0 and 3 dots. Participants were instructed to press the J key with their right index finger for match trials and the K key with their right middle finger for mismatch trials, with each trial type of equal frequency. Importantly, the contents of the Self and Other avatars' perspectives were either congruent or incongruent. Note that in the congruent trials both avatars faced the shared central space, whereas in the incongruent trials the relevant space could be the shared central section or one of the peripheral sections. This means that the congruency manipulation reflected the difference between shared and non-shared views and not simply that the two avatars see the same number of dots.

Procedure. Each trial began with a text prompt revealed gradually in two parts to ease comprehension. In the first 1000 ms, participants were shown two lines of centred text revealing the target avatar (“Your avatar / will see” or “Other’s avatar / will see”) followed by a third line below revealing the prompt number (e.g., “three dots”). To further ensure prompt comprehension, participants were given unlimited time to read the full prompt and proceed by pressing the spacebar. Next, to ensure fixation location, a 900-ms fixation sequence was used in which two fixation crosses converged toward the centre of the screen at a rate of one character per 300 ms, merging in the centre for the final 300 ms. Then, the visual scene was displayed for 650 ms, after which it was replaced by a blank screen for 2000 ms or until the participant responded. If no response was recorded within 2000 ms of the blank screen onset, participants immediately received the message “Please respond faster!” in centred red type for 1500 ms and proceeded to the next trial prompt. Failures to respond were recorded as errors. For a graphical representation of the full trial time course and details, see Figure 2.2.

The perspectives task began with a set of written and visual instructions on how to take the perspective of a given avatar followed by 12 practice trials representing at least one of each possible condition. The subsequent experimental block included 192 trials, of which 96 were match trials. After every 10 trials, a four-trial procedure was implemented to remind participants of the avatars’ identities. In each trial, the two avatars were presented together randomly on the left and right side of the screen. Centred text above the two avatars asked participants to select the avatar that matches a given target identity (e.g., “YOU”) by pressing the J key for the left avatar and the K key for the right avatar.

Analysis protocol. A 3-standard-deviation guideline was used to exclude outliers from analysis in both the perceptual-matching task and the perspective-taking task. This was done at the participant level for response time data and at the group level for accuracy rate data. Based on the LATER model (Reddi, Asrress, & Carpenter, 2003), we assumed that variability in accuracy and RT responses arise from the same decision mechanism. Therefore, to guard against speed-accuracy trade off effects and condense reported results, accuracy and RT measures were combined to obtain the psychological efficiency index: The mean RTs of correct responses were divided by the proportion of accurate response for each condition and each participant (Townsend & Ashby, 1983). Statistical analyses were performed on these combined efficiency scores only, although similar patterns of results were obtained for the separate accuracy and RT indices (see Tables 2.1 and 2.2 for RT, accuracy, and efficiency statistics for the perceptual-matching and perspective-taking tasks, respectively).

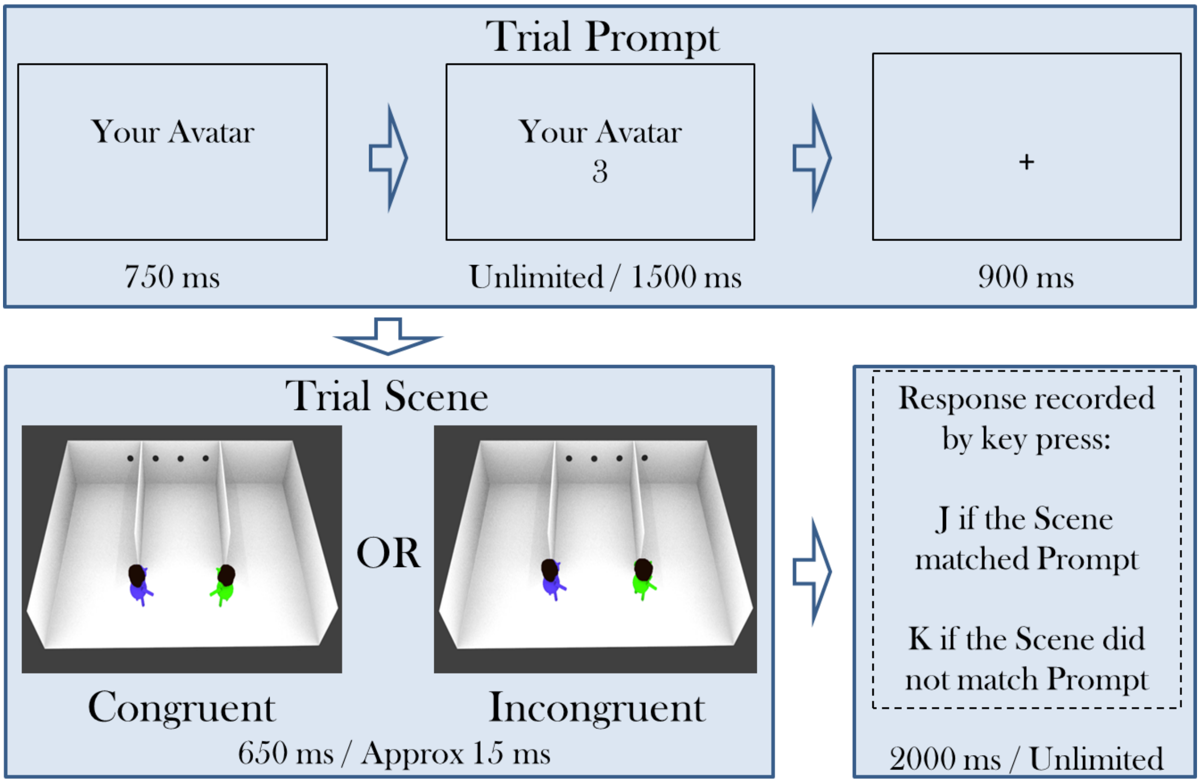


Figure 2.2. Trial procedure for the 3PP-3PP task used in Experiments 1–2. In the Trial Prompt, participants were presented with the target identity (e.g., “Your Avatar / will see” - Experiment 1; “Your Avatar” - Experiment 2) for 750 ms after which the expected number of dots for the target identity was added to the display. In Experiment 1, participants had unlimited time (or an additional 750 ms in Experiment 2) after the second frame to proceed to the fixation. Participants then viewed a 900 ms centered fixation sequence that consisted of two fixation crosses initially separated by a 3-character gap; each cross moved one character closer at 300 ms, and at 600 ms the two crosses converged to form one cross in the center character position. Following fixation, participants viewed the Trial Scene (650 ms, Experiment 1; approximately 15 ms, Experiment 2). Responses were subsequently recorded by key press. Note that the trial scene images are from Experiment 2.

For the perspective-taking task, analyses focused on match trials only. Due to the design of mismatch trials, the prompt always matched only the contents of the 1PP, which was always greater than the contents of either avatar's perspective. As a result, mismatch trials were likely confounded by deductive strategies. A similar analytical approach has been applied in previous VPT studies in which mismatch trials were subject to systematic variations (see Qureshi et al., 2010; Samson et al., 2010; Surtees & Apperly, 2012). Nonetheless, we also report the results of the mismatch trials for completeness.

2.2.3. Results

Avatar identity-matching task. Incorrect responses (29.5% of trials) and correct responses with latencies exceeding 3 standard deviations from the individual's overall mean (0.3%) were trimmed prior to analysis. One participant was excluded from analysis due to an outlier in accuracy rate, with a mean response accuracy of 39.6%. This participant was also excluded from the analysis of the perspective-taking experiment as it was assumed that she failed to form reliable associations with the avatars. For completeness, RT, accuracy, and efficiency results are provided in Table 2.1.

Efficiency scores were submitted to a 2 (Avatar Identity: self, other) × 2 (Label Match: match, mismatch) repeated-measures ANOVA. Results revealed a significant main effect of avatar identity, $F(1,34) = 29.1$, $MSE = 43186$, $p < .001$, $\eta_p^2 = .461$, such that the Self avatar resulted in more efficient judgements relative to the Other avatar. A significant Avatar Identity × Label Match interaction, $F(1,34) = 47.8$, $MSE = 30031$, $p < .001$, $\eta_p^2 = .584$, suggests that the main effect of Avatar Identity was driven by a significant self-advantage on match trials, $t(34) = 6.84$, $d = 1.15$, $p < .001$, but not on mismatch trials, $p = .66$. These results replicate previous findings on self-tagging in a perceptual-matching paradigm (Sui et al., 2012, 2013), thus showing that participants formed reliable self-associations with the avatar.

Table 2.1

Descriptive Statistics for the Avatar Identity-Matching Task, Experiment 1

Response Index	Avatar Image	Matched Label	Mismatched Label	Average
RT (ms)	Self	505 (12.7)	596 (12.1)	551[a]
	Other	584 (15.8)	598 (11.0)	591[a]
Accuracy	Self	.850 (.021)	.779 (.022)	.814[b]
	Other	.629 (.027)	.791 (.022)	.710[b]
Efficiency	Self	614 (30.7)	790 (29.6)	702[c]
	Other	1006 (60.5)	777 (26.4)	892[c]

Note. Standard errors are provided in parentheses. [a,b,c] Pairwise *t*-test, $p < .001$.

Perspective-taking task. In addition to the participant excluded from the matching task, two additional participants were excluded for outliers in response time or accuracy exceeding the group mean by 3 standard deviations. For completeness, means and standard error for the RT, accuracy, and efficiency data are found in Table 2.2.

Incorrect responses (14.2% of match trials) and correctly-answered trials with response latencies exceeding 3 standard deviations from the individual's overall mean (3.65% of match trials) were trimmed prior to analysis. Importantly, mean accuracy for each condition was reliably above chance (all $p < .001$). This suggests that all participants were able to easily complete the task within the required time window, despite the seemingly complex display.

Table 2.2

Descriptive Statistics for 3PP-3PP Task, Experiment 1

Trial Type	Response Index	Target Identity	Congruent	Incongruent	Interference Difference	Average
Match trials	RT (ms)	Self	688 (30.4)	700 (30.2)	12	694
		Other	705 (28.3)	725 (32.5)	20	715
	Accuracy	Self	.907 (.015)	.884 (.022)	.023	.896
		Other	.838 (.023)	.861 (.024)	-.023	.850
	Efficiency	Self	764 (35.5)	810 (40.3)	46	787[a]
		Other	857 (35.9)	879 (58.2)	22	868[a]
Mismatch trials	RT (ms)	Self	710 (34.2)	704 (33.3)	-6	707
		Other	724 (33.6)	728 (38.9)	4	726
	Accuracy	Self	.934 (.013)	.939 (.012)	-.005	.937
		Other	.947 (.012)	.912 (.020)	.035	.929
	Efficiency	Self	767 (41.6)	754 (38.3)	-13	760
		Other	771 (40.9)	831 (68.4)	60	801

Note. Standard errors are provided in parentheses. [a] Pairwise *t*-test, $p < .05$.

Efficiency scores for the match trials were analysed using a 2 (Target Identity: self, other) × 2 (Perspective Congruence: congruent, incongruent) ANOVA. This revealed a reliable main effect for target identity, $F(1,32) = 13.1$, $MSE = 16346$, $p = .001$, $\eta_p^2 = .291$, such that participants were more efficient for Self than Other trials. Although the effect of congruence trended in the expected direction, it was non-significant, $F(1,32) = 2.52$, $p = .12$.

The interaction of target identity and perspective congruence was non-significant, $F(1,32) = 0.221$, $p = .64$. Analysis of mismatch trials revealed no reliable effects[3].

2.2.4. Discussion

Results from Experiment 1 showed that participants were more efficient on trials when the Self avatar was the target identity. This third-person self-advantage suggests that previously observed self-tagging effects (Sui et al., 2012, 2013) can have downstream consequences in visual-spatial processing and judgements (Sui, Liu, Wang, & Han, 2009), particularly when they are task-relevant. Interestingly, this effect was observed in spite of the fact that attending to the target avatar's view was not necessary. Because the target avatar always faced the shared central space and never toward the periphery (see Appendix 2.1), it was possible for participants to develop a strategy in which they ignore the avatars and their gaze directions and attend only to the shared space. At debriefing none of the participant reported that they used such a strategy. We discuss this issue in more detail below.

The lack of any effect or interaction from perspective congruence is surprising given that previous research has demonstrated a robust tendency to process unattended perspectives (Qureshi et al., 2010; Samson et al., 2010; Surtees & Apperly, 2012), even when the unattended perspective is never prompted as the target perspective (e.g., Samson et al., 2010). One explanation is that the added complexity of computing a second avatar's perspective attenuated the social-attentional cuing from avatar orientation. It is worth noting that the steps of perspective computation are effectively doubled in the 3PP: Perceivers first need to

[3] The same 2 × 2 ANOVA for mismatch trials revealed a marginal effect of effect for target identity, $F(1,32) = 3.208$, $MSE = 17394$, $p = .083$, $\eta_p^2 = .091$, with greater efficiency for Self than Other trials. As in the match-trial analysis, the effect of perspective congruence was non-significant, $F(1,32) = 1.63$, $p = .21$. The Target Identity × Perspective Congruence interaction was also non-significant, $F(1,32) = 2.799$, $p = .10$.

apprehend each avatar's gaze direction and then view the appropriate wall segments (left, centre, or right) to confirm the number of dots in each view. Thus, due to the relatively high level of computation required, participants may have selectively encoded only the perspective needed for a given trial.

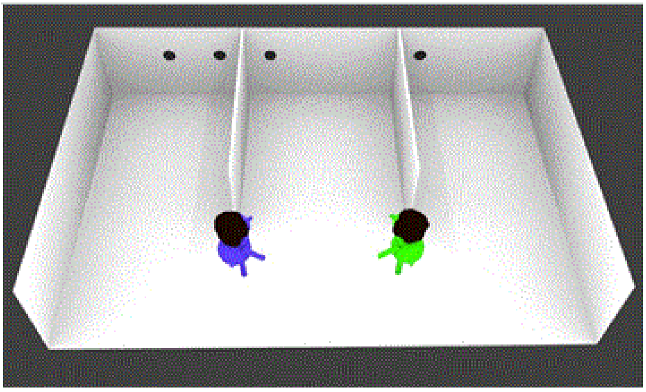
Although tempting to attribute the current findings to task complexity, the paradigm design merits further consideration. As the task was designed, the target perspective always faced the central shared space between the two barrier locations and never toward the lateral section of the wall (Figure 2.2). This was done to avoid systematic association between the target avatar's orientation and the number of dots in its view line (see 2.2.2 and Appendix 2.1, for details). As mentioned above, one consequence of this was that the participants could solve the task by counting the dots on the shared central space, ignoring the avatars' orientations. Importantly, no participant indicated any use of this strategy during debriefing. However, some participants did spontaneously report that avatar gaze was not always readily apparent due to the unified colour of the avatar body and head. Finally, the fixation cross may also have attenuated attentional cuing as it focused participants on the centre of the screen instead of at the bottom, where both avatars were located. In Experiment 2, these considerations were taken into account and the 3PP-3PP task was modified appropriately.

2.3. Experiment 2: 3PP-3PP Task Replication

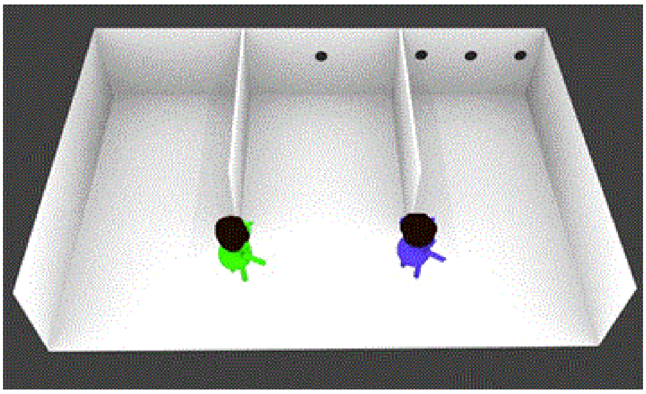
2.3.1. Introduction

The second experiment used a modified version of Experiment 1 and aimed to test the same hypotheses. The following changes were included: First, the virtual room was slightly modified to create a trial set in which it was equally likely that the target avatar faced the central space or the periphery. This ensured that encoding the target avatar's orientation was essential to correctly complete the task. Second, we added hair to both avatars to make their head/face orientation more salient. (See Figure 2.3 for examples of the modified visual scene and avatars used in Experiment 2.) Third, we ensured that participants' attention was initially focused on the two avatars by presenting the fixation sequence on the same horizontal plane as the avatars. Finally, to minimise variability in accuracy across participants, we varied the duration of the display of the virtual room keeping each participant's accuracy at approximately 75–80%. Participants failing to reach at least 70% accuracy on both tasks were excluded from analysis. (See Appendix 2.2 for more details on 3PP-3PP task design modifications for Experiment 2.)

As in Experiment 1, we expected that participants would perform more efficiently when instructed to take the Self perspective (i.e., a main effect of target perspective). We further expected the classic congruency effect (e.g., Samson et al., 2010) and that this would interact with target avatar identity such that the Self avatar would produce more interference than the Other avatar.



Congruent Trial



Incongruent Trial

Figure 2.3. Trial examples from Experiment 2. In the Congruent Trial (top), both avatars are facing inward and see the same number of dots. In the Incongruent Trial (bottom), one avatar (e.g., blue) faces to the outside, such that each avatar has a different perspective. The target avatar always views more dots than the non-target.

2.3.2. Method

Participants. Forty-seven students (39 female; M_{age} = 19.7 years, SD_{age} = 2.83) from the University of Birmingham were recruited through an online research participation scheme and received either cash or course credit for their participation. The sample composition was 87.2% White British/Other, 8.5% Asian, and 4.3% Black. In accordance with ethical approval, participants received information on the experimental procedure and gave informed consent prior to participating. Following the completion of all tasks, participants were administered a brief demographic survey, debriefed, and compensated accordingly.

Avatar identity-matching task. The same three avatars used in Experiment 1 were used in this experiment (see 2.2.2). However, in this experiment, the backs of avatar heads were manually coloured a dark brown (C = 0, M = 63, Y = 93, K = 89) using GIMP version 2.8.2 (Free Software Foundation, Inc., Boston, MA) to simulate hair and facilitate the detection of avatar orientation. The same blue and green avatars used in this matching task were later used in the perspective-taking task.

Procedure. The avatar identity-matching task procedure was similar to that reported in Experiment 1 (see 2.2.2). Key changes included (1) a modified training procedure, leading to an optimised stimulus display time for each participant (detailed below), (2) an unlimited amount of time for participants to respond (limited to 1 s in Experiment 1), (3) fewer experimental trials (96 vs. 192 trials), and (4) less frequent feedback (after every 10 trials rather than every trial).

After a brief introduction to the task, participants completed a series of practice runs to determine the minimum stimulus duration at which they could reach 75% accuracy. This threshold was chosen to equate for overall task difficulty and to ensure variability in accuracy while minimising contamination from guessing. The practice runs consisted of at least five blocks of 12 trials, each pulled randomly from the experimental trial set. The initial stimulus duration was set at 1000 ms and decreased incrementally depending on the performance of the participant (e.g., 500 ms, 100 ms, 50 ms, 15 ms). If a participant failed to reach the requisite 75% accuracy on a given block, the stimulus duration time was raised slightly or kept the same for the next practice block. The final stimulus duration time was determined once a participant maintained approximately 75% accuracy for two consecutive practice blocks or reached the minimum display time of 15 ms.

After the presentation duration was established, participants completed 96 experimental trials at that duration. Participants were also informed of their accuracy after every 10 trials and given the opportunity to rest as the feedback was displayed. Failure to achieve at least 70% accuracy resulted in exclusion from analysis for both tasks. Analyses focused on responses to the Self and Other avatars only, as these were the relevant avatars to the main experimental question.

3PP-3PP task. A number of changes were made to the 3PP-3PP task on the basis of the initial piloting in Experiment 1. Changes were made to the virtual room configuration, the prompt/trial design, and trial/task procedures.

Stimuli and design. The blue and green avatars representing Self and Other in the identity-matching task (above) were used in the perspective-taking task. The virtual room from the pilot study (Experiment 1) was modified to correct potential sources of noise identified during the pilot. Figure 2.3 gives examples of the new virtual room displays. The size of the new room was 18.5 cm wide at the far wall (view angle = 22.1°) by 13 cm long from the fore to the far wall (view angle = 12.2°). As before, the internal walls partially divided the room into three sections; the size of each section was 6.7° wide by 12.2° long. Black dots (view angle = .5°) were placed on the far wall. There were nine possible dot locations at equal distance from one another (distance between potential dots locations 1.9° view angle): three in each area. On any given trial, four dots were presented. This made it feasible to control for the first-person perspective by displaying a total of four dots on every trial while ensuring each avatar could only ever see between one and three dots. Thus, the first-person perspective was both constant and incongruent with either avatar's perspective (cf. 2.2.2). Avatar positioning and orientation were as in Experiment 1 (i.e., located at the bottom of the screen, facing toward the far wall at 45° angles).

Prompts were also modified from the pilot. The number of dots predicted by the prompt was either 2 or 3, but not less than 2 (cf. 2.2.2). For complete details on 3PP-3PP task modifications for this experiment are provided in Appendix 2.2.

Procedure. As in the foregoing avatar identity-matching task, accuracy was controlled between participants by a series of practice runs. Blocks with 12 trials were used to estimate difficulty levels and adjust stimulus duration to achieve 75% accuracy, to a minimum of 15 ms. The estimated stimulus duration was used throughout the main experiment. The experimental block was decreased from 192 to 128 perspective-taking trials, split evenly between matching and mismatching prompts. Participants failing to reach at least 70% accuracy on either task were excluded from analysis.

Relative to Experiment 1, the trial procedure was streamlined. Initially, the target perspective ("Your avatar" or "Other avatar") was displayed on the screen for 750 ms (vs. 1000 ms in Experiment 1) followed by a number of dots the target will see ("2" or "3") for another 750 ms (vs. unlimited in Experiment 1), after which both the identity and number disappeared. The same 900-ms fixation sequence from Experiment 1 immediately followed the prompt. Then, the visual scene was displayed for a fixed duration (determined in the practice block), after which it was replaced by a blank screen until the participant responded (vs. 2000 ms in Experiment 1). For a graphical representation of the full trial time course and details, see Figure 2.2. As in Experiment 1, participants completed four avatar-identity reminder trials after every 10 experimental trials (see 2.2.2).

Analysis protocol. The analysis protocol was the same as in Experiment 1 (2.2.2). Primary statistical analyses focus on efficiency scores for prompt–scene match trials only. However, for completeness, we also report analyses for the mismatch trials as well as formal comparisons between the match and mismatch trials (see Appendix 2.3). Finally, we note that similar patterns of results were obtained for the separate accuracy and RT indices, although analyses are not reported here (see Tables 2.3 and 2.4 for RT, accuracy, and efficiency statistics for the perceptual-matching and 3PP-3PP tasks, respectively).

2.3.3. Results

Avatar identity-matching task. Incorrect responses (12.0% of trials) and correct responses with latencies exceeding 3 standard deviations from the individual's overall mean (1.6%) were trimmed. Only one participant with a mean accuracy score of 66% was excluded for failing to reach the 70% accuracy threshold for inclusion.

Table 2.3

Descriptive Statistics for the Avatar Identity-Matching Task, Experiment 2

Response Index	Avatar Image	Matched Label	Mismatched Label	Average
RT (ms)	Self	678 (16.4)	792 (20.1)	735[a]
	Other	884 (87.1)	832 (23.4)	858[a]
Accuracy	Self	.938 (.008)	.863 (.016)	.900[b]
	Other	.754 (.025)	.923 (.015)	.838[b]
Efficiency	Self	726 (19.8)	926 (25.3)	826[c]
	Other	1230 (116)	911 (29.2)	1070[c]

Note. Standard errors are provided in parentheses. [a] Pairwise contrast significant at $p < .05$. [b,c] Pairwise contrast significant at $p < .001$.

Efficiency scores were submitted to a 2 (Avatar Identity: Self, Other) × 2 (Label Match: match, mismatch) repeated-measures ANOVA. Results confirmed a significant main effect of avatar identity, $F(1,45) = 15.3$, $MSE = 179130$, $p < .001$, $\eta_p^2 = .254$, such that the Self avatar resulted in more efficient judgements than did the Other avatar. The main effect of label match was not significant, $F(1,45) = 0.992$, $p = .32$. However, a significant Avatar Identity × Label Match interaction, $F(1,45) = 21.7$, $MSE = 142260$, $p < .001$, $\eta_p^2 = .326$, was observed, with a significant self-advantage on match trials, $t(45) = 4.37$, $d = 0.644$, $p < .001$, but not on mismatch trials, $p = .57$. These results replicate previous findings on self-tagging in a perceptual-matching paradigm (Sui et al., 2012, 2013), showing that participants formed reliable self-associations with the avatar.

3PP-3PP task. Incorrect responses (17.7%) and response latencies exceeding 3 standard deviations from the individual mean (0.9%) were trimmed prior to computing mean RTs for each condition. In addition to the participant excluded from analysis in the matching task, four additional participants were excluded from analysis for failing to reach the 70% accuracy threshold on the perspective-taking task.

Mean accuracy for each condition was reliably above chance (all $p < .001$). However, there was some variability between participants in overall accuracy, ranging from 70% to 95% with a median of 83%. Mean RTs were also somewhat variable, ranging from 469 ms to 1178 ms with a median of 792 ms. Thus, efficiency scores were used as the key unit of analysis (Townsend & Ashby, 1983). For completeness, means and standard error for the RT, accuracy, and efficiency data are found in Table 2.4.

A 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA on efficiency scores for match trials (i.e., trials in which the prompt was consistent with the virtual room) was used to compute reliability. Replicating previous studies, the data showed a significant main effect for perspective congruence, $F(1,41) = 7.91$, $MSE = 37494$, $p = .007$, $\eta_p^2 = .162$, such that participants were more efficient for congruent than incongruent trials. A significant effect for target perspective, $F(1,41) = 4.68$, $MSE = 23346$, $p = .036$, $\eta_p^2 = .102$, showed more efficient judgements for the Self avatar relative to the Other avatar. The interaction term was non-significant, $F(1,41) = 0.264$, $p = .61$.

Table 2.4

Descriptive Statistics for 3PP-3PP Task, Experiment 2

Trial Type	Response Index	Target Identity	Congruent	Incongruent	Interference Difference	Average
Match trials	RT (ms)	Self	790 (30.7)	821 (32.3)	31	806
		Other	807 (33.0)	829 (30.2)	22	818
	Accuracy	Self	.862 (.018)	.824 (.017)	.038	.840[b]
		Other	.830 (.016)	.778 (.020)	.052*	.804[b]
	Efficiency	Self	901 (50.0)	970 (50.5)	69	936[a]
		Other	951 (43.4)	1017 (40.1)	66*	984[a]
Mismatch trials	RT (ms)	Self	831 (29.9)	864 (36.6)	33	848
		Other	828 (30.2)	883 (34.6)	55*	856
	Accuracy	Self	.827 (.018)	.788 (.020)	.039	.808
		Other	.844 (.019)	.827 (.018)	.017	.836
	Efficiency	Self	1024 (44.0)	1119 (48.1)	95	1072
		Other	1009 (46.9)	1104 (63.2)	95	1057

Note. Standard errors are provided in parentheses. [a,b] Pairwise contrast significant at $p < .05$. * Interference significant at $p < .05$.

2.3.4. Discussion

The current findings provide evidence that participants can engage in the simultaneous processing of two 3PPs. The main effect of perspective congruence confirmed the prediction that participants would respond more efficiently when the two avatars shared the same visual perspective. Although this finding is well established in 1PP-3PP tasks (e.g., Qureshi et al., 2010; Samson et al., 2010; Surtees & Apperly, 2012), to the best of our knowledge, it has not yet been demonstrated in a paradigm involving competing third-person perspectives (but see Carlson-Radvansky & Irwin, 1994; Carlson-Radvansky & Jiang, 1998). Congruence effects were reliable for both the match and mismatch trials.

Regarding our self-related hypotheses, we observed that participants tended to prioritise self-relevant over non-relevant perspectives when the Self avatar's perspective was being actively engaged (i.e., when the target perspective was the Self avatar). This finding supports our hypothesis of a self-advantage at the explicit level. Importantly, a null Target Perspective × Perspective Congruence interaction offered no support for the hypothesised self-advantage at the implicit level in a 3PP-3PP paradigm. Interference effects from the Self and Other avatars were not reliably different. Taken together, these findings suggest that self-prioritisation is likely strategic (i.e., not automatic). Additionally, the self-advantage effect was more reliable during the prompt–scene match than mismatch trials, although this trend did not reach statistical significance. The reasons for weaker and less reliable self-advantage effects in the mismatch trials for both the avatar identity-matching and the 3PP-3PP tasks are unclear and warrant further research.

One open question from Experiment 2 is whether the self-advantage observed in the 3PP-3PP task arises from an association of the avatar with the self. An alternative explanation is that the use of the word "Your" in the prompt for Self trials triggered increased vigilance for the trial, resulting in better performance overall for these trials. In other words, participants may have been reminded that their performance was being evaluated when prompted with the external view on the self implied by the prompt, "Your avatar". This interpretation is consistent with accounts of strategic processing in which conscious self-awareness facilitates the encoding of self-relevant information (Geller & Shaver, 1976; Hull & Levy, 1979; see also Rogers et al., 1977). Relatedly, Sui and colleagues (Sui, Liu, Wang, & Han, 2009) have shown that self-tagged directional cues lead to enhanced attentional bias under conditions favouring conscious attention only (i.e., long ISI). Because the 3PP-3PP task cued the target perspective prior to the presentation of the virtual room, there was sufficient time for conscious allocation of attention. This interpretation would suggest that the prompt, rather than the self-tagged avatar, was responsible for the observed explicit self-perspective prioritisation effect. Experiment 3 thus aimed to test the relationship between the two avatars and the participant's phenomenological self.

2.4. Experiment 3: Comparison of 3PP-3PP and 1PP-3PP Tasks

2.4.1. Introduction

In our day-to-day experience, we frequently consider the views of others relative to our own current perspective (see David et al., 2006; Epley, Keysar, Van Boven, & Gilovich, 2004). Consequently, the VPT literature tends to define the self as 1PP (Gallagher, 2000; Vogeley & Fink, 2003) rather than as 3PP (e.g., Experiments 1–2). Although Experiments 1–2 were useful for demonstrating participants' prioritisation of the Self avatar, the relationship between the first-person view and third-person self-relevance (i.e., Self avatar) remains to be examined. Recall that, in Experiments 1–2, the first-person view was always incongruent with the avatars' and irrelevant to the task. A third experiment was conducted to examine whether self-relevant perspectives (e.g., the Self avatar) are prioritised when one's own first-person view is made salient.

In Experiment 3, participants completed a 1PP-3PP task in which they viewed scenes similar to the 3PP-3PP task in Experiment 2, but with only one avatar (i.e., Self or Other) appearing in any given scene. The target perspective was prompted at the beginning of each trial, varying across trials between 1PP and 3PP (i.e., the Self/Other avatar). As in previous perspective-taking studies (e.g., Samson et al., 2010), 1PP was congruent with 3PP on half the trials and incongruent on the other half. In sum, the study had a 2 (Trial Type: match, mismatch) × 2 (Target Perspective: 1PP, 3PP) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Avatar Identity: Self, Other) within-participants design. Given the main effect of the target perspective in Experiments 1–2, we predicted the self-avatar advantage would emerge under conditions favouring the explicit processing of self-relevance.

We further predicted that the Self avatar's greater salience would result in it yielding greater interference than the less salient Other avatar on the 1PP. Concretely, we predicted a

Target Perspective × Perspective Congruence × Avatar Identity interaction, with greater interference from 3PP on trials where the Self avatar was present compared to trials where the Other avatar was present. This predicted interaction would provide evidence against the possibility that the self-advantage observed in Experiments 1–2 was solely due to heightened vigilance from the prompt. This is because, unlike target perspectives, distractor perspectives (i.e., source of interference effects on incongruent trials) are not revealed in the prompt. Alternatively, a Target Perspective × Avatar Identity interaction, with improved performance for the Self (vs. Other) avatar when it is the target perspective, would support the possibility that the observed self-advantage in Experiments 1–2 stemmed from the prompt rather than the presence of a self-tagged avatar.

2.4.2. Method

Participants. Forty-one students (25 female; M_{age} = 23.6 years, SD_{age} = 5.04) from the University of Birmingham were recruited through an online research participation scheme and received either cash or course credit for their participation. The sample composition was 63.4% White British/Other, 24.4% Asian, and 12.2% Other. The informed consent procedure was implemented as in Experiment 2. Following the completion of all tasks, participants were administered a brief demographic survey, debriefed, and compensated accordingly.

Avatar identity-matching task. The same matching task and procedure from Experiment 2 (see 2.3.2) was used to train participants on avatar colour. As in Experiment 2, failure to achieve at least 70% accuracy resulted in exclusion from analysis.

3PP-3PP task. To ensure participants were able to distinguish and adopt the perspectives of the two avatars, participants also completed the 3PP-3PP task and procedure from Experiment 2. This task was completed after the avatar identity-matching task but before the critical 1PP-3PP task. To shorten the overall length of the experiment and reduce fatigue, the main block of trials for this task was limited to 64 trials, randomly pulled from the trial list used in Experiment 2[4]. Also to reduce fatigue, minimum stimulus duration was increased from 15 ms to 150 ms. As in the avatar identity-matching task, failure to achieve at least 70% accuracy resulted in exclusion from analysis from this task.

1PP-3PP task. The 1PP-3PP task was similar to the 3PP-3PP task. The key difference was that only one avatar at a time appeared in the virtual room. Avatar identity was randomised across trials between Self and Other, with an equal number of appearances from each. Dot configurations were modified so that on half of the trials, the same number of dots visible to 1PP was also visible to 3PP (i.e., Self/Other avatar). As in Experiment 2, participants indicated whether a preceding prompt predicted the number of dots (e.g., 2 or 3) visible to the target perspective (1PP or 3PP). Participants pressed the J key with their right index finger for match trials and the K key with their right middle finger for mismatch trials; each trial type was represented with equal frequency.

Procedure. As in both previous tasks, accuracy was controlled between participants by a series of practice runs. Blocks with 12 trials were used to estimate difficulty levels and adjust stimulus duration to achieve 75% accuracy, to a minimum of 150 ms. This estimated stimulus duration was used throughout the main block of trials. This experimental block was comprised of 128 perspective-taking trials, divided evenly between all conditions. Participants failing to reach at least 70% accuracy on this task or either of the previous tasks were excluded from analysis.

As in Experiment 2, a two-part prompt began each trial. Initially, the target perspective ("[Your/Other's] avatar" or "Yourself") was displayed on the screen for 750 ms

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[4] As a result of this adaptation to the 3PP-3PP task in Experiment 3, the number of trials per cell varied. Nonetheless, each cell held between 3 and 14 observations, both for RT (M_{obs} = 7, SD_{obs} = 1.8) and accuracy (M_{obs}= 8, SD_{obs} = 1.9).

followed by a number of dots ("2" or "3") for another 750 ms, after which both the identity and number disappeared. The remainder of the trial procedure was identical to the procedure used in Experiment 2's 3PP-3PP task. For a graphical representation of the full trial time course and details, see Figure 2.4.

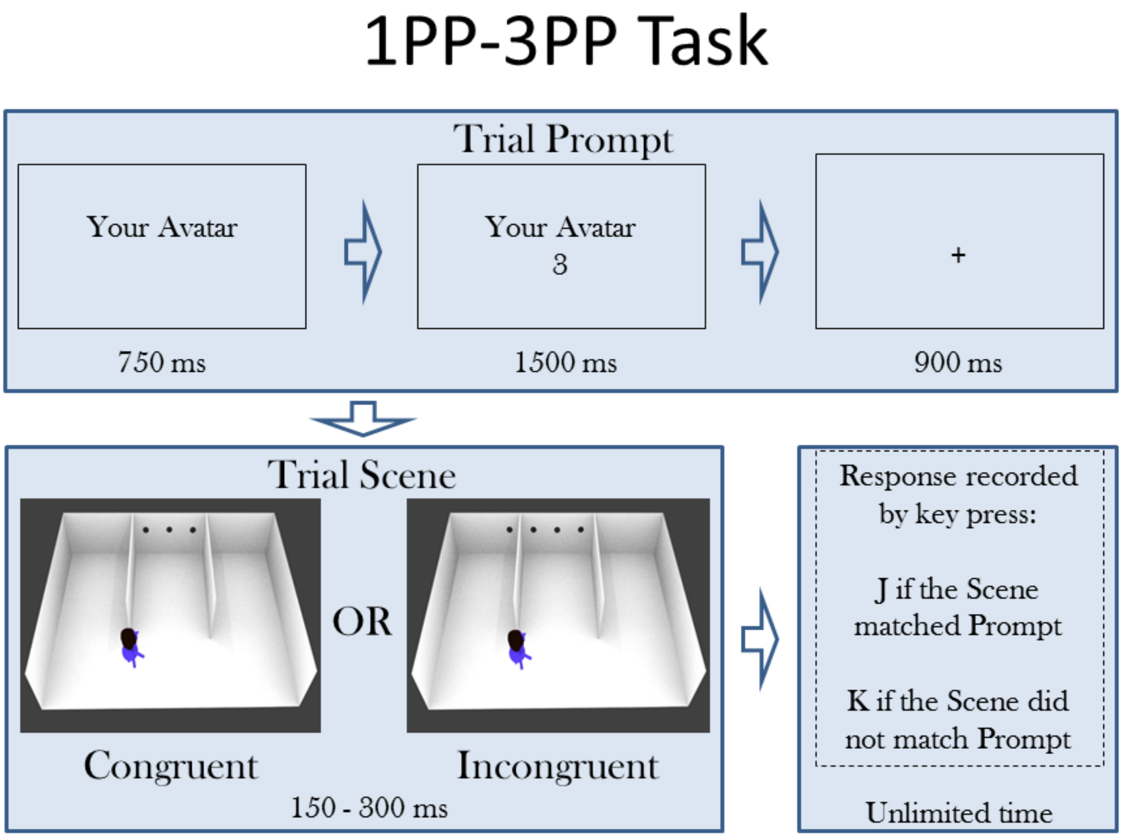


Figure 2.4. Trial procedure for the 1PP-3PP task used in Experiment 3. In the Trial Prompt, participants were presented with the target perspective (e.g., "Your Avatar") for 750 ms after which the expected number of dots for the target perspective was added to the display. Participants had an additional 750 ms after the appearance of the dot number to proceed to the fixation. Participants then viewed a 900 ms centred fixation sequence that consisted of two fixation crosses initially separated by a 3-character gap; each cross moved one character closer at 300 ms, and at 600 ms the two crosses converged to form one cross in the centre character position. Following fixation, participants viewed the Trial Scene for approximately 150-300 ms, depending on participant's performance in the practice block. Responses were subsequently recorded by key press.

Analysis protocol. As in Experiment 2, statistical analyses were performed on efficiency scores only. See Tables 2.5–2.7 for RT, accuracy, and efficiency statistics for each of the tasks in this experiment. As in the 3PP-3PP task from Experiment 2, analysis focused on the findings from the match trials. However, for completeness, results from the mismatch trials and formal comparisons between the two conditions are reported (see Appendix 2.4).

Avatar identity-matching task. Incorrect responses (9.4% of trials) and correct responses with latencies exceeding 3 standard deviations from the individual's overall mean (1.4%) were trimmed. All participants met the 70% accuracy threshold for inclusion. For completeness, means and standard error for the RT, accuracy, and efficiency data are found in Table 2.5.

Table 2.5

Descriptive Statistics for the Avatar Identity-Matching Task, Experiment 3

Response Index	Avatar Image	Matched Label	Mismatched Label	Average
RT (ms)	Self	689 (17.8)	833 (27.0)	761[a]
	Other	821 (24.9)	804 (24.8)	812[a]
Accuracy	Self	.924 (.011)	.909 (.015)	.916[b]
	Other	.837 (.017)	.919 (.014)	.878[b]
Efficiency	Self	752 (23.4)	929 (34.6)	841[c]
	Other	999 (37.6)	881 (29.3)	940[c]

Note. Standard errors are provided in parentheses. [a,c] Main effect significant at $p < .001$. [b] Main effect significant at $p < .01$.

Efficiency scores were submitted to a 2 (Avatar Identity: Self, Other) × 2 (Label Match: match, mismatch) repeated-measures ANOVA. Results confirmed a significant main effect of avatar identity, $F(1,40) = 20.1$, $MSE = 20222$, $p < .001$, $\eta_p^2 = .334$ such that the Self avatar resulted in more efficient judgements relative to the Other avatar. The main effect of label match was not significant, $F(1,40) = 1.32$, $p = .26$. However, a significant Avatar

Identity × Label Match interaction was observed, $F(1,40) = 45.6$, $MSE = 19617$, $p < .001$, $\eta_p^2 = .532$, with a significant self-advantage on match trials, $t(40) = 6.32$, $d = 0.987$, $p < .001$, and a smaller albeit significant other-advantage on mismatch trials, $t(40) = 2.37$, $d = 0.369$, $p = .023$. These results again confirm a reliable pattern of prioritisation for the Self avatar, at least for matching trials, replicating previous findings (Sui et al., 2012, 2013).

3PP-3PP task. Incorrect responses (11.3%) and response latencies exceeding 3 standard deviations from the individual mean (1.3%) were trimmed prior to computing mean RTs for each condition. One participant was excluded from analysis for failing to reach the 70% accuracy threshold on the 3PP-3PP task with a mean accuracy of 64%.

Mean accuracy for each condition was reliably above chance (all $p < .001$). However, there was some variability between participants in overall accuracy, ranging from 75% to 100% with a median of 91%. Overall RTs were also somewhat variable, ranging from 521 ms to 1277 ms with a median of 762 ms. For completeness, means and standard error for the RT, accuracy, and efficiency data are found in Table 2.6.

A 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA on efficiency scores for match trials (i.e., trials in which the prompt was congruent with the virtual scene) was used to compute the reliability of the effects. Replicating the results of Experiment 2, we found a significant main effect for target perspective, $F(1,39) = 5.45$, $MSE = 16694$, $p = .025$, $\eta_p^2 = .123$, showing more efficient judgements for the Self avatar than the Other avatar. Although participants showed numerically smaller efficiency scores for perspective congruence than incongruence, this effect was not significant, $F(1,39) = 0.30$, $p = .59$. The interaction term was also non-significant, $F(1,39) = 0.44$, $p = .51$.

Table 2.6

Descriptive Statistics for 3PP-3PP Task, Experiment 3

Trial Type	Response Index	Target	Congruent	Incongruent	Interference Difference	Average
Match Trials	RT (ms)	Self	753 (27.0)	763 (29.1)	10	758[a]
		Other	795 (33.3)	789 (26.4)	-6	792[a]
	Accuracy	Self	.906 (.019)	.907 (.021)	-.001	.907
		Other	.917 (.016)	.891 (.021)	.026	.904
	Efficiency	Self	848 (36.2)	850 (31.8)	2	849[b]
		Other	880 (43.0)	913 (45.5)	33	897[b]
Mismatch trials	RT (ms)	Self	790 (30.8)	805 (29.6)	15	798
		Other	800 (31.9)	840 (33.1)	40	820
	Accuracy	Self	.884 (.017)	.874 (.019)	.01	.879
		Other	.906 (.017)	.869 (.022)	.037	.888
	Efficiency	Self	911 (43.8)	936 (37.4)	25	924
		Other	902 (45.8)	1010 (58.9)	108	956

Note. Standard errors are provided in parentheses. [a,b] Main effect significant at $p < .05$.

In summary, using few trials and longer exposure duration, we replicated the effects of the Self avatar for matching trials. Congruence effects were overall less reliable in Experiment 3 compared to Experiment 2. The lack of reliable interactions of trial type with target perspective or perspective congruence in both experiments suggests that the pattern of responses in the mismatch trials was similar to that of the match trials despite previously discussed conceptual and methodological differences between these conditions.

1PP-3PP task. Incorrect responses (5.8%) and response latencies exceeding 3 standard deviations from the individual mean (1.4%) were trimmed prior to computing mean RTs for each condition. For subsequent analysis, only one participant was excluded for failing to achieve a minimum of 70% accuracy on the 3PP-3PP task. All participants achieved the 70% accuracy minimum on the 1PP-3PP task.

Mean accuracy for each condition was reliably above chance (all $p < .001$). As in Experiment 2, there was some variability between participants in overall accuracy, ranging from 82% to 99% with a median of 95%. Overall RTs also varied considerably, ranging from 435 ms to 935 ms with a median of 606 ms. See Table 2.7 for all means and standard errors for efficiency data. For completeness, descriptive statistics are also reported for RT and accuracy data (see Table 2.8).

A 2 (Target Perspective: 1PP, 3PP) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Avatar Identity: Self, Other) repeated-measures ANOVA on efficiency scores for match trials was computed. Replicating previous studies, the data showed a significant main effect for perspective congruence, $F(1,39) = 42.3$, $MSE = 16455$, $p < .001$, $\eta_p^2 = .520$, such that participants were more efficient for congruent than incongruent trials. A significant effect for target perspective, $F(1,39) = 9.08$, $MSE = 15362$, $p = .005$, $\eta_p^2 = .189$, showed more efficient judgements for 1PP relative to 3PP. The Target Perspective × Perspective Congruence interaction was non-significant for match trials, $F(1,39) = 1.31$, $p = .259$. Notably, the Avatar Identity × Perspective Congruence interaction was significant, $F(1,39) = 4.91$, $MSE = 9747$, $p = .033$, $\eta_p^2 = .112$ (cf. 1PP-3PP combined analysis). On trials where 1PP and 3PP were congruent, participants showed significantly more efficient performance when the Self avatar was present than when the Other avatar was present, $t(39) = 2.69$, $d = 0.425$, $p = .011$. On trials where 1PP and 3PP were incongruent, there was no significant difference in performance between Self and Other trials, $t(39) = 0.563$, $p = .58$. All other main effects and interactions were non-significant for match trials, all $p > .20$.

Table 2.7

Descriptive Statistics for 1PP-3PP Task: Efficiency Scores, Experiment 3

Trial Type	Target	Avatar	Congruent	Incongruent	Interference Difference	Average
Match Trials	1PP	Self	588 (24.1)	693 (35.8)	105	641
		Other	639 (29.8)	693 (30.6)	54	666
	3PP	Self	627 (23.9)	758 (34.8)	131	693
		Other	656 (26.4)	739 (31.5)	83	698
Mismatch trials	1PP	Self	627 (19.1)	591 (18.5)	-36	609
		Other	620 (26.0)	608 (21.8)	-12	614
	3PP	Self	682 (27.3)	792 (28.4)	110	737
		Other	661 (23.6)	793 (28.9)	132	727

Note. Standard errors are provided in parentheses.

2.4.4. Discussion

Results of the avatar identity-matching task and of the matching trials in the 3PP-3PP task run in Experiment 3 replicated the findings of Experiment 2. Results differ with respect to the mismatch trials of the 3PP-3PP task. During the 3PP-3PP task and the avatar identity-matching tasks of Experiment 2, mismatch trials did not show a reliable self-advantage (see Appendix 2.3). However, in these same conditions we did observe reliable self-advantages in Experiment 3 (Appendix 2.4.1). This strengthens the argument that responses to mismatch trials are less reliable and are more susceptible to interference from confounding factors not directly related to the experimental question. This topic is further elaborated in the General Discussion.

More importantly, the 1PP-3PP task provided evidence that self-relevant perspectives facilitated perspective taking even when 1PP was contextually relevant. Specifically, avatar identity interacted with perspective congruence. Participants were more efficient at perspective taking for both the avatar (3PP) and their own 1PP when the Self avatar was present than when the Other avatar was present; this effect emerged only when the avatar's (3PP) and the participant's (1PP) perspectives were congruent. This interaction was not modulated by target perspective, as originally anticipated.

Although the originally predicted three-way interaction was not observed, the Avatar Identity × Perspective Congruence interaction nonetheless demonstrated that the Self avatar, relative to the Other avatar, had a special relationship with the self-as-1PP. Namely, the presence of the Self (vs. Other) avatar in the virtual room boosted perspective-taking efficiency when its perspective was congruent with the 1PP, irrespective of the target perspective conveyed by the trial prompt. Notably, the presence of the Self (vs. Other) avatar was not associated with additional processing costs when the perspective of the self-as-1PP conflicted with the perspective of the virtual Self avatar (i.e., for incongruent trials). Finally, the absence of a reliable Target Perspective × Avatar Identity interaction offers no support to the alternative hypothesis that the Self avatar effect observed in the 3PP-3PP task (Experiments 1–3) were driven solely by heightened vigilance elicited by the prompt wording for the Self avatar (e.g., "Your avatar"). Indeed, the Self avatar effect in this experiment was observed independent of whether the Self avatar was mentioned in the prompt.

Table 2.8

Descriptive Statistics for 1PP-3PP Task: RT and Accuracy, Experiment 3

Trial Type	Index	Target	Avatar	Congruent	Incongruent	Interference Difference	Average
Match trials	RT (ms)	1PP	Self	580 (21.5)	604 (22.8)	24	592
			Other	602 (23.4)	677 (26.6)	75	640
		3PP	Self	600 (19.3)	617 (24.9)	17	609
			Other	623 (21.6)	666 (23.9)	43	645
	Accuracy	1PP	Self	.991 (.007)	.897 (.018)	.094	.944
			Other	.956 (.013)	.903 (.018)	.053	.930
		3PP	Self	.966 (.013)	.913 (.020)	.053	.940
			Other	.959 (.014)	.916 (.017)	.043	.938
Mismatch trials	RT (ms)	1PP	Self	605 (17.9)	578 (17.8)	-27	592
			Other	591 (19.4)	593 (19.7)	2	592
		3PP	Self	627 (19.0)	725 (26.3)	98	676
			Other	619 (20.5)	717 (22.7)	98	668
	Accuracy	1PP	Self	.969 (.012)	.981 (.007)	-.012	.975
			Other	.963 (.011)	.978 (.008)	-.015	.971
		3PP	Self	.934 (.015)	.925 (.019)	.009	.930
			Other	.941 (.011)	.916 (.016)	.025	.929

Note. Standard errors are provided in parentheses.

Results also revealed a robust main effect of target perspective, with participants showing greater efficiency for 1PP than for 3PP targets. This finding is consistent with a number of VPT studies that have found 1PP to be prioritised over 3PP (e.g., Keysar et al., 2000; Surtees & Apperly, 2012; Vogeley et al., 2004). However, one study using a similar paradigm to the current study have found no differences in overall performance for one's own perspective versus that of a third-person avatar (Qureshi et al., 2010), and others report that performance is enhanced for the avatar relative to 1PP when the two perspectives are congruent (Ramsey et al., 2013; Samson et al., 2010). Potential factors contributing to this variability in perspective prioritisation are considered in greater detail in the General Discussion.

2.5. General Discussion of Experiments 1–3

2.5.1. Chapter Summary

This chapter investigated whether self-prioritisation effects reported across many different cognitive domains can also be observed in the context of perspective-taking tasks. The data provided evidence for the prioritisation of self-relevant compared to low-relevance (i.e., Other-avatar) perspectives. Prioritised processing of the Self over Other avatar was observed when the perspectives of the two avatars were viewed together, and when each was contrasted solely with the 1PP. Specifically, in the 3PP-3PP task (Experiments 1–3), participants showed better performance when the target was the Self compared to a non-relevant Other. In this task, 1PP was kept constant and was irrelevant to the task. The 1PP-3PP task (Experiment 3) examined whether a self-relevant 3PP may similarly benefit performance when the first-person view is meaningfully varied. In this task, we observed that 1PP was prioritised over both avatars. More importantly, the results revealed that the presence of a self-relevant perspective facilitates the computation of congruent first- and third-person perspectives. However, the level of interference occasioned by the different perspectives was similar for all distractor entities (i.e., 1PP and both 3PPs). Finally, the overall pattern of results was more reliable for matched than for the mismatch trials, though both trial types showed a similar pattern of results. Collectively, these findings showed advantageous processing for self-relevant perspectives especially when they are actively engaged (i.e., as a target vs. distractor perspective).

2.5.2. Prioritisation of Self-Relevant Perspectives

In the current experiments, priority for self-relevant perspectives (i.e., Self avatar, 1PP) was observed during explicit processing. This advantage of 1PP over 3PP is consistent with previous findings from the VPT literature showing that 1PP is often privileged over 3PP (e.g., David et al., 2006; Kockler et al., 2010; Surtees & Apperly, 2012; Vogeley et al., 2004). This is also consistent with previous findings reporting more efficient processing of target stimuli that are especially relevant to the self (Sui, Liu, Wang, & Han, 2009; Sui et al., 2012; Symons & Johnson, 1997). For example, previous studies (e.g., Sui et al., 2012), including our current findings, show that judging the matching of a label and an arbitrary visual stimulus was faster when the visual stimulus was associated with the self as opposed to someone else.

However, the current findings are inconsistent with some VPT studies that do not show a reliable advantage for judging self-relevant perspectives (e.g., Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010). As noted above, these previous studies compared 1PP (i.e., Self) to an avatar's 3PP (i.e., Other). Importantly, the head and body orientation of the avatar make its gaze direction, and hence its perspective, relatively salient compared to the 1PP. In the current study (3PP-3PP task), we compared the processing of Self and Other perspectives by using two avatars that were socially-tagged to represent these identities. Relative to previous paradigms, the current study also reduced the differences in gaze direction between 3PP and 1PP from a 90° difference (e.g., Samson et al., 2010) to a 45° difference. This latter change reduced the visibility of the avatar's frontal profile, which is assumed to reduce the salience of facial gaze cues (see Hietanen, 1999). We note that the relative salience of perspectives is unlikely to explain prioritisation patterns from 3PP-3PP tasks such as the one used in this study. Unlike in the 1PP-3PP paradigms discussed above, the 3PP-3PP paradigm explicitly controlled for gaze-cueing differences between the Self and Other perspectives; both perspectives were equally salient, differing only in the avatar-colour assignment, which was counterbalanced across participants. Eliminating this salience difference between perspectives revealed an overall advantage for the Self avatar's perspective. In light of the current findings, we suggest that explicit self-advantages in previous paradigms may have been masked by attentional capture from visual cues such as the avatar's head and body orientation.

None of the three experiments revealed any indication that participants were favouring the Self avatar's perspective at an implicit level. Recall that the current study indexes implicit processing as the amount of interference from the distractor perspective. In other words, the interaction between the target perspective and perspective congruence factors served as the marker for implicit processing. In the 3PP-3PP task, interference levels did not differ between Self and Other avatars (Experiments 1–3). The 1PP-3PP task similarly failed to show any difference between the Self and Other avatars in terms of their interference on 1PP (Experiment 3). We also did not observe implicit prioritisation of 1PP, as target perspective and perspective congruence did not interact in this task either. As described in the introduction, the literature is inconsistent with respect to the level of implicit prioritisation of given perspectives. In some studies, 1PP produced greater interference than the avatar perspective (Ramsey et al., 2013; Samson et al., 2010). One study found the opposite (see adult sample error analysis from Surtees & Apperly, 2012), and another found no difference in interference between the perspectives (Qureshi et al., 2010). The absence of a consistent behavioural pattern across these many VPT studies suggests that there is no reliable evidence supporting automatic prioritisation of any perspective at an implicit level. The lack of implicit self-prioritisation in these perspective-taking tasks contrasts with the attention literature showing that self-relevant information captures attention even when irrelevant to the task (A. R. A. Conway et al., 2001; Moray, 1959; Wood & Cowan, 1995b). However, given the importance of simultaneously holding multiple perspectives during social interaction, it is perhaps unsurprising that this process is not implicitly biased toward the self. We speculate that the social nature of perspective taking likely requires greater flexibility and hence does not show an automatic self-advantage. Nonetheless, we note that it is possible that biases to one perspective may occur at the neuronal level (see Ramsey et al., 2013) without always manifesting behaviourally.

There are a number of explanations that may account for the explicit self-advantage in the present study. Our findings could be interpreted as resulting from participants' identification with the Self avatar. Certainly, the labels "YOU" versus "OTHER" (in the avatar identity-matching task) and the prompts "Your avatar" versus "Other's avatar" (in the perspective-taking tasks) are suggestive of some level of identification. We note, however, that many factors are thought to drive Self-avatar identification, ranging from emotional attachment, past experience, and physical similarity (see Ganesh et al., 2012, for a review) to agency (Corradi-Dell'Acqua et al., 2008) and multisensory synchrony (Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2009). However, perspective-taking appears to be unreliably affected by avatar realism. In two experiments, MacDorman and colleagues (MacDorman, Srinivas, & Patel, 2013) found similar performance for human-like avatars and eerie fantasy creatures in perspective adoption and interference. Considering these factors, it is unclear whether participants actually identified with the mono-colour cartoon avatars used in the current study (similar to those used by Corradi-Dell'Acqua et al., 2008). This possibility remains to be empirically assessed.

An alternative explanation for the present findings is that the social-tagging procedure heightened the relevance of the Self avatar through simple association learning. It is a well-known phenomenon that contextual significance is readily learned, leading to robust prioritisation effects. For example, in minimal group paradigms, arbitrary group assignments (e.g., via coloured wristbands) can engender immediate prioritisation of the self-associated group (e.g., Ashburn-Nardo, Voils, & Monteith, 2001; Bernstein et al., 2007; Kawakami et al., 2014; Quinn & Rosenthal, 2012; Ratner & Amodio, 2013; Tajfel, Billig, Bundy, & Flament, 1971). Similarly, imagined ownership of an object increases the ascribed value and recognition of the object (e.g., Cunningham, Turk, Macdonald, & Macrae, 2008; Gawronski, Bodenhausen, & Becker, 2007; Kim & Johnson, 2012, 2014; van den Bos, Cunningham, Conway, & Turk, 2010). Therefore, it is likely that the mere association of an avatar to the self increased the Self avatar's contextual relevance and, consequently, its prioritisation.

Irrespective of whether the self-advantage during explicit perspective taking arose due to identification with or the increased relevance of the Self avatar, the results of the 1PP-3PP task clearly showed that the Self avatar bears a special relationship with the phenomenological self. When participants' 1PP was congruent with the self-associated avatar's 3PP, overall performance was enhanced compared to when 1PP was congruent with the Other avatar.

2.5.3. Implications for Perspective Computation and Selection

Similar to previous (1PP-3PP) perspective-taking experiments (Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012), we observed reliable congruence effects. In the 1PP-3PP task, when the number of total dots on the wall did not match the number of dots a single avatar (Self, Other) saw, performance for both perspectives were less efficient compared to when they both saw the same number of dots. Going beyond this we showed that, when the perspectives of two avatars are considered (e.g., in the 3PP-3PP task), interference between the two is nonetheless observed. This suggests that participants can simultaneously compute and process at least two 3PPs, even when it hinders task performance. In 1PP-3PP paradigms, it is argued that gaze cues (e.g., head and body orientation) mediate the interference from a 3PP on a 1PP perspective via automatic attentional capture (see Ramsey et al., 2013; Samson et al., 2010). In the 3PP-3PP task, two sets of attentional cues (i.e., the body orientation cues from each avatar) were simultaneously presented. Therefore, the interference effects observed suggest that participants' attention was distributed across multiple locations and, hence, could be simultaneously captured by more than one set of orientation cues. This possibility is in agreement with findings from the attention literature showing that the efficacy of spatial cues is not necessarily diminished when more than one location is simultaneously cued (Bay & Wyble, 2014). Furthermore, Carlson-Radvansky and colleagues report interference when two visual reference frames are in conflict (Carlson-Radvansky & Irwin, 1994; Carlson-Radvansky & Jiang, 1998). Concretely, judgements regarding the location of a dot relative to an object from a given reference frame (e.g., viewing the object from above) are affected by the information provided by alternative frames (e.g., viewing the object from the side). This evidence is consistent with our interpretation that participants represent multiple 3PPs simultaneously, despite the increased computational demand and potential interference costs. More specific to the study of social cues, our finding of interference between two 3PPs in the 3PP-3PP task strengthens the idea that we tend to compute what others see, even when it is not required by the task (Samson et al., 2010). Recall that in the 3PP-3PP task, each trial prompted participants to process only one avatar perspective.

In light of the reliable congruence effects obtained in Experiments 1–2, it is worth considering the stage at which the Self advantage arises. One approach to perspective taking defines it as the attribution of mental states to others. This process is hypothesised to involve two stages: computation and selection (Leslie, German, & Polizzi, 2005; Ramsey et al., 2013; Samson et al., 2010). The computation mechanism generates content for available perspectives, whereas the selection mechanism selects the relevant perspective from among these competing options. This framework can also be conceptualised in terms of bottom-up and top-down processing. In other words, a scene-driven bottom-up computation (e.g., two dots + blue avatar; one dot + green avatar) and a top-down process of perspective attribution to identities (e.g., "*my avatar sees* 2 dots"; "*the other avatar sees* 1 dot") enable the selection of the target over the distractor perspective (Ramsey et al., 2013; Samson et al., 2010). The relative ease of computing specific perspectives implicitly makes one perspective more salient, biasing responses at the selection stage. When the salient perspective is not relevant to the task, one needs to inhibit it to be able to explicitly select the correct perspective (Leslie et al., 2005; Ramsey et al., 2013; Samson, Apperly, & Humphreys, 2007; Samson & Apperly, 2010).

The current study suggests that the presence of a self-relevant 3PP can lead to a generalised enhancement in VPT when that perspective and 1PP are congruent. It is unclear how the presence of a Self avatar in the 1PP-3PP task could have had a bottom-up (i.e., automatic) effect on VPT for the avatar *and* the first-person in congruent but not incongruent trials. Instead, we speculate that this enhancement arose during the attribution phase of perspective computation. In other words, the identical 3PP and 1PP perspectives may both be efficiently attributed to the same viewer: the participant's self-concept (see Newen & Vogeley, 2003). The social neuroscience literature provides ample evidence for anatomically overlapping representation of the self perspective (i.e., 1PP) and 3PPs (e.g., Ochsner et al., 2005; Vogeley et al., 2004). Moreover, a pair of fMRI studies has shown that the overlapping representation of mental states for the self and others in the VMPFC is modulated by the perceived similarity of the other person and the self (Mitchell, Banaji, & Macrae, 2005; Mitchell, Macrae, & Banaji, 2006). Ultimately, such a cognitive shortcut is less plausible for a 3PP that is more distant from the self-concept (e.g., Other avatar), or when 1PP and 3PP provide conflicting information (e.g., incongruent trials).

2.5.4. Methodological Considerations

In the current study, we reported perspective-taking data for trials in which the prompt matched the virtual room (i.e., match) and trials in which the prompt did not match the room (i.e., mismatch). These trials were analysed separately, as it was assumed that the decision processes for match and mismatch trials may engage partly distinct processes. Nonetheless, we note that the pattern of results was similar across both types of trials, although less reliable and consistent in the mismatch trials. A number of factors may have contributed to this pattern. For example, mismatch trials present scenes in which neither perspective matches the prompted number of dots. In other words, both perspectives, whether congruent or not, contribute to the same behavioural response. Additionally, cognitive theories on comparative judgements (e.g., same vs. different) argue that "different" judgements are "noisier" and may involve additional processes such as re-checking (Farell, 1985; Krueger, 1978). This potentially leads to increased variance, consequently obscuring differences between conditions for trials requiring a "different" judgement. In sum, these factors are thought to reduce the reliability of mismatch trials. We note that similar rationales for focusing on match trials have been offered by previous perspective-taking studies (see Samson et al., 2010). Nonetheless, we note that the modification of VPT paradigms to avoid the use of match-mismatch decisions may improve the sensitivity of such tasks (see 3.2.2).

2.5.5. Conclusion

The current chapter provides evidence that self-relevant perspectives can facilitate perspective-taking processes in distinct contexts. When presented with two competing 3PPs varying in relevance (3PP-3PP task; Experiments 1–3), participants showed more efficient performance when explicitly adopting the more self-relevant perspective. When the Self avatar was presented as the distractor perspective, no difference was observed relative to the less-relevant Other avatar. We conclude that the prioritisation of self-relevant 3PPs is most reliable under conditions of intentional VPT. When considered in contrast to the first-person view (1PP-3PP task; Experiment 3), the presence of a self-relevant (instead of other-relevant) 3PP facilitated performance for both perspectives, but only on trials where the first- and third-person views were congruent. We suggest this pattern results from the attribution of both perspectives to the self-concept, a cognitive shortcut that is not available for a non-self perspective. Lastly, the current results suggest that gaze cues may play an important role in the relative prioritisation of 1PP versus 3PP. Examining the extent to which motivation, memory, and attention may contribute to the facilitation of self-relevant perspectives represents a fruitful topic for further research.

CHAPTER 3: VISUAL PERSPECTIVE TAKING AND INDIVIDUAL DIFFERENCES IN SOCIAL COGNITION[5]

3.1. Introduction

3.1.1. How Social Is Visual Perspective Taking?

One of the hallmarks of human evolution is thought to be our ability to represent the world as experienced by others (Call & Tomasello, 2008; Premack & Woodruff, 1978). This ability to mentalise, also known as theory of mind, has been investigated using a number of paradigms, ranging from simple VPT tasks (e.g., Flavell, Everett, Croft, & Flavell, 1981; Masangkay et al., 1974; Piaget & Inhelder, 1948; Samson et al., 2010; Vogeley et al., 2004) to more classic false-belief reasoning tasks (Baron-Cohen, Leslie, & Frith, 1985; Perner, 1991; Premack & Woodruff, 1978; Wimmer & Perner, 1983). In adults, perspective-taking ability has been linked to factors promoting evolutionary fitness including the size of one's social support network (Stiller & Dunbar, 2007), cooperativeness (Paal & Bereczkei, 2007), skilful resolution of competing interests (Artinger, Exadaktylos, Koppel, & Sääksvuori, 2014; Galinsky, Maddux, Gilin, & White, 2008), and subjective power (Galinsky, Magee, Inesi, & Gruenfeld, 2006). Frequently, such studies rely on paradigms in which participants must infer others' mental states (i.e., mentalising, theory of mind; but see Galinsky et al., 2006). One

[5] Experiment 4 has been adapted from a paper that has been accepted for publication in *Cognitive Neuroscience* (Mattan, Quinn, & Rotshtein, in press). All co-authors contributed to that publication, which also benefitted from the valuable feedback of action editor Prof. Glyn Humphreys and two anonymous reviewers. Experiment 5 is adapted from a manuscript that has been accepted for publication in the *Quarterly Journal of Experimental Psychology* (Mattan, Quinn, Acaster, Jennings, & Rotshtein, 2015). All co-authors contributed to that publication, which has benefitted from the insightful comments of action editor Dr. Sheila Cunningham and two anonymous reviewers.

goal of the present chapter was to examine whether lower-level VPT, like mentalising, is associated with relatively well characterised aspects of social-cognitive functioning (e.g., empathy, personal relevance in ageing).

Although demands on executive control and reasoning may vary between paradigms (Apperly, 2010; Hartwright, Apperly, & Hansen, 2014, 2015; Samson & Apperly, 2010), there is a prevailing assumption that all of the above paradigms require the representation of others' views. Moreover, this representational component is assumed to reflect an important and early-developing mechanism that ultimately supports higher level social-cognitive processes, such as behavioural inferences (Frith & Frith, 2006; Samson & Apperly, 2010) and empathy (Decety, 2005). However, because VPT tasks do not require the attribution of a perspective to the avatar for successful performance and may be construed as affect-neutral, it could be argued that these tasks are not inherently social (e.g., Santiesteban, Catmur, Hopkins, Bird, & Heyes, 2014). In a variation of the VPT paradigm developed by Samson and colleagues (2010), for example, replacing the human-like avatar with an arrow of similar low-level features yields a similar perspective-congruence effect (Santiesteban et al., 2014). Using a variation of the director task (Keysar et al., 2000; Keysar, Lin, & Barr, 2003), Apperly and colleagues (2010) have also shown that removing the director's avatar and inviting participants to use an arbitrary non-social rule improved participant's ability to perform this VPT task. Taken together, this evidence suggests that performance on such paradigms may be equivalent or even improved when reconceptualised as non-social tasks.

Nonetheless, the non-social strategies do not appear to be adopted spontaneously by participants, who readily attribute perspectives and/or mental states to computerised avatars and even two-dimensional geometric shapes (Abell, Happé, & Frith, 2000; Castelli, Happé, Frith, & Frith, 2000; Heider & Simmel, 1944; A. M. Klein, Zwickel, Prinz, & Frith, 2009;

Zwickel, White, Coniston, Senju, & Frith, 2011). Indeed, it is thought that the tendency to process the perspective of an avatar may be elicited spontaneously (Klein et al., 2009; Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012; Surtees, Noordzij, & Apperly, 2012; Tversky & Hard, 2009). Moreover, explicit instructions explaining that the avatar's position constrains her perspective significantly improve perspective-taking performance (J. J. Wang, Cane, Ferguson, Frisson, & Apperly, in preparation). In further support of the relevance of social context to VPT performance, we have found that the presence of a self- versus other-associated avatar can facilitate VPT for 1PP and 3PP (Mattan, Quinn, Apperly, et al., 2015; see also Chapter 2). Thus, social context is readily inferred in VPT paradigms, and it may even help to improve performance.

If VPT is sensitive to social context, then it is plausible that performance on VPT tasks, like performance on mentalising tasks, would correlate with socially relevant traits such as empathy. The perspective-taking literature offers mixed support for this hypothesis. For example, subjective power has been shown to increase egocentrism in both visual and emotional perspective-taking paradigms (Galinsky et al., 2006). Additionally, several studies on the visual-spatial transformation of body position have shown correlations with different dimensions of empathy, but only in women (Mohr, Rowe, & Blanke, 2010; Thakkar, Brugger, & Park, 2009; Thakkar & Park, 2010). In contrast to this evidence, the literature on autism and VPT suggests that individuals with autism perform at similar levels to controls on VPT but show egocentric deficits when performing tasks that require the representation and/or elaboration of mental states (Baron-Cohen et al., 1985; Baron-Cohen, 1988; T. Reed & Peterson, 1990). Although these findings do not discount a relationship between VPT and social functioning, they do suggest that visual and cognitive perspective taking may depend on partly separable processes. Indeed, it has been suggested that VPT may heavily rely on domain-general representational mechanisms such as working memory or mental rotation compared to mentalising, which requires the additional step of inferring an actor's desires and/or beliefs (Aichhorn et al., 2006; Baron-Cohen, 1988; Schurz, Aichhorn, Martin, & Perner, 2013).

3.1.2. Chapter Overview

On the assumption that VPT paradigms tap into a representational mechanism that is shared in higher-level social cognition (e.g., mentalising), performance on these tasks should show a meaningful relationship with social functioning. However, this relationship is relatively under-researched (but see Bukowski & Samson, 2015; Galinsky et al., 2006; Thakkar et al., 2009; Thakkar & Park, 2010). In the current chapter, we address this gap by examining the relationship between VPT and empathy (Experiment 4) and social-cognitive ageing (Experiment 5). In both cases, we examine whether known individual differences related to social-cognitive functioning map meaningfully onto performance in relatively simple VPT tasks (e.g., 3PP-3PP and 1PP-3PP tasks, see Chapter 2).

3.2. Experiment 4: Self Priority as a Function of Empathic Tendency

3.2.1. Introduction

It is generally agreed that empathy is a multi-faceted construct, involving affective and cognitive components (Davis, 1996; Decety & Jackson, 2004). The affective component involves sensitivity to and simulation of another person's affective state, whereas the cognitive component captures the awareness and flexible use of others' mental states (i.e., mentalising). Two crucial aspects of cognitive empathy include mental flexibility to adopt the potentially conflicting perspective of another and effective maintenance of a distinction between self and other even when simulating others' experiences (see Decety & Jackson, 2004; Decety & Lamm, 2006; Eisenberg, 2000). In other words, cognitive empathy is associated with the propensity to represent and flexibly shift between experiences of self and other, without confusing the two. This definition for cognitive empathy maps nicely onto the representational and executive-control aspects of mentalising (see Apperly, 2010). In brief, the representational component involves representing the mental states/viewpoints of others, and the executive-control component involves inhibiting and/or selecting between these sometimes conflicting perspectives. Both of these aspects can be tested using VPT paradigms that experimentally manipulate perspective conflict (e.g., Bukowski & Samson, 2015; Mattan, Quinn, Apperly, et al., 2015; Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010). Consistent with the above definition of cognitive empathy, we anticipate that empathic individuals will demonstrate greater mental flexibility and management of conflicting perspectives while still remaining sensitive to differences between self and other.

One important aspect of VPT paradigms is that the first-person view is qualitatively distinct from a third-person view. This presents a potential confound of first- versus third-person perspective-taking paradigms that potentially obscures the interpretation of self-bias effects (see Mattan, Quinn, Apperly, et al., 2015). Hence, the current study adopts the use of the 3PP-3PP paradigm from Chapter 2, which involves only third-person avatars as target perspectives. Although perspectives and/or mental states are readily attributed to computerised avatars (Mattan, Quinn, Apperly, et al., 2015; Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012; Surtees et al., 2012) and even two-dimensional geometric shapes (Abell et al., 2000; Castelli et al., 2000; Heider & Simmel, 1944; A. M. Klein et al., 2009; Zwickel et al., 2011), effective processing potentially involves some degree of immersion within the virtual space. Relevant to the current study's focus on empathy, existing measures of empathy have assessed participants' propensity for absorption in fictitious worlds (e.g., plays and novels: Davis, 1980, 1983). Additional evidence suggests that subjective immersion within a virtual environment is positively predicted by participants' trait-level empathy (Nicovich, Boller, & Cornwell, 2005; Sas & O'Hare, 2003). Therefore, it is especially important for this experiment not to confound perspectives (i.e., self/other) and the nature of the entities (real/virtual), as the latter may interact with empathy.

Hypotheses. The use of the 3PP-3PP paradigm permitted an examination of empathy's relationship with two VPT phenomena: (1) cost of selecting between conflicting perspectives (i.e., perspective-congruence effects; Samson et al., 2010) and (2) prioritisation of a self-associated perspective (Mattan, Quinn, Apperly, et al., 2015). Specifically, we focused on self-prioritisation in terms of perspective-selection costs when adopting the Self (vs. Other) avatar's perspective (i.e., Target Perspective × Perspective Congruence interaction effects). These relationships were assessed with analysis of covariance (ANCOVA), using self-reported empathy scores as the covariate. For the empathy measure, we used the Interpersonal Reactivity Index (IRI: Davis, 1980). This measure includes subscales related to cognitive (e.g., perspective-taking) and affective (e.g., empathic-concern) aspects of empathy.

Perspective selection. We tested competing hypotheses regarding empathy's effect on perspective-congruence effect magnitude. On the one hand, empathy may be linked to a greater tendency to attend to other perspectives (Decety, 2005), such that high-empathy individuals pay more attention to distractor perspectives, resulting in a larger perspective-congruence effect. Alternatively, empathy may be linked to greater capacity and flexibility in attending to other perspectives (Chartrand & Bargh, 1999; Decety & Jackson, 2004), such that high-empathy individuals more effortlessly represent and select between conflicting perspectives, resulting in smaller perspective-congruence effects.

Self-prioritisation. We also tested competing hypotheses regarding empathy's effect on self-prioritisation. Given the definition of empathy as an other-oriented response to the cognitive and emotional experiences of others (Davis, 1996; Decety & Jackson, 2004; Eisenberg, 2000), one possibility is that high-empathy participants are less egocentric, showing increasingly similar overall performance for Self and Other. Alternatively, empathy may enhance sensitivity to the Self avatar, consistent with previous research showing that dispositional or situational levels of empathic concern predict prioritisation of people with a degree of personal familiarity or relevance (Batson & Ahmad, 2009; Batson, Klein, Highberger, & Shaw, 1995; Cialdini, Brown, Lewis, Luce, & Neuberg, 1997; Decety & Batson, 2009; Decety & Cowell, 2014; Oceja, 2008).

3.2.2. Method

Participants. Forty-three students (38 female; M_{age} = 19.2 years, SD_{age} = 1.77) were recruited from the University of Birmingham's research participation scheme, receiving course credit for their participation. After giving informed consent, participants completed the introduction task, the social-tagging manipulation, and the perspective-taking task described below. Participants then completed the IRI and a brief demographic survey online. Following all tasks, participants were debriefed and compensated accordingly.

Introduction task. To generate names for and introduce participants to the identities used in subsequent tasks, we included a novel task in which participants create a two-dimensional map of how they would position themselves with respect to the other identities used in this study (i.e., friend, family member, and a stranger named Jamie). Like the Inclusion of the Other in the Self Scale (IOS; Aron et al., 1992), this pictorial measure invites participants to place self and non-self entities in a two-dimensional space. However, unlike the IOS, this measure allows the placement of multiple non-self identities within the same scene (see Appendix 3.1). The data from this task are not germane to the present research question and so will not be discussed. For the purpose of the present study, this task served merely to generate (friend and family member) or introduce (self and Jamie) the social identities used in subsequent tasks.

Social-tagging manipulation. For the purpose of the present analysis, the social-tagging task served to familiarise participants with the Self and Jamie avatar identities that would be used subsequently in the perspective-taking task. As the focus of this experiment is on empathy and VPT, we do not test hypotheses regarding self-tagging here. However, data from this task were used in a separate pilot study on social-cognitive ageing not reported in the present work.

Design adaptations. The social-tagging manipulation was adapted from Chapter 2 (2.3.2). Participants were presented with four (increased from three) avatars, each randomly assigned to one identity from the introduction task: self, a friend, a family member, and a stranger named Jamie. The friend and family avatars were included in this manipulation to increase task engagement, but they were not used in the VPT task (cf. Mattan, Quinn, Apperly, et al., 2015). In the present task version, we added a secondary memory task to pilot the effects of cognitive load in social-cognitive ageing (not reported in the present work). The secondary task followed a blocked design with each participant completing one block of each condition (i.e., high and low cognitive load). The ordering of high- and low-load blocks was counterbalanced across participants. Due to the addition of a fourth identity and a concurrent cognitive load manipulation, we raised the minimum stimulus display time from 15 ms (see 2.3.2) to 300 ms in order to reduce participant fatigue. Participants were instructed to press the M key for match trials and the K key for mismatch trials.

Procedure. As in Chapter 2 (see 2.3.2), participants first completed a series of approximately five practice rounds of 12 trials. All participants completed their final practice block at the minimum duration of 300 ms with a minimum accuracy of 80% (increased from 75% in Chapter 2). After the practice rounds, participants completed 240 experimental trials (15 trials per condition). The experimental trial set was divided into sequences of 10 trials. Each sequence began with a prompt of unlimited duration, informing participants that the following screen would present a letter string they would need to memorise. When ready, the participant pressed any key to view the letter string (low-load blocks: B; high-load blocks: CPM, DHW, FDV, GNQ, KXT, LJH, MZL, NMK, PVN, QBR, RQC, SGP, TWJ, WFG, XRD, ZKF). The letter string was presented for 1000 ms to discourage over-rehearsing. The first experimental trial immediately followed the letter string. After every 10 experimental trials, the program would ask the participant to recall the letter string provided at the beginning of the 10-trial sequence. Response-specific feedback (e.g., “correct” or “incorrect”) was provided after the recall response.

Perspective-taking task. The third-person perspective-taking (3PP-3PP) task was adapted from our previous work (see Mattan, Quinn, Apperly, et al., 2015, or Chapter 2). In this task, more realistic avatars were used, based on a template that was downloaded from http://www.blendswap.com/blends/view/14445 under a creative commons license permitting its use and modification for research purposes. The prompt was further streamlined by removing the number dots and presenting only the target perspective. Thus, participants viewed a prompt indicating the target perspective (i.e., “SELF” or “JAMIE”) that was followed by a trial-specific scene with the two embedded avatars (see Figure 3.1). Instead of judging whether the target perspective could see the number of dots indicated in the prompt, participants simply judged whether the prompted avatar saw one dot or two[6]. A final key change was the addition of a cognitive load manipulation. The load manipulation followed a blocked design with each participant completing two alternating blocks of each condition (i.e., high and low load). The ordering of high- and low-load blocks was counterbalanced across participants. The cognitive load manipulation used in the perspective-taking and social-tagging tasks was included to address a separate question, not germane to this study on empathy (but see Appendix 3.6 for an experiment on ageing that conserves this factor). Interactions between cognitive load and empathy were neither expected nor observed. For the sake of simplicity, reported analyses collapse across this factor.

Trial design. Because of extensive changes to the paradigm, we provide full details of the paradigm here. The experimental trial set was divided into sequences of eight trials. Each sequence began with the presentation of a letter string to memorise (see description of social-

[6] We note here that in the original version of this paradigm (see Mattan, Quinn, Apperly, et al., 2015; Chapter 2), the prompt designated both the target perspective (e.g., “Self avatar”) and the expected number of dots (e.g., “2”). Participants responded based on whether the scene matched (i.e., true trials) or mismatched (i.e., false trials) the information conveyed in the prompt. However, because false trials are thought to be relatively less reliable, these are frequently excluded from analysis (e.g., Mattan, Quinn, Apperly, et al., 2015; Samson et al., 2010). One strength of this new design is that it requires participants to directly report the number of dots seen by the prompted target avatar. Thus, it avoids the use of “false” trials, leading to an ultimately more efficient design.

tagging manipulation for details). The first experimental trial immediately followed the letter string. Trials began with a 1000-ms prompt indicating the target avatar's identity (e.g., "JAMIE"), followed by a 900-ms fixation sequence. Next, the virtual room with the embedded avatars and dots was presented for 400 ms. A blank screen then appeared until the participant provided a response, pressing the 1 key if the target avatar saw one dot and the 2 key if it saw two dots. After every eight trials, the program would ask the participant to recall the letter string provided at the beginning of the 8-trial sequence. Response-specific feedback (e.g., "correct" or "incorrect") was provided after the recall response. Following recall, participants also completed four avatar-identity reminder trials (see 2.3.2).

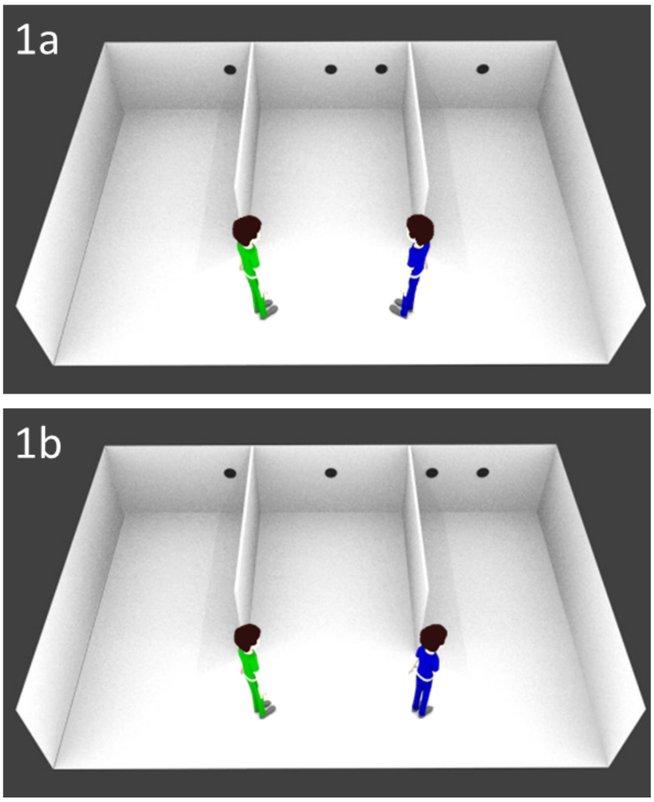


Figure 3.1. Virtual room examples from the third-person VPT task (adapted from Mattan, Quinn, Apperly, et al., 2015). Colour assignment for the Self and Other avatars was randomised across participants. Here, we refer to the blue avatar (on the right) as the Self avatar. For congruent trials (1a), the Self and Other avatars viewed the central area of the room and therefore saw the same number of dots on the far wall. For incongruent trials (1b), one or both avatars gazed toward one of the peripheral sections of the room, such that each avatar viewed a different section of the room and a different number of dots. In this example, the Self avatar is oriented toward the periphery.

Procedure. Participants first completed an introductory training round, following the same procedure as in Experiment 2. All participants completed their final practice block at the minimum duration of 400 ms with a minimum accuracy of 80%. These limits were increased from Experiment 2 (which used minimum duration of 15 ms and a minimum accuracy of 75%). After the practice rounds, participants completed 256 experimental trials with a 400-ms stimulus duration.

Empathy measure. The Interpersonal Reactivity Index (IRI; Davis, 1980) was used to assess empathy. The IRI operationalises empathy as the reactions elicited by observing the experience of others, and comprises four self-report rating subscales: perspective taking, the extent to which participants spontaneously adopt the views of others (e.g., "I try to look at everybody's side of a disagreement before I make a decision"); fantasy, the tendency to imagine oneself in the place of fictional characters (e.g., "I really get involved with the feelings of the characters in a novel"); empathic concern, other-oriented feelings of sympathy and concern for others (e.g., "I often have tender, concerned feelings for people less fortunate than me"); and personal distress, self-oriented feelings of anxiety during perceived or real interpersonal conflict (e.g., "In emergency situations, I feel apprehensive and ill-at-ease"). Participants rated the extent to which they agreed with each of 28 statements along a 5-point scale anchored by 1 (*does not describe me well*) and 5 (*describes me very well*).

Analysis protocol. Analyses focused on the perspective-taking task. To assess whether the overall pattern of the data replicated previous findings (Mattan, Quinn, Apperly, et al., 2015), we first computed 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVAs for efficiency data. We then used ANCOVA to explore the role of empathy, both globally and as a function of each IRI subscale. For analyses of RT and accuracy data, see Appendix 3.2[7].

3.2.3. Results

Incorrect responses (13.2%) and correct response latencies exceeding 3 standard deviations from the participant's overall mean (1.3%) were trimmed prior to computing mean RTs for each condition. One participant with a mean accuracy score of 66% and another participant with a mean RT of 1354 were excluded from analysis as outliers (i.e., exceeding 3 standard deviations from the group mean).

3PP-3PP task replication. A 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA was computed to determine the reliability of effects at the group level. Consistent with previous VPT research (e.g., Samson et al., 2010), results showed a significant main effect of perspective congruence, $F(1,40) = 148$, $MSE = 23094$, $p < .001$, $\eta_p^2 = .787$, with more efficient performance for congruent than for incongruent trials. Replicating previous findings with this paradigm (Mattan, Quinn, Apperly, et al., 2015), a significant effect of target perspective was also found, $F(1,40) = 8.08$, $MSE = 6849$, $p = .007$, $\eta_p^2 = .168$, with participants showing greater efficiency for the Self target than for the Other target. The main effect of cognitive load was non-significant, $F(1,40) = 0.024$, $p = .88$.

As in the analysis of accuracy data (see Appendix 3.2.1), the Target Perspective × Perspective Congruence interaction was reliable, $F(1,40) = 12.0$, $MSE = 6474$, $p = .045$, η_p^2 =

[7] We note that Chapter 2 also relied on efficiency scores for analysis. This was done to counteract possible speed–accuracy trade-offs and to condense the reporting of results. At the encouragement of an anonymous reviewer, the published version of this study reported instead separate RT and accuracy analyses (Mattan, Rotshtein, & Quinn, in press). However, we provide both analyses here to convince the reader that effects were not substantially altered by the computation of efficiency means.

.231. Post-hoc *t*-tests were computed to compare performance for Self vs. Other at each level of perspective congruence. For congruent trials, no reliable difference in efficiency was observed for the Self compared to the Other avatar, $t(40) = 0.732$, $p = .47$. However, for incongruent trials there was a reliable self-advantage, $t(40) = 3.39$, $d = 0.531$, $p = .002$. In other words, when the two perspectives were incongruent, performance was more efficient when the Self (vs. Other) avatar was the target. Taken together, the Target Perspective × Perspective Congruence interaction provides evidence of greater interference from the Self avatar versus Other avatar. All other two-way interactions were non-significant, $p > .50$. See Table 3.1 for efficiency means for each condition.

Table 3.1

Descriptive Statistics for 3PP-3PP Task, Experiment 4

Analysis	Target	Congruent		Incongruent		Interference	Average
RT (ms)	Self	646	(16.2)	715	(21.2)	69	681
	Other	642	(16.0)	711	(20.1)	69	677
Accuracy	Self	.939	(.007)	.840	(.011)	.099	.890
	Other	.941	(.008)	.781	(.009)	.160	.861
Efficiency	Self	687	(16.7)	860	(28.8)	173	774
	Other	682	(15.5)	917	(27.1)	235	800

Note. Standard errors are provided in parentheses.

Empathy and VPT. Across participants, global IRI empathy scores showed a reasonable distribution, with a mean of 2.53 (*min* = 1.57, *max* = 3.25, *SD* = .405). Mean empathy scores showed good internal consistency, α = .82. All IRI subscales showed similar levels of internal consistency (perspective taking: α = .81; fantasy: α = .81; empathic concern: α = .85; personal distress: α = .81).

Main analysis. Efficiency scores were submitted to separate 2 (Cognitive Load: high, low) × 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANCOVAs, with each ANCOVA including one of the individual difference measures (i.e., global empathy or empathy subscale) as a single covariate. To condense reporting of results, we focus on effects involving empathy. ANCOVA statistics for these effects are summarised in Table 3.2.

Table 3.2

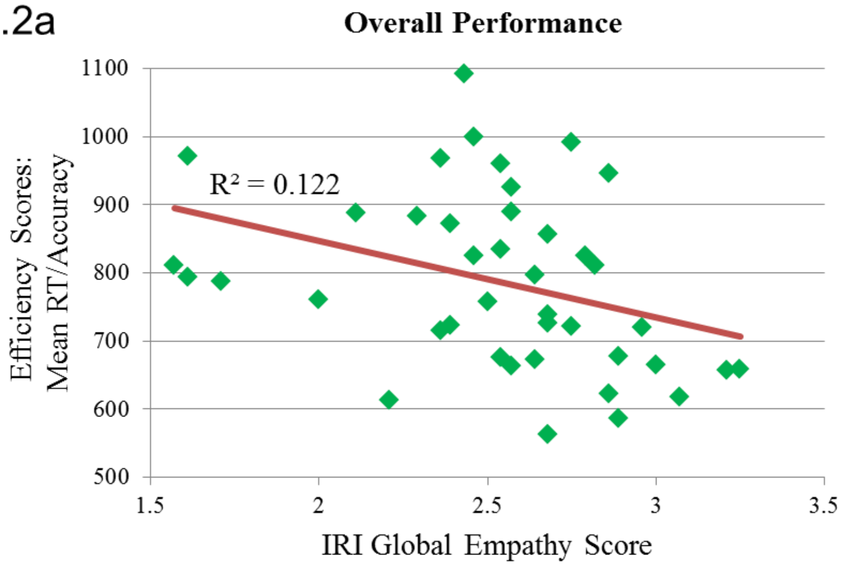
ANCOVA Summaries for Empathy Subscales: Efficiency, Experiment 4

Analysis	IRI Covariate	Effect	*F*(1,39)	*MSE*	η_p^2
Efficiency: RT/Accuracy	Global Empathy (Emp-G)	Emp-G [neg]	5.48*	120950	.123
		TP × Emp-G	0.11	3502	.003
		PC × Emp-G	5.56*	20730	.125
		TP × PC × Emp-G	2.25	3139	.055
	Perspective Taking (Emp-PT)	Emp-PT [neg]	5.29*	60730	.119
		TP × Emp-PT	0.98	3426	.025
		PC × Emp-PT	4.70*	10570	.108
		TP × PC × Emp-PT	2.00	3158	.049
	Fantasy (Emp-F)	Emp-F [neg]	3.51†	63273	.083
		TP × Emp-F	0.22	3493	.006
		PC × Emp-F	4.41*	10640	.102
		TP × PC × Emp-F	1.09	3230	.027
	Empathic Concern (Emp-EC)	Emp-EC [neg]	3.14†	63825	.075
		TP × Emp-EC	0.02	3510	.001
		PC × Emp-EC	4.44*	10633	.102
		TP × PC × Emp-EC	2.56	3115	.117
	Personal Distress (Emp-PD)	Emp-PD	0.29	68922	.001
		TP × Emp-PD	1.47	3385	.036
		PC × Emp-PD	0.02	11838	.000
		TP × PC × Emp-PD	0.01	3319	.000

Note. PC = Perspective Congruence. TP = Target Perspective.
†p < .09. *p < .05.
[neg] Negative correlation with covariate.

Results of the ANCOVA with global empathy as covariate a yielded significant main effect of empathy score, reflecting greater efficiency (i.e., smaller RT/accuracy values) as a function of empathy score (Figure 3.2a). Additionally, a significant Perspective Congruence × Empathy Score interaction was observed, reflecting a negative relationship between empathy scores and perspective-congruence effect magnitude, such that higher empathy scores were associated with smaller perspective-congruence effects—that is, less interference from a competing perspective (Figure 3.2b).

3.2a



3.2b

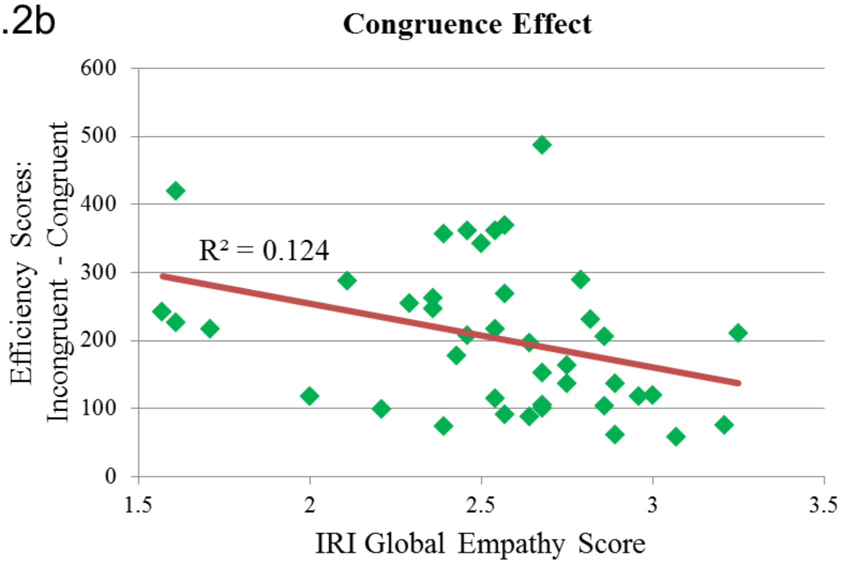


Figure 3.2. IRI global empathy scores were associated with overall efficiency (a) and congruence-effect magnitude (b). Overall, high-empathy participants were better at the task (i.e., smaller efficiency scores) and better able to manage conflicting perspectives (i.e., smaller congruence effect).

Results for the perspective taking, fantasy, and empathic concern subscales were similar to those reported for the global empathy score; these measures correlated negatively with overall performance (significant: perspective taking; marginal: fantasy, empathic concern) and with the magnitude of the perspective-congruence effect. The personal distress subcomponent did not correlate with any effects in the perspective-taking task (see Table 3.2).

In summary, global empathy was reliably associated with overall better perspective-taking performance and reduced interference from distractor perspectives, regardless of target perspective. These effects were also observed for the perspective-taking, empathic-concern, and fantasy subscales.

Supplementary analysis. Analysis of RT and accuracy revealed a more nuanced pattern of results (see Appendix 3.2.2). Although generally consistent with analysis of efficiency scores, analysis of RT data also revealed that the Global Empathy × Perspective Congruence interaction was modulated by target perspective. Global empathy was associated with a greater reduction in interference when targeting the Self (vs. Other) avatar. Empathic concern was the only IRI subscale to reliably replicate this pattern. However, the perspective-taking subscale showed a similar albeit non-significant trend. The personal-distress analysis yielded a distinct pattern of results, showing a marginal negative correlation with Self avatar prioritisation (i.e., main effect of target perspective).

3.2.4. Discussion

In the current study, we directly tested the relationships between VPT ability and empathy. We examined the effects of empathy on two aspects of VPT: (1) the ability to manage conflicting views, and (2) sensitivity to a self-associated avatar's perspective. Analysis of efficiency data showed that high empathy was associated with a diminished cost of selecting between incongruent perspectives. Supplementary analysis of non-adjusted RTs showed that this diminished perspective-selection cost was especially reliable when judging the perspective of the Self avatar. In this same analysis, we found that empathy was also associated with reduced self-prioritisation when the avatars' perspectives were congruent. This interaction most reliably observed in the empathic-concern subscale, although a similar trend was observed for the perspective-taking subscale. The findings are consistent with the hypothesis that empathy is associated with flexibility in managing competing perspectives and preserved sensitivity to the self–other distinction.

Consistent with the hypothesis that VPT performance is related to socially adaptive traits, the current study suggests that that high-empathy individuals are more capable and flexible perspective-takers (Chartrand & Bargh, 1999; Decety & Jackson, 2004). The finding that higher empathy scores were associated with overall faster RTs and reduced cost of processing conflicting (i.e., incongruent) perspectives suggests that high-empathy (vs. low-empathy) participants performed better on the VPT task. This is consistent with the observation that high-empathy individuals have a greater tendency to immerse themselves in simulations (Nicovich et al., 2005; Sas & O'Hare, 2003) and fiction (Davis, 1983, 1996), ultimately showing superior performance on these tasks. Further research will be helpful in determining whether high-empathy participants are intrinsically more interested in perspective-taking tasks or, by virtue of their expertise in representing others' perspectives (Chartrand & Bargh, 1999), more flexible in simultaneously computing and selecting between multiple perspectives.

Nonetheless, the above trends should be interpreted with caution due to the presence of a significant higher-order interaction in the analysis of RT data (see Appendix 3.2.2). Specifically, overall improved performance may have been driven by a significant empathy-related reduction in interference from the Other avatar when targeting the Self avatar's perspective (i.e., Target Perspective × Perspective Congruence × Global Empathy interaction). In other words, as trait-level empathy increased, participants were quicker to judge the Self avatar's perspective in the presence of the Other avatar's conflicting perspective, relative to when both avatars were congruent. This observation is consistent with the hypothesis that empathy requires an awareness of self as separate from other together with a degree of mental flexibility required to switch between perspectives (Decety & Jackson, 2004). Intriguingly, this empathy-related reduction in interference from the Other avatar was accompanied by reduced bias for the Self (vs. Other) avatar on congruent trials. This suggests that, in the absence of perspectival conflict, empathic participants more equitably allocated attentional resources for the Self and Other avatars.

Our results suggest that empathy disproportionately facilitates focus on external perspectives bearing some personal relevance (e.g., Self avatar) in the presence of a conflicting perspective of relatively lesser personal relevance (e.g., Other avatar). However, in the absence of conflict, high-empathy participants showed diminished Self bias. This apparent contrast in egocentrism as a function of empathy is consistent with existing literature showing that the effects of empathy on behaviour are modulated by conflict and implied social relevance (Batson & Ahmad, 2009; Batson et al., 1995; Decety & Batson, 2009; Decety & Cowell, 2014; Galinsky, Maddux, et al., 2008; Oceja, 2008). Specifically, the more affective aspects of empathy (e.g., empathic concern) are associated with impaired insight into opponents during competitive negotiations (Galinsky, Maddux, et al., 2008) and a tendency for favouritism in relatively less competitive manipulations of social relevance (see Batson & Ahmad, 2009; Decety & Cowell, 2014, for reviews), despite explicit endorsement of fairness principles (Batson et al., 1995). The current study is consistent with this literature, showing that the affectively loaded empathic-concern subscale showed a decrease in interference from the Other when adopting the Self avatar's perspective (cf. global empathy). Although a similar trend was observed for the cognitive perspective-taking subscale, the difference in empathy-related interference reduction for Self and Other was not reliable. Given the inherent impartiality reflected in perspective-taking subscale items (e.g., "I try to look at everybody's side of a disagreement before I make a decision."), it is perhaps unsurprising that this cognitive empathy subscale most reliably predicted reduced interference costs in a symmetric fashion for Self and Other avatars.

In summary, results show that empathy is associated with an overall improvement in VPT and reduced interference costs from conflicting perspectives, suggesting that empathy may entail greater flexibility or engagement with such tasks (Chartrand & Bargh, 1999; Decety & Jackson, 2004). The tendency for empathic concern to reduce interference from conflicting low-relevance perspectives is consistent with previous findings linking empathic concern to reduced insight into adversaries (Galinsky, Maddux, et al., 2008) and a tendency for favouritism in paradigms contrasting the needs of personally familiar/relevant people with those of less familiar/relevant others (Batson & Ahmad, 2009; Batson et al., 1995; Decety & Batson, 2009; Decety & Cowell, 2014; Oceja, 2008). Notably, such accounts are largely based on paradigms contrasting a 1PP (i.e., self) with a 3PP (i.e., other). Future work is needed to better understand the neurocognitive mechanisms supporting self-prioritisation among 3PPs and how this may differ from contrasts of 1PP and 3PP (e.g., Mattan, Quinn, Apperly, et al., 2015; Chapter 2).

Conclusion. Consistent with the notion that high-empathy individuals are skilled and flexible perspective-takers (Chartrand & Bargh, 1999; Decety & Jackson, 2004), we found that self-report measures of empathy were associated with overall improved performance and a reduction in perspective-selection costs. In the RT analysis, global empathy scores had contrasting effects on egocentrism, depending on the presence of perspective conflict. When processing redundant (i.e., congruent) perspectives, high-empathy participants showed increasing similarity in their responses to Self and Other, consistent with the putative other-oriented nature of empathy (Decety & Jackson, 2004). However, when processing conflicting (i.e., incongruent) perspectives, high-empathy participants showed less interference from the Other avatar when adopting the Self avatar's perspective compared to the reverse case. This pattern was most reliable in the affective IRI subscale of empathic concern, consistent with previous work linking empathic concern to the prioritisation of familiar and/or personally relevant others in contexts of real or implied competing interests (see Decety & Batson, 2009; Decety & Cowell, 2014, for reviews). Overall, the current findings suggest that performance in VPT tasks is meaningfully affected by socially adaptive traits such as empathy. This offers some support to accounts that propose partially overlapping networks supporting visual and socio-affective perspective-taking (Frith & Frith, 2006; Saxe & Wexler, 2005; Vogeley & Fink, 2003). We are optimistic that continuing research will further delineate the shared and separable neurocognitive mechanisms implicated in VPT, affect, and empathy.

3.3. Experiment 5: Prioritisation of Self-Relevant Perspectives in Ageing

3.3.1. Introduction

As populations in countries around the world age, understanding the implications of ageing on behaviour is becoming increasingly important. An extensive body of research has focused on the cognitive implications of healthy ageing, which includes alterations in processing speed (Cerella, 1990; Salthouse, 1996), selective attention (Madden et al., 2014; Naveh-Benjamin et al., 2014; Samanez-Larkin, Robertson, Mikels, Carstensen, & Gotlib, 2009; Tsvetanov, Mevorach, Allen, & Humphreys, 2013), working memory (Mikels, Larkin, Reuter-Lorenz, & Cartensen, 2005; Rypma & D'Esposito, 2000; Van der Linden, Brédart, & Beerten, 1994), and short-term memory (Gutchess et al., 2005; Rosa & Gutchess, 2013). Although these well-documented changes are commonly conceptualised as cognitive decline, age is not always associated with declines in performance. For example, older adults' processing of socially or emotionally meaningful information is often comparable to that of younger adults (e.g., Carstensen & Mikels, 2005; Fung & Carstensen, 2003; Hess, Rosenberg, & Waters, 2001; Mikels et al., 2005; Narvaez, Radvansky, Lynchard, & Copeland, 2011). The aim of this study is to assess how age affects social-cognitive processing, specifically in context of VPT.

Research on social-cognitive ageing suggests that healthy ageing is often associated with changes in emotion regulation (Carstensen et al., 2011; Scheibe & Carstensen, 2010), personality (Roberts & Mroczek, 2008), and motivation (Carstensen, Mikels, & Mather, 2006; Carstensen, 2006; Hess, 2005, 2014; Mather & Carstensen, 2005; A. E. Reed & Carstensen, 2012). In brief, older adults tend to show memory and/or attentional biases for information that is personally meaningful (Carstensen, 2006; Fung & Carstensen, 2003; Rademacher, Salama, Gründer, & Spreckelmeyer, 2014), self-relevant (Hess, 2014), or emotionally tinged—especially for positive emotions (Mather & Carstensen, 2005; A. E. Reed, Chan, & Mikels, 2014; Sullivan, Mikels, & Carstensen, 2010). Enhanced sensitivity to socio-emotional information in advanced age is thought to compensate for memory and attention deficits (e.g., Fung & Carstensen, 2003; Hess et al., 2001; Mikels et al., 2005; Narvaez et al., 2011). Socio-emotional sensitivity, in concert with greater life experience, may also support older adults' ability to reason effectively about social conflicts (Grossmann et al., 2010), although perhaps not about non-social problems, such as those presented in reward paradigms (Tymula, Rosenberg Belmaker, Ruderman, Glimcher, & Levy, 2013; but see Li, Baldassi, Johnson, & Weber, 2013; Ross, Grossmann, & Schryer, 2014).

Bearing in mind the cognitive changes and motivational aspects of healthy cognitive ageing, the current study focused on the impact of age on social-cognitive processes supporting the ability to consider the viewpoints of others (i.e., VPT, mentalising, etc.). Research overwhelmingly suggests that, relative to younger adults, older adults have difficulties managing mental representations of others, particularly when these conflict with the participant's own understanding of the world (Charlton, Barrick, Markus, & Morris, 2009; German & Hehman, 2006; Henry, Phillips, Ruffman, & Bailey, 2013; Maylor, Moulson, Muncer, & Taylor, 2002; Moran, Jolly, & Mitchell, 2012; Moran, 2013; Rakoczy, Harder-Kasten, & Sturm, 2012). This deficit is attributed to older adults' declining top-down executive control processes, which are assumed to support selection between competing views in younger adult populations (Apperly, 2010; Hartwright et al., 2014; Lieberman, 2007; Qureshi et al., 2010; Ramsey et al., 2013). Notably, older adults also show poorer performance relative to younger adults even in low-level gaze detection and following (Slessor, Phillips, & Bull, 2008). This suggests that bottom-up attentional mechanisms may also play a role in age-related perspective-taking/mentalising deficits. These declines were not reliably associated age-related declines in visual attention and visual acuity, suggesting attentional declines specific to social attention exist over and above any more domain-general declines in attention.

Despite the generally observed egocentrism in older adults' social attention and perspective-taking abilities, one study by Zhang and colleagues (Zhang, Fung, Stanley, Isaacowitz, & Ho, 2013) highlights the importance of personal relevance as a key performance factor. The authors examined the effects of personally relevant experimenters (e.g., familiar vs. unfamiliar experimenter; Experiment 1) and personally relevant targets (e.g., faces of people that were construed as similar/dissimilar to the participant; Experiment 2) on mentalising and emotion-recognition abilities, respectively. The second experiment from Zhang and colleagues is most similar to the present study. In that experiment, younger and older participants judged the emotions of target faces. Depending on the participant's experimental condition, target individuals (represented by faces) were primed as similar, primed as dissimilar, or not primed at all (control condition). In older adults, enhanced emotion recognition performance was observed in the primed similarity condition relative to the other conditions. Moreover, only in the primed similarity condition did older adults perform as well as younger adults in the same condition. Notably, the authors did not examine responses to both self-relevant and non-relevant others in the same participants. To increase power in the present study, we examined the extent of preference for personally relevant perspectives using a within-subjects design.

On the basis of the reviewed literature, we anticipated that older adults would show an enhanced egocentric preference for the 1PP versus 3PP (German & Hehman, 2006; Henry et al., 2013; Moran et al., 2012; Moran, 2013). When it comes to 3PPs, we expected that older adults would perform better on self- versus other-associated 3PPs (Zhang et al., 2013).

Study overview. To test these predictions, the current study used the VPT paradigms from Chapter 2 (3PP-3PP and 1PP-3PP tasks) to assess how age affects the ability to represent and select between competing perspectives. One sample of younger participants and one sample of older participants completed the avatar identity-matching, 3PP-3PP, and 1PP-3PP tasks sequentially in the same experimental session.

For the avatar identity-matching task, we explored the impact of age on the ability to learn novel social associations for the self and other avatars (i.e., social tagging: Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012, 2013). Although this task was primarily intended to help solidify avatar-colour associations for the subsequent perspective-taking tasks, it also permitted a comparison of younger and older adults' baseline levels of self-bias in a relatively simple perceptual task. On the basis of evidence that older adults are especially motivated by self-relevant aspects of cognitive tasks (Yiwei Chen, 2004; Germain & Hess, 2007; Hess et al., 2001; Zhang et al., 2013, see Hess, 2005, 2014, for reviews), we anticipated that older adults would show preserved, if not enhanced, self-biases compared to younger adults.

Two perspective-taking tasks (3PP-3PP and 1PP-3PP: Mattan, Quinn, Apperly, et al., 2015) were used to assess how ageing modulates VPT biases for perspectives varying in self-relevance. We predicted that age would enhance performance for self-relevant visual perspectives. Additionally, based on previous work showing that older adults have greater difficulty in selecting between competing perspectives (see Henry et al., 2013, for a meta-analysis), we anticipated effects of age at the perspective-selection stage, manifesting as poorer performance on incongruent trials compared to younger adults. Because the literature on ageing and mentalising tends to use non-social control tasks to focus on perspective-selection difficulties (see Moran, 2013, for a review), it is unclear whether age has an impact on perspective computation per se. We therefore explored this possibility in the current study.

To facilitate the reader's comprehension, we first provide details on the participant samples, stimuli, and analysis protocols common to all tasks in the General Method. We then report task-specific methods, results, and discussion for each task in turn, concluding with the General Discussion.

3.3.2. General Method

Participants. Thirty-three students (26 women; M_{age} = 19.1 years, SD_{age} = .765) from the University of Birmingham were recruited through an online research participation scheme and received course credit for their participation. Younger participants represented a subset of participants from Experiment 2. These participants were selected because they completed the 1PP-3PP after completing both the avatar identity-matching task and the 3PP-3PP task, although results from the 1PP-3PP task were not reported there. Four participants from this young-adult subset were excluded from all analyses for failing to reach the overall accuracy threshold of 70% for the 3PP-3PP task. Due to a computer error during the 1PP-3PP task, responses from one participant were not recorded for the final 30 trials (~23% of total trials). Results were not affected by excluding this participant and so the participant was kept in all analyses. The final young-adult sample was comprised of 29 participants.

Thirty-one older adults (17 women; M_{age} = 71.1 years, SD_{age} = 6.04) were recruited through a university-based panel of participants for studies on ageing. The general cognitive status of 26 older adults was assessed using the Oxford Cognitive Screen (OCS: Demeyere, Riddoch, Slavkova, Bickerton, & Humphreys, 2015). Five participants did not complete the OCS as the measure was not yet available at the time of testing. The OCS is a freely available short (15–20 minute) standardised psychological assessment intended for the diagnosis of a range of cognitive deficits, similar to the MOCA (Nasreddine et al., 2005) and Mini-Mental State (Folstein, Folstein, & McHugh, 1975) assessments. The OCS results in the present study suggest that only one older adult had borderline performance on the executive function task (scoring just beyond the cut-off). The same participant's performance on the remaining 11 cognitive tasks fell well within the normative range. All other older participants showed performance within the normative range on all OCS tasks. Descriptive statistics for the OCS and demographic data for older participants are provided in Appendix 3.3. All older participants were included in the analyses except for two participants. One reported impaired colour vision and hence was unable to complete the experiments because colours were used to distinguish the avatars. The other participant's response times exceeded 3 standard deviations from the group mean on all tasks. Thus, the final older-adult sample was comprised of 29 participants.

In accordance with ethical approval, all participants received information on the experimental procedure and gave informed consent prior to participating. Following the completion of all tasks, participants were debriefed and compensated accordingly.

Stimuli and procedure. All avatar and virtual room stimuli are identical to those used in Chapter 2 (see also Mattan, Quinn, Apperly, et al., 2015). Details on the avatar identity-matching task and 3PP-3PP paradigm can be found in 2.3.2. The 1PP-3PP paradigm description is reported in 2.4.2. The same procedure was followed for all tasks.

Generic analysis protocol. For the avatar identity-matching, 3PP-3PP, and 1PP-3PP tasks, RTs exceeding 3 standard deviations were trimmed prior to analysis. This was done separately for each participant and task. Only RTs for correct responses were used for the analysis of RT data. Because the present experiment used the same paradigms as in Chapter

2, analyses for all tasks focused on responses to trials requiring a match/true response (see 2.3.2, for discussion of rationale). However, for completeness, we also report extended analyses for each task that include data from match/true and mismatch/false trials (see Appendix 3.4).

Because ageing is associated with slowed processing speed (Cerella, 1990; Salthouse, 1993, 1996), conditions that pose a greater demand on cognitive capacity may take disproportionately longer. This can potentially confound any interaction pattern. To control for age differences in response speed and variance (Hultsch, MacDonald, & Dixon, 2002; Myerson, Robertson, & Hale, 2007), trimmed RTs for match/true trials were Z-transformed separately for each participant and task (see Faust, Balota, Spieler, & Ferraro, 1999). Z-transformed RTs were subsequently averaged across each condition and analysed in separate ANOVAs for each task. Analogous analyses of untransformed accuracy data are also reported. Mean untransformed RT data for each task are provided in Appendix 3.5.

3.3.3. Results and Discussion

3.3.3.1. Task 1: Avatar Identity-Matching Task

Summary of hypotheses. In this task, we explored the impact of age on the ability to learn novel social associations for the Self and Other avatars (i.e., social tagging: Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012, 2013). On the basis of evidence that older adults are especially motivated by self-relevant aspects of cognitive tasks (Chen, 2004; Germain & Hess, 2007; Hess et al., 2001; Zhang et al., 2013; see Hess, 2005, 2014, for reviews), we anticipated that older adults would show a preserved, if not enhanced, perceptual bias for the self, compared to younger adults.

Results. From the older adult sample, data from two participants were unavailable for the identity-matching task analysis. One participant failed to follow instructions, responding incorrectly for all trials in which the Self avatar was correctly matched to the participant's name (i.e., missing RT cell mean). A second participant did not complete this task due to experimenter error. Both participants performed adequately on the subsequent perspective-taking tasks, suggesting that avatar-identity associations were successfully learned. Therefore, these participants were not excluded from subsequent analyses. Descriptive statistics for standardised response latency and accuracy are reported in Table 3.3 (for unstandardised RTs, see Appendix 3.5).

Response latency. Z-transformed match-trial RTs were analysed using a 2 (Avatar Identity: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. Consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015), the ANOVA revealed overall faster responses for the Self avatar compared to the Other avatar, $F(1,54) = 35.6$, $MSE = .214$, $p < .001$, $\eta_p^2 = .397$. Age group did not reliably modulate Z_{RT}s, all $p > .10$.

Table 3.3

Descriptive Statistics for the Avatar Identity-Matching Task, Experiment 5

Response index	Age group	Self avatar		Other avatar	
Z_{RT}	Younger	-.162	(0.082)	.506	(0.072)
	Older	-.069	(0.085)	.307	(0.074)
Accuracy	Younger	.946	(0.009)	.735	(0.031)
	Older	.961	(0.010)	.775	(0.033)

Note. Standard errors of the mean are provided in parentheses

Accuracy. The same two-way split-plot ANOVA was also performed on participants' accuracy scores. Results revealed more accurate performance for the Self compared to the

Other avatar, $F(1,54) = 71.3$, $MSE = .015$, $p < .001$, $\eta_p^2 = .569$. Age group did not reliably modulate accuracy data for match trials, all $p > .25$. However, a supplementary analysis combining match and mismatch trials did reveal evidence that older (vs. younger) adults differed in their sensitivity to the presence of the Self avatar on mismatch (vs. match) trials (i.e., Response × Avatar Identity × Age Group interaction: see Appendix 3.4.2). Contrary to their performance on match trials, younger adults were significantly more accurate for the Other (vs. Self) avatar on mismatch trials. Relative to younger adults, older adults showed marginally more accurate performance for the Self avatar on mismatch trials, ultimately showing a non-significant difference in the accuracy of their judgments for the Self and Other avatars on mismatch trials.

Discussion. In summary, younger and older adults showed superior performance for the Self versus Other avatar. These findings are consistent with previous work on social tagging showing that participants prioritise the self when learning novel self-associations (e.g., Frings & Wentura, 2014; Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012, 2013). Although the predicted age differences were not reliable in the main analysis of match trials only, supplementary analysis combining match and mismatch trials showed that older adults were relatively more resistant to errors on mismatch trials when the Self (vs. Other) avatar was present (see Appendix 3.4.2, for discussion of this finding). Taken together, findings from the Avatar Identity-Matching Task suggest that perceptual prioritisation of self-relevance is relatively preserved, if not enhanced, in advanced age.

3.3.3.2. Task 2: 3PP-3PP Task

Summary of hypotheses. In the third-person perspective-taking (3PP-3PP) task, participants judged the 3PPs of the same Self and Other avatars used in the avatar identity-matching task. We predicted that older adults would show a greater preference for the self-relevant 3PP (i.e., Self avatar). Additionally, based on previous work showing that older adults have greater difficulty in selecting between competing perspectives (see Henry et al., 2013, for a meta-analysis), we also anticipated effects of age at the perspective-selection stage, manifesting as poorer performance on incongruent trials compared to younger adults.

Results. To condense reporting of results, standardised RT data are reported in Figure 3.3 and accuracy descriptive statistics are provided in Table 3.4 (for unstandardised RTs, see Appendix 3.5).

Response latency. Z-transformed true-response trial RTs were analysed using a 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. Replicating previous findings (Mattan, Quinn, Apperly, et al., 2015), all main effects were significant, with the exception of age group. Younger and older participants were faster for congruent versus incongruent trials, $F(1,56) = 4.70$, $MSE = .139$, $p = .034$, $\eta_p^2 = .077$, and for the Self versus Other avatar (i.e., self-prioritisation effect), $F(1,56) = 15.5$, $MSE = .066$, $p < .001$, $\eta_p^2 = .217$, see Figure 3.3 for an illustration of younger and older participants' performance. No main effects or interactions were found for the age-group factor, all $p > .29$. However, a supplementary analysis combining true- and false-response trials revealed a significant Perspective Congruence × Target Perspective × Age Group interaction (see Appendix 3.4.3) that was not reliably modulated by response. In brief, this interaction was characterised by significantly larger self-biases for older (vs. younger) adults on congruent trials only. This general pattern was apparent in the true-response trial data (see Figure 3.3), but it was not statistically reliable.

Table 3.4

Response Accuracy by Condition: 3PP-3PP Task, Experiment 5

Age group	Perspective congruence	Self avatar		Other avatar		Self-prioritisation
Younger	Congruent	.864	(.021)	.830	(.019)	.034
	Incongruent	.828	(.025)	.774	(.026)	.054
Older	Congruent	.869	(.021)	.828	(.019)	.041
	Incongruent	.841	(.025)	.821	(.026)	.019

Note. Standard errors of the mean are provided in parentheses

Accuracy. The same two-way split-plot ANOVA was also performed on participants' true-response trial accuracy scores. Accuracy scores revealed significant self-prioritisation, $F(1,56) = 12.6$, $MSE = .006$, $p < .001$, $\eta_p^2 = .184$. The effect of perspective congruence was non-significant, $F(1,56) = 2.58$, $MSE = .023$, $p = .11$, $\eta_p^2 = .044$. No main effects or interactions were found for the age-group factor, all $p > .12$.

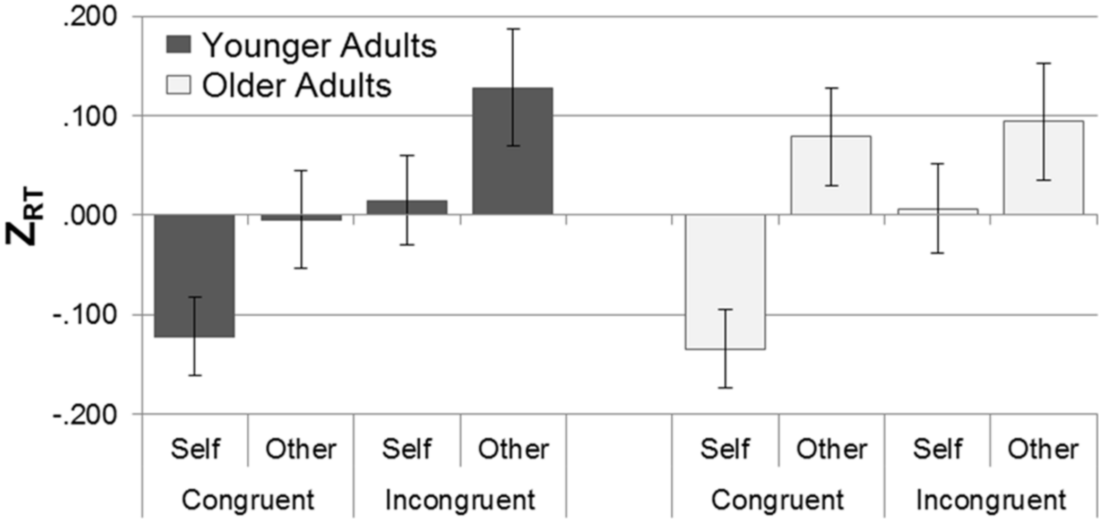


Figure 3.3. Depiction of Z-transformed RT data in the 3PP-3PP task. Results replicate previous findings, showing that both younger and older adults are faster when targeting the Self (vs. Other) avatar and when both perspectives are congruent (vs. incongruent).

Discussion. The findings (summarised in Table 3.5) confirmed previous reported effects showing an enhanced computational advantage for the Self avatar (Mattan, Quinn, Apperly, et al., 2015) and superior performance for trials in which both perspectives were congruent (Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012). Consistent with our hypothesis that older adults would show larger self-biases, supplementary analysis of response latencies to both true- and false-response trials revealed that older (vs. younger) adults were relatively more biased toward the Self avatar on congruent trials but not on incongruent trials (see Appendix 3.4.3, for further discussion). Again, this effect was not reliably modulated by response (true vs. false).

Contrary to our predictions, older adults showed no evidence of poorer perspective-selection performance compared to younger adults. This is surprising given that older adults consistently show difficulties in selecting between conflicting perspectives (Henry et al., 2013). One possibility is that perspective-selection biases in older adults are limited to contexts in which the first-person perspective is salient. Recall that, in the 3PP-3PP task, four dots were always visible to the first-person perspective—effectively controlling for the otherwise salient first-person view. Notably, previous research on perspective-selection biases across the life span has focused on 1PP-3PP paradigms (see Moran, 2013; Royzman, Cassidy, & Baron, 2003, for reviews). Therefore, the third task aimed at testing the impact of age when the 1PP is task-relevant.

3.3.3.3. Task 3: 1PP-3PP Task

Summary of hypotheses. As in the 3PP-3PP task, we predicted that age would enhance prioritisation of self-relevant visual perspectives. Specifically, we anticipated that older adults would show prioritisation of both the Self avatar compared to the Other avatar (i.e., Avatar Identity × Age Group interaction) and for 1PP compared to 3PP (i.e., Target

Perspective × Age Group interaction). Additionally, consistent with the extant literature on age-related egocentrism in perspective selection (see Henry et al., 2013), we anticipated greater first-person bias for older adults on incongruent trials (i.e., Perspective Congruence × Target Perspective × Age Group interaction).

Results. To condense reporting of results, mean standardised response latencies and mean accuracy by condition are illustrated for both age groups in Figures 3.4 and 3.5, respectively (for unstandardised RTs, see Appendix 3.5).

Response latency. Z-transformed RTs were analysed using a 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: first-person, third-person) × 2 (Avatar Identity: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. Replicating previous findings (e.g., Mattan, Quinn, Apperly, et al., 2015, Experiment 2; Surtees & Apperly, 2012), we found faster overall performance for congruent compared to incongruent trials, $F(1,56) = 73.7$, $MSE = .126$, $p < .001$, $\eta_p^2 = .568$, and for the first- versus third-person perspective, $F(1,56) = 54.0$, $MSE = .302$, $p < .001$, $\eta_p^2 = .491$. Also consistent with previous findings, a Perspective Congruence × Target Perspective interaction was observed, $F(1,56) = 23.7$, $MSE = .078$, $p < .001$, $\eta_p^2 = .298$. Both age groups showed superior performance when adopting the first-person compared to the third-person perspective at each level of perspective congruence. However, the first-person advantage effect was relatively larger for incongruent, $t(57) = 4.28$, $d = 0.562$, $p < .001$, than congruent trials, $t(57) = 9.02$, $d = 1.18$, $p < .001$.

Participants were faster overall for trials in which the Self (vs. Other) avatar appeared, $F(1,56) = 5.12$, $MSE = .095$, $p = .028$, $\eta_p^2 = .084$. However, consistent with our prediction of an age-related preference for self-relevant perspectives, this main effect of avatar identity was reliably modulated by age group, $F(1,56) = 5.50$, $MSE = .095$, $p = .023$, $\eta_p^2 = .089$. This interaction is illustrated in Figure 3.4c. Contrasts revealed a reliable main effect of avatar identity for older adults, $t(28) = 3.06$, $d = 0.569$, $p = .005$, but not for younger adults, $t(28) = 0.063$, $p = .95$. Additional post-hoc contrasts comparing performance for each avatar across age groups showed that older adults performed worse than younger adults when the Other avatar was present, $t(56) = 2.63$, $d = 0.346$, $p = .011$. Compared to younger adults, older adults also showed a marginal trend for better performance when the Self avatar was present, $t(56) = 1.81$, $p = .076$. All significant contrasts survive Bonferroni correction for multiple comparisons (× 4), $\alpha = .0125$. Notably, the effect of avatar identity did not interact reliably with perspective congruence, $F(1,56) = 2.47$, $p = .12$. Although this effect has been previously observed in young adults (see 2.4.3), the interaction with age also failed to reach significance, $F(1,56) = 2.91$, $p = .093$. All other main effects and interactions were non-significant, all $p > .12$.

In summary, an age effect was observed in response to the avatar's identity: Older (vs. younger) adults showed a greater overall advantage when the Self (vs. Other) avatar was present in the virtual scene, irrespective of perspective congruence or target perspective. We note here that supplementary analysis revealed that avatar identity interacted with trial type. Relative to the Other avatar, the Self avatar's presence facilitated performance on true-response trials and hindered performance on false-response trials. Higher-order interactions suggested that this pattern was only reliable for congruent (and not incongruent) trials and was driven primarily by older adults, suggesting a potential perspective-computation bias for the Self avatar in this age group, irrespective of target perspective (see Appendix 3.4.4).

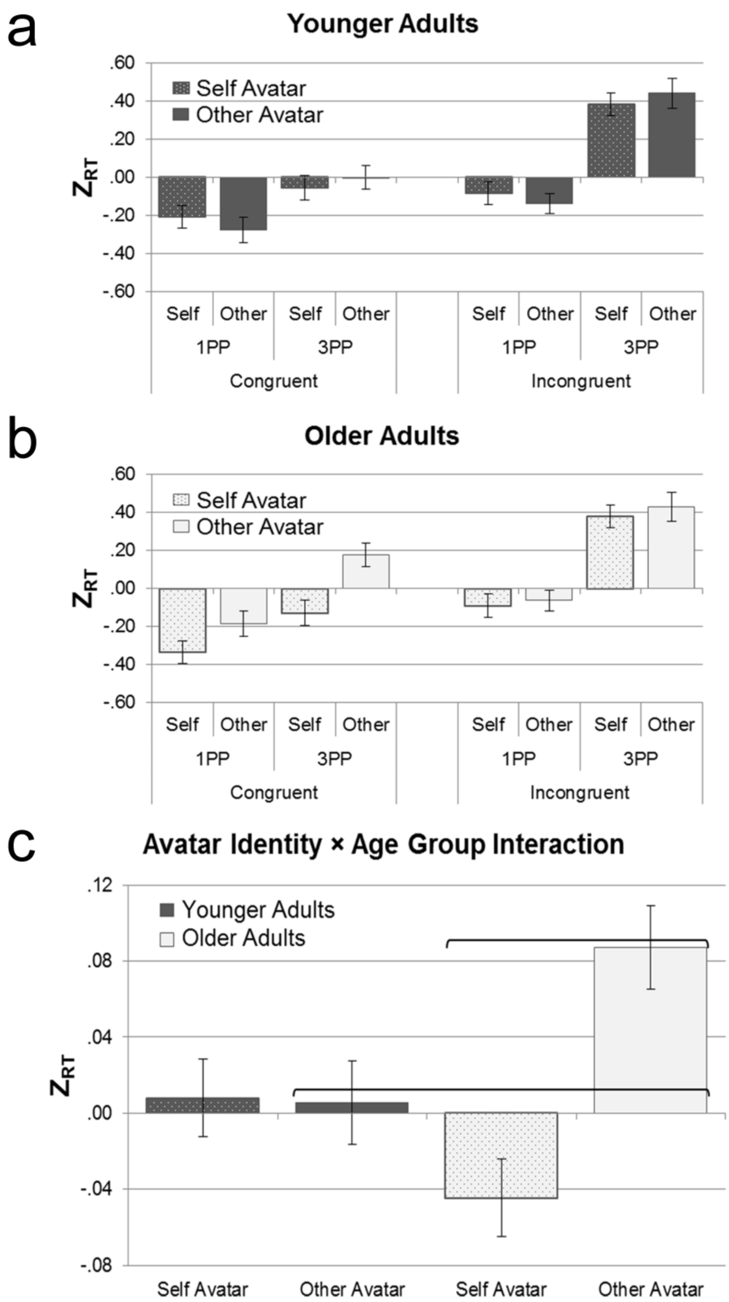


Figure 3.4. Depiction of Z-transformed RT data in the 1PP-3PP task for younger (a) and older (b) participants. A significant Avatar Identity × Age Group interaction (c) showed that older adults are overall more sensitive to the presence of the Self (vs. Other avatar) compared to younger adults, irrespective of perspective congruence and target perspective. Significant contrasts of interest are denoted with a single horizontal bracket.

Accuracy. As for the standardised RT data, accuracy scores were analysed using a 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: first-person, third-person) × 2 (Avatar Identity: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. A reliable main effect was observed for perspective congruence, $F(1,56) = 21.0$, $MSE = .016$, $p < .001$, $\eta_p^2 = .273$, with more accurate performance for congruent compared to incongruent trials. In contrast to the analysis of standardised RTs, main effects were not reliable for the target perspective ($p = .19$) and avatar identity ($p = .09$) factors.

Analysis of accuracy data yielded significant interactions involving the age group factor. A reliable Target Perspective × Age Group interaction, $F(1,56) = 9.09$, $MSE = .019$, $p = .004$, $\eta_p^2 = .140$, was observed. Because the Target Perspective × Age Group interaction interaction was further modulated by perspective congruence (see Figure 4), $F(1,56) = 8.07$, $MSE = .015$, $p = .006$, $\eta_p^2 = .126$, follow-up analyses were conducted in the context of this three-way interaction . Separate 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: first-person, third-person) ANOVAs were conducted within each age group, collapsing across the avatar identity factor. Results from younger adults showed a main effect of perspective congruence, $F(1,28) = 18.6$, $MSE = .007$, $p < .001$, $\eta_p^2 = .399$, consistent with the omnibus analysis. All other effects were non-significant, all $p > .19$. For older adults, main effects were observed for perspective congruence, $F(1,28) = 5.35$, $MSE = .009$, $p = .028$, $\eta_p^2 = .161$, and target perspective, $F(1,28) = 7.85$, $MSE = .012$, $p = .009$, $\eta_p^2 = .219$. Consistent with the omnibus RT and accuracy analyses, older adults were more accurate for congruent versus incongruent trials and for first-person versus third-person targets. However, these main effects in older adults were qualified by a significant Perspective Congruence × Target Perspective interaction, $F(1,28) = 9.40$, $MSE = .006$, $p = .005$, $\eta_p^2 = .251$. Contrasts revealed a reliable first-person advantage in older adults for incongruent trials, $t(28) = 3.51$, $d = .652$, $p = .002$, but not for congruent trials, $t(28) = 0.536$, $p = .60$ (see Figure 4c). Additional post-hoc contrasts examining congruence effects for each

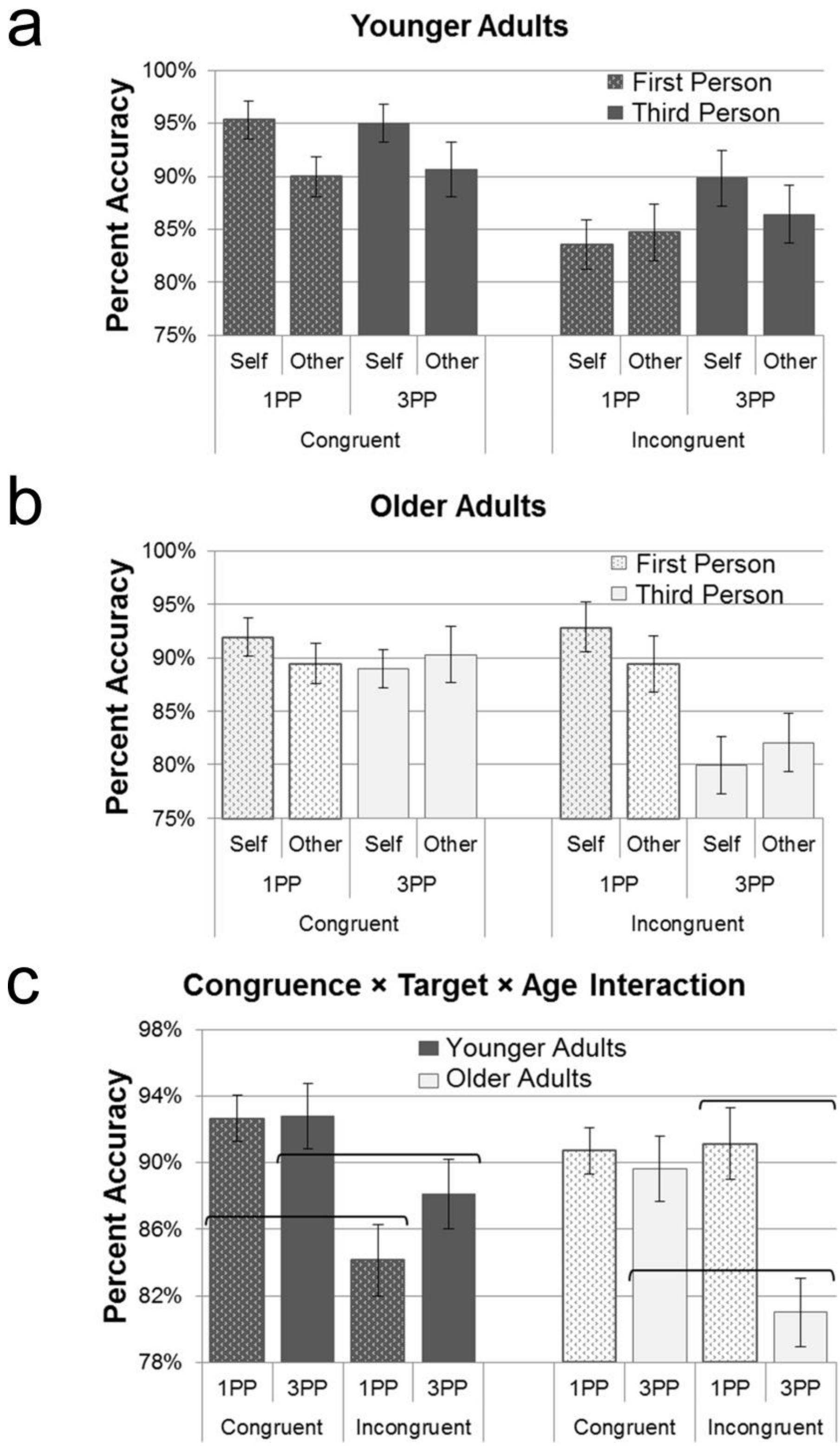


Figure 3.5. Depiction of accuracy data in the 1PP-3PP task for younger (a) and older (b) participants. Results revealed a significant Perspective Congruence × Target Perspective × Age Group interaction (c). A reliable Perspective Congruence × Target Perspective interaction for older adults only shows that these participants prioritised the first-person perspective (1PP) over the third-person perspective (3PP), but only for incongruent trials. Older adults also showed reliable interference (i.e., congruence effect) on third-person target trials (3PP) but not on first-person target trials (1PP). Significant contrasts of interest are denoted with a single horizontal bracket.

perspective (i.e., first- and third-person) revealed a reliable congruence effect (i.e., interference) when adopting the third-person perspective, $t(28) = 3.80$, $d = .706$, $p < .001$, but not when adopting the first-person perspective, $t(28) = 0.184$, $p = .86$. All significant contrasts survive Bonferroni correction for multiple comparisons (× 8), $\alpha = .00625$.

Table 3.5

Summary of Findings for Experiment 5

Task	Effects	Younger adults	Older adults	Age interaction
Identity-Matching	Avatar identity (self vs. other)	Z_{RT}, ACC	Z_{RT}, ACC	
3PP-3PP	Perspective congruence	Z_{RT}	Z_{RT}	
	Target perspective (self vs. other)	Z_{RT}, ACC	Z_{RT}, ACC	
1PP-3PP	Perspective congruence	Z_{RT}, ACC	Z_{RT}, ACC	
	Target perspective (first- vs. third-person)	Z_{RT}	Z_{RT}, ACC	ACC
	Avatar identity (self vs. other)		Z_{RT}	Z_{RT}
	Perspective Congruence × Target Perspective	Z_{RT}	Z_{RT}, ACC	ACC

In summary, an age effect was observed for 1PP. Consistent with previous research, older (vs. younger) adults were more accurate for 1PP. This highlights a relationship between age and first-person egocentrism observed using traditional mentalising tasks (Henry et al., 2013; Moran, 2013). Age-related egocentrism was especially pronounced for trials in which

1PP and 3PP conflicted (i.e., incongruent trials). Notably, this age effect was observed for true-response but not false-response trials in the supplementary analysis (see Appendix 3.4.4).

Discussion. Overall, results from the 1PP-3PP task (summarised in Table 3.5) were largely consistent with previous findings using similar 1PP-3PP paradigms: Participants showed robust prioritisation of 1PP versus 3PP (e.g., Keysar et al., 2000; Surtees & Apperly, 2012; Vogeley et al., 2004) and for congruent (vs. incongruent) perspectives (e.g., Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012). Also consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015), participants showed greater first-person prioritisation on incongruent trials (i.e., Perspective Congruence × Target Perspective). In other words, participants showed less interference (i.e., from the avatar) when they targeted 1PP than when they targeted the avatar's 3PP and disregarded the 1PP. In the accuracy data, this two-way interaction was modulated by age group, with older (vs. younger) participants showing relatively reduced interference on incongruent trials when targeting 1PP versus 3PP (Figure 3.5c). Considered in the context of Samson's model of VPT (Samson et al., 2010), older adults' enhanced first-person prioritisation on incongruent trials suggests an egocentric bias during perspective selection. This interpretation is consistent with previous claims of age-related egocentrism that are based on classic mentalising tasks (German & Hehman, 2006; Moran et al., 2012).

Regarding our hypothesis about an age-related preference for self-relevant 3PPs (i.e., the Self avatar), the standardised RT data from the 1PP-3PP task revealed a relationship between age group and avatar identity. Namely, older adults showed greater prioritisation of the Self (vs. Other) avatar compared to younger adults (Figure 3.4c). Interestingly, this Self-avatar advantage was not reliably modulated by perspective congruence, suggesting it was present at each stage of perspective taking: perspective computation and perspective selection.

Nonetheless, we note that supplementary analyses combining true- and false-response trials found evidence that prioritisation of the Self avatar in older adults was most evident for congruent trials (see Appendices 3.4.3–3.4.4). This would suggest an age-related processing advantage for self-relevant third-person perspectives may arise at the perspective-computation stage and merely carry over into perspective selection.

3.3.4. General Discussion

3.3.4.1. Age-Related Biases in Perspective Taking

The current study provides evidence of an apparent age-related focus on self-relevant perspectives in older adults. This was primarily observed when the 1PP was relevant to the task. Through the use of two VPT paradigms, we found evidence of age-related biases toward 1PP (vs. 3PP) and toward a self-associated (vs. other-associated) 3PP (see Table 3.5 for a summary of results across all tasks). Critically, these biases arose at the perspective-selection and perspective-computation stages, respectively. As these stages are thought to involve distinct and separable neuro-cognitive underpinnings (Apperly, Samson, Chiavarino, & Humphreys, 2004; Hartwright et al., 2014; Ramsey et al., 2013; Samson et al., 2010; Samson, Apperly, Kathirgamanathan, & Humphreys, 2005), we consider the implications of each age bias separately.

First-person prioritisation. Consistent with previous research identifying egocentric biases in older adults' perspective-taking abilities (Charlton et al., 2009; German & Hehman, 2006; Henry et al., 2013; Maylor et al., 2002; Moran et al., 2012; Moran, 2013; Rakoczy et al., 2012), the 1PP-3PP task showed that older adults were more accurate in judging their own first-person perspective compared to judging the third-person perspective. This age-related egocentric bias was especially evident at for incongruent trials, which are thought to engage perspective-selection processes (see Ramsey et al., 2013; Samson et al., 2010). For incongruent trials, older (vs. younger) adults were less affected by the avatar's perspective in the accuracy of their judgments. In other words, older adults showed a clear asymmetric pattern: The incongruent avatar's perspective did not affect the judgment accuracy of their own (first-person) perspective, but judgment accuracy for the avatar's (third-person) perspective was diminished by their own incongruent first-person perspective. Younger adults showed more symmetric interference in their accuracy patterns, although similar asymmetry in young and elderly emerged at the RT analysis. Taken together, the findings suggest that age affects the perspective-selection stage of VPT, hampering the flexibility to change between 1PP and 3PP. This is consistent with previous claims based on findings using traditional theory-of-mind paradigms that older adults have difficulties in correctly selecting between conflicting perspectives (e.g., German & Hehman, 2006; Moran et al., 2012). As perspective selection is assumed to be associated with executive-control processes (see Qureshi et al., 2010; Ramsey et al., 2013), this observation fits with the general consensus that age is associated with a reduction in these types of processing (see Drag & Bieliauskas, 2010, for a review).

It is worth mentioning that this first-person bias may also be supported by older adults' greater susceptibility to error from salient distractor stimuli, so far primarily reported for non-social visual saliency (Madden et al., 2014; Tsvetanov et al., 2013). In the 1PP-3PP task, it can be assumed that the 1PP is relatively more salient than the 3PP. This is supported by developmental studies, where 1PP is frequently prioritised over 3PP (e.g., Surtees & Apperly, 2012). We note that the saliency of 1PP may be conceptualised as the default mode of the observer. In other words, 1PP is easier to process. This may be because it requires fewer computational steps. Specifically, 1PP does not require the inference of a restricted perspective due to visual barriers, as is the case for 3PPs. The relative salience of 1PP is also supported by the observation that both younger and older adults showed faster RTs for 1PP (vs. 3PP) on both congruent and incongruent trials and greater RT interference from 1PP (vs. 3PP). The same interference pattern was also found in the accuracy data, but only for older adults (see Figure 3.5c). In other words, selecting the third-person over the putatively salient first-person perspective is associated with slower responses in both age groups. However, this slowing in older (vs. younger) adults does not appear to translate as efficiently to similar accuracy levels for the first- versus third-person perspectives.

Finally, the salience of 1PP is thought to result from the relatively low visibility of gaze cues associated with the third-person avatar in the 1PP-3PP paradigm (Mattan, Quinn, Apperly, et al., 2015) compared to other similar paradigms (e.g., Samson et al., 2010). Given that existing research on ageing and perspective taking relies heavily on paradigms in which 1PP is relatively salient (see Moran, 2013, for a review), future research using paradigms that vary the salience of 1PP versus 3PP (e.g., Samson et al., 2005) is needed to determine whether the egocentric perspective-taking bias in ageing may be better understood as a salience effect.

Self-avatar prioritisation. In addition to their bias for 1PP, older adults' performance for 3PP was sensitive to the avatar's degree of self-relevance, although this effect was most reliably observed when 1PP was also relevant to the task. Relative to younger adults, we found that older adults benefitted from the presence of the self-associated avatar in the 1PP-3PP task. This effect was found in the absence of an interaction with perspective congruence, suggesting that this effect arises at the perspective-computation stage (Ramsey et al., 2013; Samson et al., 2010). The presence of the Self (vs. Other) avatar also benefitted older adults' performance irrespective of whether it was the target perspective. We previously suggested that the prioritisation of the Self avatar, independent of target perspective (i.e., first- vs. third-person), may have resulted from an integration of the Self avatar with the first-person self, effectively attributing both perspectives to the same agent. Such a cognitive short-cut would not be feasible for congruent trials in which the Other avatar was present (see Mattan, Quinn, Apperly, et al., 2015; Experiment 3). Notably, this interpretation is consistent with evidence that redundant self-associated stimuli are processed in a relatively integrated and efficient manner (i.e., at "super-capacity": Sui, Yankouskaya, & Humphreys, 2015). Given the increased processing costs associated with advanced age (Hess, 2014), it is plausible that older (vs. younger) adults would especially benefit from integrating redundant self-associated perspectives. Nonetheless, this interpretation is not entirely consistent with the present analysis of true-response trials. Previous findings from a young-adult sample (Mattan, Quinn, Apperly, et al., 2015, Experiment 2) showed an RT facilitation effect for the self-associated avatar that was only reliable for congruent trials. In the present study, this interaction fell short of statistical significance for both age groups (see RT analysis). Here, the Self-avatar advantage in older adults was also reliable for incongruent trials, arguing against the possibility that this perspective was somehow integrated with 1PP (but see Appendix 3.4.4 for evidence of a Trial Type × Perspective Congruence × Avatar Identity × Age Group interaction consistent with that interpretation.) Irrespective of the reliability of the Perspective Congruence × Avatar Identity interaction, superior performance for the Self avatar on congruent trials in older adults suggests that this advantage arises at the stage of perspective computation. It is possible that the apparent effect at the stage of perspective selection (i.e., incongruent trials) is carryover from a putative computational advantage for the Self avatar. We return to this issue in the discussion of alternative interpretations below.

Further evidence, albeit less reliable, of an age-related computational advantage for the Self (vs. Other) avatar was found in the 3PP-3PP task, which presented Self and Other avatars simultaneously while controlling for 1PP variability. Both younger and older participants showed a bias when targeting the Self relative to the Other avatar (cf. Mattan, Quinn, Apperly, et al., 2015). Supplementary analysis combining data from true- and false-response trials showed that this bias was greater in older adults, but only on congruent trials. As in the 1PP-3PP task, an age effect in the prioritisation of the Self avatar during congruent trials suggests that the perspective-computation boost for Self avatar was larger for older adults than for younger adults.

Across both perspective-taking tasks, younger and older participants performed similarly for the Self avatar, whereas older adults performed relatively poorly for the Other avatar. In other words, older adults appear to be able to strategically prioritise self-relevant perspectives over less relevant perspectives, ultimately showing similar performance to younger adults for the self-relevant perspective (cf. Zhang et al., 2013). This suggests that perspective-taking deficits in advanced age may be limited to external perspectives that lack some degree of personal relevance (e.g., a non-specific "Other"). Consistent with our initial hypotheses, we argue that the computational bias for self-relevant 3PPs in older adults stems from older adults' greater motivation to perform in self-relevant contexts (Chen, 2004; Germain & Hess, 2007; Hess et al., 2001; Zhang et al., 2013; see Hess, 2005, 2014, for reviews).

3.3.4.2. Future Directions

Of theoretical interest, evidence of an age-specific self-prioritisation effect at the stage of perspective computation (i.e., congruent trials) suggests that age differences in VPT (i.e., bias toward self-relevant 3PPs) may manifest even prior to age differences observed at the perspective-selection stage (i.e., for 1PP). In future research, it could be fruitful to systematically examine how a putatively motivated tendency to focus on one perspective at computation may bias responses toward that perspective and others at the selection stage in both younger and older populations. The neuro-anatomical and temporal correlates of such a process remain to be explored (but see Ramsey et al., 2013).

One potentially exciting avenue for future research may be to examine how regions of the recently coined Self-Attention Network (SAN: Humphreys & Sui, 2015) may support perspective-taking biases for self-relevant perspectives. It has been proposed that the SAN is comprised of two attentional pathways. Top-down attentional control for self-associated stimuli is thought to be mediated by the IPS and DLPFC. This network would presumably facilitate performance for the target perspective especially in the presence of perspective conflict (e.g., Ramsey et al., 2013). These regions interface with a second set of regions (MPFC and pSTS) that facilitate bottom-up monitoring of self-relevance. This network would presumably respond to the presence of self-relevant perspectives, irrespective of their status as target (e.g., on the 1PP-3PP task). Notably, the regions of the top-down network are subject to a U-shaped quadratic pattern of grey matter deterioration starting from 20 years through old age (Sowell et al., 2003). The pronounced decline in these top-down control regions is consistent with the reduced BOLD response in older adults when mentalising under conditions of perspective conflict (e.g., Moran et al., 2012). However, the grey matter volumes in the pSTS (part of the bottom-up attentional network) remain relatively stable through mid-life, decaying relatively late in life (from 60 years onward: Sowell et al., 2003). Indeed, in an fMRI study on theory of mind in older adults, the pSTS was one of the few regions that reliably responded to classic theory of mind paradigms (albeit to a lesser extent than was observed in younger adults). Although we can only speculate at this point, it is possible that the pSTS may support the “bottom-up” computational advantage for the Self avatar in older adults.

It bears mentioning that the two self-prioritisation effects discussed in the preceding section were observed for different response metrics (i.e., RT vs. accuracy). Greater prioritisation of the 1PP on incongruent trials for older (vs. younger) adults was particularly evident in judgment accuracy. In light of evidence that both age groups showed similar increases in latency for the 1PP and 3PP on incongruent trials, it would seem that participants slowed their responses sufficiently to avoid a drop in accuracy for the 1PP but not for the 3PP. We have argued that this is due to the presumed salience of the first-person perspective, which generates considerable interference during perspective selection in older adults. In contrast to the above, age-related prioritisation of the Self (vs. Other) avatar in the 3PP-3PP and 1PP-3PP tasks was only ever observed in the RT data for correct responses. Accuracy data did not show reliable differences between the Self and Other avatars. This lack of consistency across performance metrics suggests these results should be treated with caution pending further study. One useful approach in future work may be to estimate decision parameters, as in drift-diffusion models (see Ratcliff, 1978; Ratcliff & McKoon, 2008, for reviews). Such an approach would permit a more fine-grained understanding of metric-selective results. For example, it is possible that the presence of a self-relevant 3PP (or the intention to adopt its perspective) speeds up the accumulation and integration of evidence while simultaneously lowering the decision threshold. In such a scenario, RTs may decrease without substantially affecting error rate. Although the present study lacks a sufficient number of trials for such an analysis, modelling of decision parameters nonetheless remains a viable option in future work.

3.3.4.3. Alternative Interpretations

Notably, most studies on ageing and engagement as a function of self-relevance rely on between-subjects designs that measure performance at the task level rather than on a trial-by-trial basis (see Hess, 2014, for a review). As mentioned in the introduction, the within-subjects design used here constitutes a strength of the present study. Nonetheless, it could be argued that a trial-by-trial recalibration of effort is implausible in older adults, and that a more parsimonious interpretation of our findings may be that older adults' preference for self-associated perspectives reflects an age-related increase in the cost of overriding the default egocentric point of view. Indeed, given the limited cognitive resources in older populations (Drag & Bieliauskas, 2010), it is reasonable to expect that inhibiting the default self-perspective and selecting a less self-relevant perspective would be particularly costly for older adults. This interpretation would be consistent with the general literature on ageing and theory of mind, which emphasises heightened egocentrism in older adults (e.g., Henry et al., 2013; Moran, 2013).

However, we believe that an explanation for present the age-related self-biases that relies solely on cognitive costs is implausible on several counts. First, although little attention has been directed to the matter of age differences in trial-by-trial variations in task engagement as a function of self-relevance, Hess (2014, p. 402) has suggested that older adults may prioritise rewarding stimuli on a trial-by-trial basis, particularly in more difficult tasks where cognitive resources may need to be conserved. This suggestion was supported by evidence that older (vs. younger) adults showed similar or greater selectivity to stimuli associated with large (vs. small) point values in stimulus blocks characterised by a series of variable values (Castel et al., 2011; Castel, Benjamin, Craik, & Watkins, 2002; Castel, Murayama, Friedman, McGillivray, & Link, 2013). Given the considerable degree of overlap observed in the processing of self-relevance and reward (e.g., Northoff & Hayes, 2011), it is plausible that self-relevant stimuli would result in a similar selectivity pattern. In the context of the present paradigm, engagement may have fluctuated depending on the personal relevance (or reward value) of the targeted avatar.

We further note that the structure of the perspective-taking paradigms used in this study may have facilitated the flexible use of selective attention on a trial-by-trial basis. Each trial prompt presented the target perspective 2.6 seconds before the appearance of the virtual room, giving participants time to selectively calibrate top-down attention. Compared to other cognitive abilities, top-down attention is relatively preserved in older adults (Madden, 2007; McAvinue et al., 2012; Whiting, Madden, & Babcock, 2007). Additionally, Sui and colleagues (2014) have demonstrated in young participants that novel self-associations such as those formed in the present study disproportionately benefit from a top-down expectancy bias on a trial-by-trial basis (i.e., self- and other-associated stimuli were randomly presented in the same block). In summary, both previous findings and the present paradigm design allow for the possibility that older adults prioritised self-relevant perspectives on a trial-by-trial basis, consistent with our interpretation of the findings.

Regarding the alternative interpretation that the present findings may be explained exclusively by older adults' over-reliance on 1PP, we acknowledge that this may partly explain the findings. This interpretation is particularly consistent with older adults' prioritisation of 1PP on incongruent trials (i.e., during perspective selection) in the 1PP-3PP task. It may also be compatible with the findings from the same task showing that older adults benefit from the presence of the Self avatar. In detail, supplementary analysis of true- and false-response trials suggested that the presence of the Self avatar was most reliably associated with better performance when it was congruent with the 1PP. Hence, if older adults were biased toward the first-person perspective and simultaneously integrated that perspective with the Self avatar's congruent perspective, then the results are indeed consistent with the view that older adults are simply more egocentric.

Although compelling, this alternative interpretation does not fully explain the present findings. In the main analysis (i.e., true-response trials only) of the 1PP-3PP task, older adults' preference for the Self avatar was not reliably modulated by perspective congruence. In other words, performance was overall better when the Self avatar was present, even when it was incongruent with 1PP. It is not clear how a mere over-reliance on 1PP in older adults would contribute to superior performance on trials in which the Self avatar was present yet incongruent with the first-person point-of-view. Finally, results from the 3PP-3PP task offer an additional challenge to the notion that the present findings are entirely attributable to age-related egocentrism. In the 3PP-3PP task, 1PP is constant and always incongruent with either avatar's view (Mattan, Quinn, Apperly, et al., 2015). Although the main 3PP-3PP task analysis (i.e., true-response trials only) yielded no age differences, results from the supplementary analysis (i.e., examining both true- and false-response trials) showed an age-related bias toward the Self avatar on congruent trials. This finding suggests an especially pronounced computational bias in older adults for a self-relevant 3PP that is independent of any influence from 1PP.

3.3.4.4. Conclusion

Despite the ongoing debate regarding the mechanisms underlying age-related alterations in perspective taking (Charlton et al., 2009; German & Hehman, 2006; Henry et al., 2013; Maylor et al., 2002; Moran et al., 2012; Moran, 2013; Rakoczy et al., 2012), there appears to be a consensus that age is associated with reduced perspective-taking capacity. The current study aimed to determine whether older adults consistently show reduced perspective taking even for relatively self-relevant perspectives. Consistent with previous findings (e.g., German & Hehman, 2006; Moran et al., 2012), results showed that older adults were indeed relatively more egocentric (i.e., more accurate for the 1PP vs. 3PP) compared to younger adults (see Moran, 2013, for a review). However, older adults also showed greater selectivity in the processing of 3PPs varying in their degree of self-relevance (e.g., Self avatar vs. Other avatar). Older adults' prioritisation of the self-relevant perspective resulted in similar performance for this perspective relative to younger adults after accounting for overall age differences in response time. This suggests that ageing does not necessarily relate to poorer perspective-taking ability, at least for perspectives or people that are personally important. This is consistent with the view that older adults strategically monitor their cognitive expenses, conserving resources for the most relevant people and contexts (Hess, 2014). Further research would help to shed greater light on the role of individual differences (e.g., empathy) and domain-general abilities (e.g., processing speed, working-memory span, etc.) supporting older adults' preference for self-relevant perspectives. In line with calls to study mentalising across the life span (Apperly, Samson, & Humphreys, 2009; Moran, 2013), research on how perspective computation and selection change in advanced age will serve to strengthen our overall understanding of the mechanisms supporting these abilities at any age.

3.4. General Discussion

3.4.1. Chapter Summary

The aim of the present chapter was to examine whether VPT performance is modulated by known individual differences in social cognition. Results from Experiment 4 suggest that empathy is associated with a reduction in the cost of perspective selection, particularly for perspectives closely associated with the self (e.g., Self avatar). This is consistent with the notion that high-empathy individuals possess greater flexibility in perspective-taking (Decety & Jackson, 2004). Additionally, results from Experiment 5 provide evidence that older adults show a bias toward self-relevant perspectives, consistent with the hypothetically greater value of such perspectives for this age group (Carstensen, 2006; Hess, 2014). The observed modulations of VPT performance as a function of empathy (Experiment 4) and age group (Experiments 5) support such a hypothesised overlap between VPT and higher-level social cognition.

3.4.2. Overlapping Systems for Visual and Social Perspective-Taking

In attempting to address the question of whether VPT draws on similar neural mechanisms as mentalising, Aichhorn and colleagues (2006) characterise VPT tasks as “cold cognition” tasks, implying that such tasks may be performed without relying on social context (see also Santiesteban et al., 2014). This assertion is partly supported by neuroimaging evidence showing that VPT tasks involving perspective differences recruit the pSTS/TPJ region, but not the VMPFC (Aichhorn et al., 2006; David et al., 2008; Ramsey et al., 2013; Schurz et al., 2013; Vogeley et al., 2004). Mentalising tasks, on the other hand, recruit additional regions including the VMPFC, an area known to be involved in the processing of self-relevance and the evaluation of similar others (Ames, Jenkins, Banaji, & Mitchell, 2008;

Jenkins, Macrae, & Mitchell, 2008; Mitchell et al., 2005). Aichhorn and colleagues (2006) thus conclude that VPT and mentalising may both recruit the pSTS/TPJ area as a means of processing distinct representations (e.g., divergent perspectives or belief-states: see Schurz et al., 2013, for a meta-analysis). However, other areas, such as the VMPFC, show little activity in VPT tasks because these tasks do not presumably require participants to predict behavioural or emotional consequences of divergent perspectives, unlike in mentalising tasks.

The findings presented in this chapter challenge the notion that VPT tasks are entirely "cold" cognition tasks that are distinct from social functioning. In Experiment 4, results revealed trends whereby empathy levels were associated with improved overall performance and smaller perspective-congruence effects. This supports the possibility that high-empathy participants were more flexible and/or engaged in the perspective-taking task, manifesting as improved performance and smaller perspective-selection costs on incongruent trials. Further support for the notion that VPT is not a purely cognitive task comes from the relationship between empathic concern and smaller perspective-interference costs when adopting the Self avatar's perspective. Unlike the "cognitive" perspective-taking subscale, empathic concern is thought to represent the affective side of empathy (Davis, 1980, 1983, 1996; Shamay-Tsoory, Aharon-Peretz, & Perry, 2009). A relationship between VPT and affective empathy suggests that VPT within an explicitly social context may indeed draw on processes specific to the social domain, such as affect (Bukowski & Samson, 2015) and/or social salience (Mattan, Quinn, Apperly, et al., 2015). Given the observed interaction of empathy, personal relevance, and perspective congruence accounted for a modest 17% of the variance in the global empathy analysis (22% for the empathic concern subscale), we acknowledge that domain-general cognitive processes such as mental rotation (Surtees, Apperly, & Samson, 2013a, 2013b) or executive function (Apperly et al., 2010; Qureshi et al., 2010) may play an important role in the processing of conflicting visual perspectives after accounting for domain-specific factors.

Additional evidence in support of social modulation of low-level VPT was obtained in Experiment 5, which examined age differences in the prioritisation of perspectives varying in personal relevance. We predicted that older adults would be biased toward self-relevant perspectives on the basis of existing evidence that older adults selectively attend to stimuli that are most relevant or meaningful to the self (Carstensen, 2006; Fung & Carstensen, 2003; Hess, 2014; Stanley & Isaacowitz, 2015; Sullivan et al., 2010; Zhang et al., 2013). Consistent with this prediction, Experiment 5 (1PP-3PP task) showed that older adults' perspective-taking performance benefited when viewing a virtual scene containing a self-relevant avatar relative to a non-self avatar. Independent of this finding, results also showed that older (vs. younger) adults were relatively more biased toward 1PP versus 3PP. This is consistent with evidence from the broader (non-visual) theory-of-mind literature that older adults tend to be more egocentric (Henry et al., 2013; Moran, 2013). Although this egocentrism in older adults may be explained by the availability of domain-general executive resources (German & Hehman, 2006), the observed bias for the self-avatar is not so easily explained (see 3.3.4, for a fuller treatment of this point). Together with Experiment 4, results from Experiment 5 provide evidence that VPT is modulated not only by target–perspective associations (Mattan, Quinn, Apperly, et al., 2015) but also by social perceiver characteristics such as emotional state (Bukowski & Samson, 2015), empathy, and age. Overall, this is consistent with accounts arguing that perceivers readily construe VPT paradigms as social contexts (A. M. Klein et al., 2009; Mattan, Quinn, Apperly, et al., 2015; Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012; Surtees et al., 2012; Tversky & Hard, 2009), even when this may hinder overall performance (Apperly et al., 2010; Samson et al., 2010).

3.4.3. Alternative Interpretation: Executive Capacity

As suggested in the previous section, it is possible that some of the effects observed in the studies on ageing may be explained by age-related declines in domain-general cognitive abilities rather than social aspects of ageing. Although we argue that such an explanation does not fully explain the age-related effects found in the present research (see 3.3.4.3), executive capacity is nonetheless important for visual (e.g., Qureshi et al., 2010) and more mentalistic forms of perspective taking (Bull, Phillips, & Conway, 2008; German & Hehman, 2006). Notably, results from the 3PP-3PP task in Experiment 5 failed to find the anticipated larger congruence effect in older adults. This pattern of results contradicts the interpretation that the observed modulation of VPT performance by age group can be entirely explained by known age differences in executive capacity. Thus, we appeal to age differences in social expertise or empathy *and* executive function in our favoured interpretation. This is consistent with previous findings suggesting that advanced age, in some contexts (e.g., when two perspectives possess equal visual salience), may be associated with relatively preserved or even enhanced social cognition (Carstensen, 2006; Fung & Carstensen, 2003; Hess, 2014; Mather & Carstensen, 2005; Ramscar, Hendrix, Shaoul, Milin, & Baayen, 2014; Sullivan et al., 2010; Zhang et al., 2013).

3.4.4. Conclusion

The present chapter tested the hypothesis that VPT may be influenced by socially relevant aspects of the perceiver. Taken together, Experiments 4–5 provide evidence in support of an overlap between VPT and higher-level social propensities. Importantly, these findings cannot be fully explained by domain-general (i.e., non-social) processes such as executive function. Although VPT tasks can be construed as simple cognitive tasks (Apperly et al., 2010; Santiesteban et al., 2014), perceivers readily construe them as social contexts. The consequence of this construal is that VPT tasks may be used to assess biases in social functioning. Such biases should extend to real-world behaviour, although this hypothesis remains to be tested. If this approach is successful, VPT tasks may serve as a useful means of studying social biases at the individual level as well as in intergroup contexts.

CHAPTER 4: NEUROCOGNITIVE DETERMINANTS OF SOCIAL TAGGING

4.1. Introduction

Ever since it was first considered by contemporary psychologists as an object of consciousness (James, 1890), the self has been observed to affect virtually all aspects of cognitive functioning from attention to memory. Yet, even after more than a century and thousands of peer-reviewed articles on the topic, the self has proven difficult to characterise (S. B. Klein, 2012). One of the reasons for this difficulty is that self stimuli are easily confounded with other factors such as familiarity. For example, perceivers may more frequently encounter their own faces, names, and belongings than those of any other given individual. As discussed in the preceding chapters, one critical means of bypassing this limitation is through the study of novel self-associations with relatively unfamiliar stimuli such as retail goods (e.g., Cunningham et al., 2008) or geometric shapes (e.g., Sui et al., 2012). Although much progress has been made on the cognitive consequences of such novel self-associations, many questions remain regarding their underpinnings (Gillihan & Farah, 2005; Mattan, Quinn, & Rotshtein, 2015). For example, do perceivers prioritise novel self-associations because of their positive value (Alicke & Govorun, 2005; Fields & Kuperberg, 2015; Heine, Lehman, Markus, & Kitayama, 1999; Lewicki, 1983; Mezulis, Abramson, Hyde, & Hankin, 2004)? Might chronic/contextual social relevance (see Brewer & Feinstein, 1999; Fiske et al., 1999; Scherer, 2001) also contribute to such prioritisation? The current study examines the hypothetical contributions of these factors in the perception of the self and others using a simple perceptual matching task (e.g., Sui et al., 2012).

4.1.1. Self-Effects in Perception and Attention, Revisited

Numerous studies on the self have shown that self-associated stimuli capture attention (Bargh, 1982; A. R. A. Conway et al., 2001; Gray, Ambady, Lowenthal, & Deldin, 2004; Moray, 1959), enhance visual perception (Sui et al., 2012, 2013; Sui, Liu, et al., 2015), and improve memory (Rogers et al., 1977; Symons & Johnson, 1997; van den Bos et al., 2010). Across cognitive domains, self-related stimuli are thought to capture attention (Sui, Liu, Wang, & Han, 2009; Sui et al., 2013; Turk et al., 2013; Wood & Cowan, 1995b), prompting top-down processing strategies (e.g., Fields & Kuperberg, 2012; Klein & Loftus, 1988; Klein, Loftus, & Burton, 1989). Integrating the above literature with recent neuroimaging findings on minimal self-relevance (Sui, Liu, et al., 2015; Sui et al., 2013), Humphreys and Sui (2015) proposed the Self-Attention Network (SAN). In brief, the SAN is comprised of three neuroanatomical nodes that mediate attention to self-related stimuli. The VMPFC is thought to rapidly respond to self-relevance, feeding forward to the pSTS, resulting in an expectancy bias for future self-related stimuli (e.g., Sui et al., 2014). This bottom-up network, particularly the VMPFC, is modulated by a fronto-parietal control network (DLPFC and IPS) to allocate attentional resources in accord with task constraints. It has been noted that these regions may be recruited in processing others who share certain qualities with the self (e.g., one's partner). This possibility is further elaborated in 4.4.1.1.

Yet, even in the case of novel self-associations, it is not clear what aspect of the self may elicit observed self-biases in behaviour and in the brain. One explanation may be that the self is prioritised because it is inherently positive (Alicke & Govorun, 2005; Fields & Kuperberg, 2015; Heine et al., 1999; Lewicki, 1983; Mezulis et al., 2004) or rewarding (Northoff & Hayes, 2011; Tamir & Mitchell, 2012). Although this interpretation is intuitive, a number of studies by Sui and colleagues suggests that self-bias is at least partly distinct from reward-bias effects (e.g., Sui et al., 2012; Sui & Humphreys, 2015; Sui, Yankouskaya, & Humphreys, 2015). Another possibility is that mere self-relevance is sufficient to activate chronic processing goals. In the Self-Memory System framework (M. A. Conway, 2005; M. A. Conway & Pleydell-Pearce, 2000), it has been proposed that a key function of the self is to serve as a superordinate goal structure (see also Markus & Wurf, 1987). This putative working self is always active and serves as a means of structuring goals and processing incoming information in a way that is coherent with the self-concept. The working self is thought to flag any information associated with the self (e.g., both self and associated others) for more elaborate processing. In the context of learning and memory, information that is flagged as self-relevant is then bound to the multi-faceted self-concept (see Markus & Wurf, 1987). Such binding is thought to serve as "memorial glue" for novel information ranging from simple self-associations (Cunningham, Brady-Van den Bos, & Turk, 2011; H. Wang, Humphreys, & Sui, 2015) to goals (Burkley, Curtis, Burkley, & Hatvany, 2015). Once learned, these self-associations are not easily broken (H. Wang et al., 2015).

Of interest in the present chapter, enhanced processing of novel associations may not be unique to the self. For example, in the self-tagging paradigm developed by Sui and colleagues (2012), the observed effects appear to scale with the extent to which the social entities are related to the self (e.g., Sui et al., 2012, 2013). Self-associated shapes show significantly more perceptual enhancement than shapes assigned to close relationships (e.g., friend or mother), which in turn show more perceptual enhancement than shapes attributed to strangers. Thus, the so-called "self-tagging" effect thus appears to benefit close associates of the self, albeit to a lesser extent. Critically, close relationships and the self can be thought to vary in their degree of personal relevance and positive valence. This raises two different, albeit related, questions. First, is the personal relevance and positive valence of others associated with improvements in behavioural performance? Second, are self-advantages linked to one's sensitivity to relevance cues and valence?

4.1.2. Chapter Overview

In this chapter, we examined the roles of relevance and valence in facilitating the perception of novel shape associations for self and others. For all experiments in this chapter, we used a five-identity perceptual-matching paradigm, adapted from Sui and colleagues (2012). In addition to learning a shape association for the self, participants learned shape associations for four other identities, varied orthogonally in terms of valence (positive vs. negative) and relevance (personally known vs. familiar but unknown): (1) Friends are both relevant to day-to-day life and well-liked (i.e., positive and high relevance). (2) Enemies are similarly relevant but disliked (i.e., negative and high relevance). Personally unknown yet familiar figures (i.e., low relevance) such as celebrities can similarly be (3) admired or (4) detested. In this chapter, these four identities are referred to as "friend," "enemy," "admired figure," and "detested figure," respectively.

In Experiment 6, we examined the extent to which dimensions of relevance and valence facilitate performance for non-self shapes. We also examined the extent to which sensitivity to these dimensions predicts the self-advantage. To determine the cross-cultural tenability of these dimensions, we replicated Experiment 6 in an Eastern collectivist context (China) in Experiment 7. Finally, in an fMRI adaptation of the paradigm used in Experiments 6–7, we examined the extent to which regions of the Self-Attention Network (SAN) are sensitive to relevance and valence dimensions and how the neural representation of these dimensions may predict self-tagging advantages.

4.2. Experiment 6: Mapping Self and Others by Relevance and Valence

4.2.1. Introduction

As outlined in the chapter introduction, we first investigated the roles of personal relevance and valence in learning novel shape associations using a five-identity perceptual matching paradigm adapted from Sui and colleagues (2012). The relevance and valence dimensions were chosen on the basis of their potential to parsimoniously account for perceptual bias for the self and others (see 4.1.1). However, the choice of these dimensions is further motivated by findings from the memory and attention literature. In the following section, we review evidence in support of attentional and memorial prioritisation of personal relevance and valence, broadly construed.

4.2.1.1. Relevance and Valence in Memory and Attention

Regarding the effects of relevance on the processing of social entities, the person perception (Brewer & Feinstein, 1999; Fiske et al., 1999) and motivation literatures (e.g., Brosch et al., 2008; Sander, Grafman, & Zalla, 2003; Vogt, Lozo, Koster, & De Houwer, 2011) predict that stimuli that are relevant to current or chronic goals will elicit enhanced attention and more efficient perceptual processing regardless of valence (see also M. A. Conway, 2005). Indeed, exposure to relevant others (e.g., potential friends and enemies vs. celebrities; students from one's own university vs. students from another university) is known to elicit more accurate impression formation (Vonk, 1998), spontaneous mentalising (Decety, Jackson, Sommerville, Chaminade, & Meltzoff, 2004; Decety & Sommerville, 2003), and more enhanced face encoding (Cassidy et al., 2014) and memory (Hugenberg et al., 2010). Taken together, we anticipate that high-relevance (vs. low-relevance) identities will be prioritised in the present perceptual matching task.

Depending on current or evolutionarily relevant goals (e.g., threat, reproduction, affiliation), both negative (Frischen, Eastwood, & Smilek, 2008; Gerritsen, Frischen, Blake, Smilek, & Eastwood, 2008; Öhman, Lundqvist, & Esteves, 2001) and positive stimuli (Brosch, Sander, Pourtois, & Scherer, 2008; Brosch, Sander, & Scherer, 2007) have been known to capture attention in a rapid fashion, particularly when these images are high in arousal. Nonetheless, others have suggested that positive (i.e., previously associated with reward) stimuli may capture attention even in the absence of contextual goals/relevance (e.g., Anderson, Laurent, & Yantis, 2011). Additional research from the attention (Fredrickson & Branigan, 2005; Gasper & Clore, 2002; Rowe, Hirsch, & Anderson, 2007) and memory (Kensinger, 2009; Mickley & Kensinger, 2008) literatures provides evidence that positive states/stimuli are associated with a more heuristic processing style, whereas negative states/stimuli elicit more detailed processing and, in some cases, rumination (e.g., Freeston, Ladouceur, Thibodou, & Gagnon, 1991). This suggests that processing advantages for positive versus negative stimuli likely depend on the task at hand. Tasks requiring relatively superficial processing may show benefits for positive (vs. negative) stimuli, whereas tasks involving more complex processing may show the opposite. Considering the present perceptual matching task involves relatively low social context and superficial judgments (i.e., match vs. mismatch), we anticipate that positive stimuli (e.g., self, friend) should show efficient processing compared to negative stimuli (e.g., enemy, detested figure).

It is also possible that valence may interact with relevance (e.g., Briggs & Martin, 2009; Mazzietti & Koenig, 2014; Strathearn & Kim, 2013; Streubel & Kunzmann, 2011; Vogt et al., 2011). Processing relevant positive stimuli (e.g., reward) is typically associated with different neuro-cognitive substrates than relevant negative stimuli (e.g., punishment: see Garrison, Erdeniz, & Done, 2013). In a more social context, Strathearn and Kim (2013) have observed evidence for a neural interaction between relevance and valence in the amygdala. Specifically, amygdala response evinced greater sensitivity to positive high-relevance baby faces (i.e., own infant's happy face) and negative low-relevance faces (i.e., other infant's unhappy face). The authors propose that this interaction reflects motivated attachment with relevant others and protective distancing from unpleasant others. Thus, behavioural facilitation may be observed for positive (vs. negative) relevant identities (i.e., friend) and for negative (vs. positive) non-relevant identities (i.e., detested figure).

4.2.1.2. Individual Differences in Relevance/Valence Sensitivity

Finally, individuals are thought to differ in the way they weight valence (Barrett, 2006; Kuppens, Tuerlinckx, Russell, & Barrett, 2013; Segerstrom, 2001) and relevance (Robinson, Yager, Cogan, & Saunders, 2014). Given the suggestion that the self partially relies on reward systems (e.g., Northoff & Hayes, 2011; Sui & Humphreys, 2015) and evidence that the self is typically construed more positively than others (e.g., Alicke & Govorun, 2005; Heine et al., 1999), individual differences in sensitivity to valence (e.g., Kuppens et al., 2013; Segerstrom, 2001) are likely to affect relative self-advantages. Similarly, given that day-to-day relevance of others depends on the self by definition, it is also plausible that individual differences in sensitivity to day-to-day relevance of social stimuli may also affect relative self-advantages. These assumptions are in line with notions that the self anchors mentalising (Epley et al., 2004) and empathic capacity (Decety & Jackson, 2004; Mattan, Rotshtein, & Quinn, in press).

4.2.1.3. Analyses and Predictions

In the current study, we examined participants' responses on the perceptual matching task in several ways. A first set of analyses focused on the role of relevance and valence on the associations of non-self identities and random shapes. As outlined in the present introduction, we predicted that both relevance- and valence-based associations would affect processing, prioritising positive (vs. negative) valence and high-relevance (vs. low-relevance) entities. A second analysis examined performance for the self relative to the other four social identities. In line with Sui and colleagues (2012, 2013), it was expected that participants would show a robust RT and accuracy advantage for the self compared to all other shapes.

A final set of analyses examined the extent to which the self-advantage can be predicted by participants' sensitivity to the relevance and the valence of the social entities. Sensitivity to valence was assessed by contrasting the responses to negative versus positive stimuli, whereas sensitivity to relevance was estimated by contrasting the responses to personal acquaintances from famous but personally unacquainted others (high vs. low relevance, respectively). We tested between two competing hypotheses: (1) On the assumptions that sensitivity to positivity and relevance should enhance performance for all positive/relevant entities and that the self is processed as merely another positive/relevant social stimulus, greater sensitivity to relevance or valence should associate with *preserved, if not enhanced*, self-advantage relative to other positive/relevant entities. (2) On the assumption that the self is maximally relevant and positive and thus serves to anchor the perception of others along these social dimensions, greater sensitivity to relevance or valence should be associated with more similar performance for identities that match the self on those dimensions (i.e., a *reduced* self-advantage).

4.2.2. Method

Participants. Forty-seven students (37 female; M_{age} = 20.2 years, SD_{age} = 3.08) from the University of Birmingham were recruited through an online research participation scheme and received course credit for their participation. The sample composition was 66.0% White

British/Other, 14.9% South Asian, 8.5% Black African/Caribbean, 6.4%, Non-White Other/Mixed Race, 4.3% East Asian. Due to computer failures, data from one participant were not recorded for the perceptual matching task. Thus, only 46 participants were included in the analyses.

Social distance task. This task is identical to the task used in Experiment 4 (see 3.2.2). The only difference is that the non-self identities were changed from three (i.e., family member, friend, and stranger) to four (i.e., a friend, an enemy, an admired figure, and a detested figure). For the admired and detested figures, the experimenter instructed participants to choose two people they did not personally know. After providing the names, the task procedure was as detailed in Chapter 3. This task was part of a separate study, and so its results are not reported here.

Perceptual-matching task. The five-identity perceptual-matching task used in this study was adapted from a three-identity version used by Sui and colleagues (Sui et al., 2012, 2013; Sui, Liu, et al., 2015). To make the task more concrete, the five identities were represented by participant-provided names instead of abstract labels (e.g., “FRIEND”; Sui et al., 2012). The five shape images (Blue Circle, Green Triangle, Red Square, Purple Diamond, & Yellow Pentagon: see Figure 4.1) were created using Microsoft PowerPoint (Microsoft Corporation, Redmond, WA) and GIMP version 2.8.2 (Free Software Foundation, Inc., Boston, MA). Each shape was drawn as a coloured outline filled with a white interior and centred on a transparent background (960 × 720 pixels). Shape size was approximately 70 mm^2 (view angle = 49°).

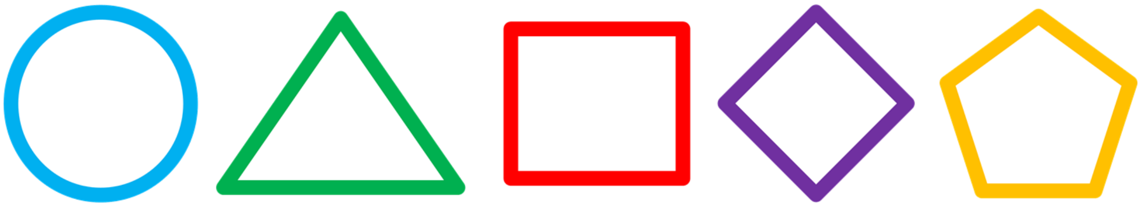


Figure 4.1. Illustration of the five shapes used in the perceptual-matching task (Experiments 6–8). Identity assignments for each shape were randomised within participant.

Procedure. Shape–label pairings were randomised and presented at the start of the perceptual-matching task. After learning the shape–label associations, participants trained on the perceptual-matching procedure. The trial procedure was similar to the version used in Experiment 2 (see 2.3.2). The only difference is that the blank screen following the shape−label stimulus remained until a response was recorded or remained for a randomly jittered duration of between 801 and 1200 ms if no response was given. This change was made to ensure a closer replication of previous work (see Sui et al., 2012). Participants responded by key press: M for a match and K for a mismatch (changed from J and K for added ergonomic comfort).

As in Chapters 2 and 3, a series of practice runs was used to determine the minimum stimulus duration at which participants could sustain 80% accuracy (increased from 75% accuracy in Chapter 2). The initial stimulus duration was set at 3000 ms (increased from 1000 ms in previous experiments) and decreased incrementally depending on the performance of the participant. The final stimulus duration time was the shortest duration at which the participant maintained at least 80% accuracy on two consecutive practice blocks, with a minimum display time of 100 ms. This minimum was increased from previous studies (see Chapters 2−3) to make the task easier, as piloting revealed participants found this five-identity version more difficult than versions with fewer identities.

Following the practice runs, participants completed 320 experimental trials at the final stimulus display time. Trials were divided evenly between all conditions, for a total of 32 trials per condition. This number was increased from previous experiments to ensure a sufficient number of trials per condition. As previously, participants were informed of their accuracy after every 10 trials and given the opportunity to rest as the feedback was displayed.

Experimental procedure. After giving informed consent, participants first completed the social distance task. Following the social distance task, participants completed the training and experimental blocks for the perceptual-matching task. Finally, participants completed some additional cognitive measures, personality data, and demographics questionnaires that were intended as key variables for a study on ageing that is not presented here. Because these measures were all recorded after the perceptual matching task, they were unlikely to have affected the data reported here. Upon completion of all tasks, participants were thanked for their participation and debriefed.

4.2.3. Results

A 3-standard-deviation guideline was used to exclude outliers from analysis in the perceptual-matching task. This was done at the participant level for response time data and at the group level for accuracy rate data. Analyses for RT and accuracy are reported separately. For the RT analysis incorrect responses (19.3% of trials) and correct responses with latencies exceeding 3 standard deviations from the individual's overall mean (0.4%) were trimmed. Because match trials typically show more reliable effects of shape identity (Sui et al., 2012, 2013), we focus on these trials in the main analysis. Analysis of mismatch trials and formal comparisons between match and mismatch trials are reported in Appendix 4.1.

4.2.3.1. Performance for Non-Self Shapes

Response time. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) repeated-measures ANOVA for match-trial RTs revealed marginal main effects for both relevance, $F(1,45) = 3.01$, $MSE = 2655$, $p = .090$, $\eta_p^2 = .063$, and valence, $F(1,45) = 3.95$, $MSE = 1324$, $p = .053$, $\eta_p^2 = .081$. Participants showed numerically faster RTs for high-relevance compared to low-relevance and for positive compared to negative identities. The Relevance × Valence interaction was non-significant $F(1,45) = 0.405$, $p = .53$. All means and standard errors for RT data are found in Table 4.1.

Table 4.1

Descriptive Statistics for the Perceptual Matching Task, Experiment 6

Trial Type	Identity	Relevance	Valence	Mean	SEM
Match	Detested	Low	Neg	638	12.7
	Admired	Low	Pos	631	11.7
	Enemy	High	Neg	627	9.1
	Friend	High	Pos	612	8.9
	Self	-	-	564	8.2
Mismatch	Detested	Low	Neg	676	11.1
	Admired	Low	Pos	683	9.5
	Enemy	High	Neg	675	10.9
	Friend	High	Pos	683	9.9
	Self	-	-	678	11.1

Accuracy. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) repeated-measures ANOVA for match-trial accuracy scores revealed significant main effects for both relevance, $F(1,45) = 8.40$, $MSE = .009$, $p = .006$, $\eta_p^2 = .157$, and valence, $F(1,45) = 13.1$, $MSE = .013$, $p = .001$, $\eta_p^2 = .226$. Participants showed greater accuracy for high-relevance compared to low-relevance and for positive compared to negative identities. The Relevance × Valence interaction was non-significant $F(1,45) = 1.29$, $p = .26$. See Figure 4.2a for accuracy performance for match trials.

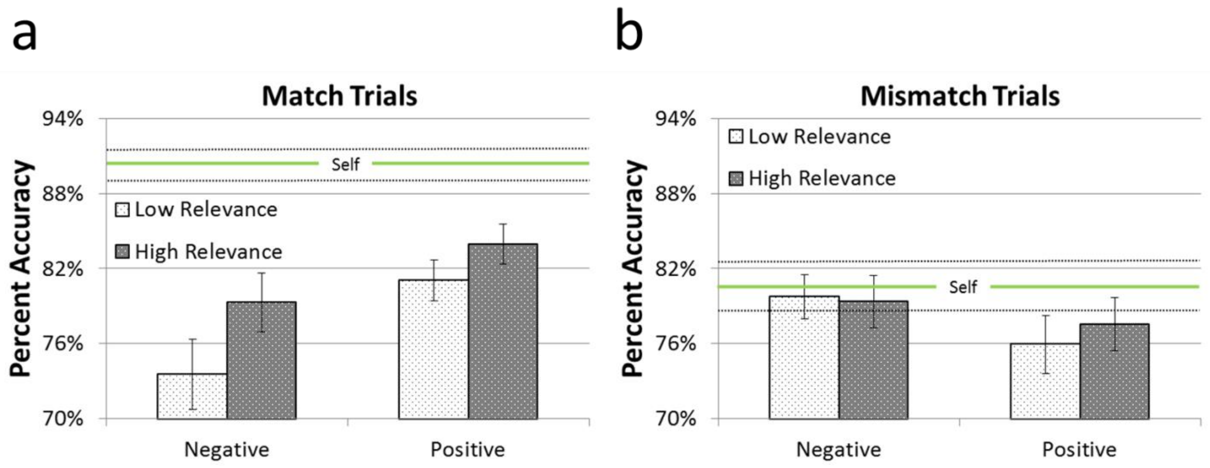


Figure 4.2. Accuracy data from the perceptual matching task for match trials (a) and mismatch trials (b). Match trials (a) show reliable prioritisation of positive (vs. negative) and high-relevance (vs. low-relevance) identities. A trend for a reversed valence effect is visible in the mismatch trials (b). Performance for the self (mean = green line, standard error = dotted lines)) is provided for a comparison.

4.2.3.2. Performance for the Self Shape

To compare overall performance for the self to all other identities, contrasts comparing the performance for the self relative to each of the non-self shapes were computed for match trials. Match-trial latencies for the self shape were significantly shorter compared to the friend, $t(45) = 6.47$, $p < .001$, $d = 0.95$, the enemy, $t(45) = 9.53$, $p < .001$, $d = 1.41$, the admired-figure, $t(45) = 7.79$, $p < .001$, $d = 1.15$, and the detested-figure, $t(45) = 8.51$, $p < .001$, $d = 1.25$, shapes. Match-trial accuracy for self-shape trials was greater compared to the friend, $t(45) = 3.93$, $p < .001$, $d = 0.58$, the enemy, $t(45) = 5.93$, $p < .001$, $d = 0.87$, the admired-figure, $t(45) = 4.92$, $p < .001$, $d = 0.73$, and the detested-figure, $t(45) = 6.54$, $p < .001$, $d = 0.96$, shapes.

4.2.3.3. Evidence for Self-Anchoring in Social Space

In this section, we summarise findings from the final set of analyses. The full analysis is provided in Appendix 4.2. The purpose of these analyses was to determine whether overall sensitivity to relevance and valence (for non-self entities) affected the extent to which participants showed bias for the self relative to those other identities. Multiple regression analyses (see Appendix 4.2.2) revealed that, as participants' relative prioritisation of relevance increased, the self advantage decreased for high-relevance entities (e.g., friend and enemy) and increased for low-relevance entities (e.g., admired and detested figures). This relationship is depicted for standardised RT data in Figure 4.3. Similarly, as participants' relative prioritisation of valence increased, the self advantage decreased for positive entities (e.g., friend and admired figure) and increased for negative entities (e.g., enemy and detested figures). This relationship is depicted for standardised RT data in Figure 4.4. Further analysis revealed that relative sensitivity to relevance and valence was unrelated to mean performance for the self (see Appendix 4.2.3).

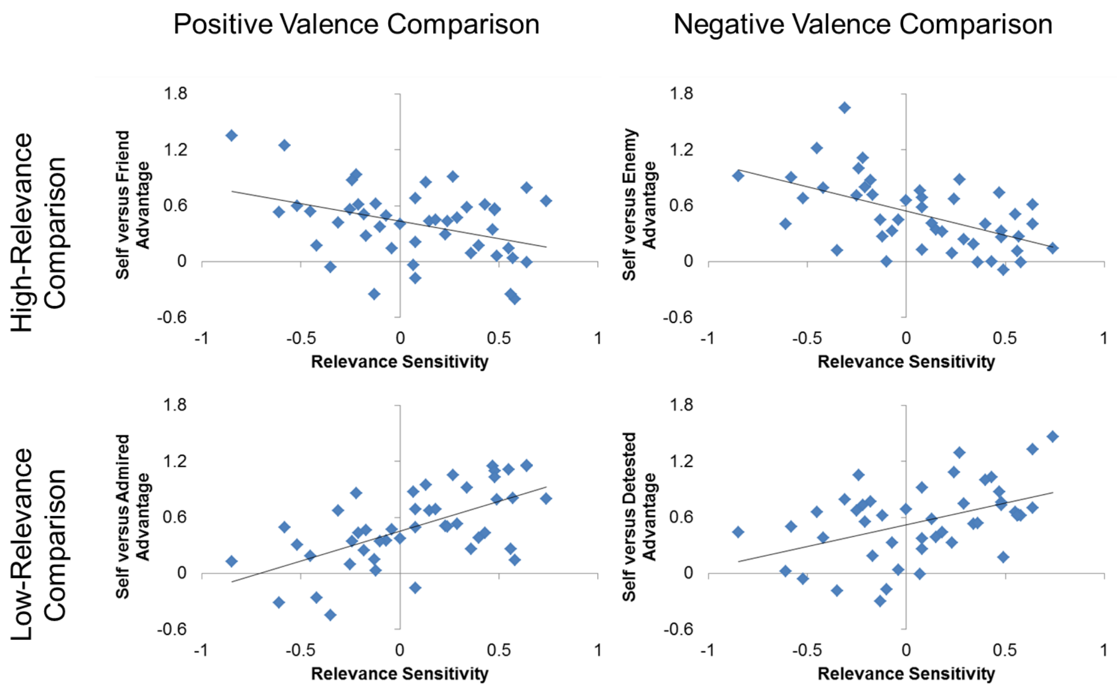


Figure 4.3. Relationship between relevance sensitivity and self-tagging advantage in the standardised RT data. Note that, as relevance sensitivity increased, the self-advantage decreased in comparison to high-relevance identities (top row: friend and enemy) and increased in comparison to low-relevance identities (bottom row: admired and detested figures). All relationships were significant.

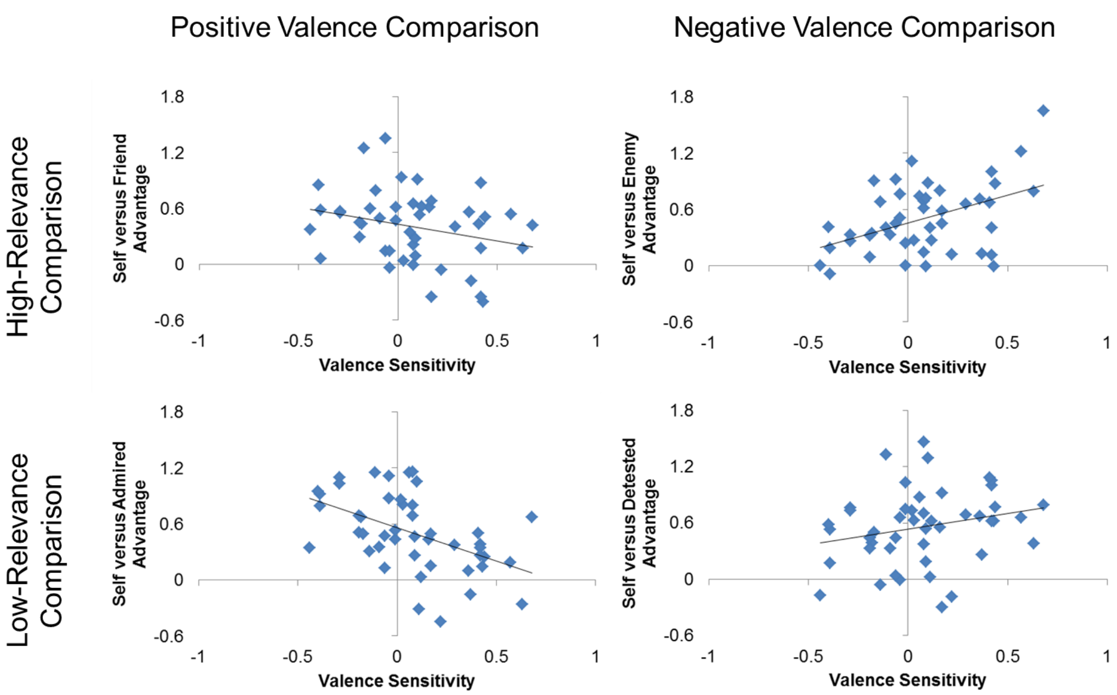


Figure 4.4. Relationship between valence sensitivity and self-tagging advantage in the standardised RT data. Note that, as valence sensitivity increased, the self-advantage decreased in comparison to positive valence identities (left column: friend and admired figure) and increased in comparison to negative valence identities (right column: enemy and detested figure). All relationships were significant.

Overall, these findings provide greater support for the second of the two competing hypotheses offered in the introduction (see 4.2.1). Rather than preserving or increasing self-advantages (as predicted by Hypothesis 1), increased sensitivity to relevance and valence *decreased* self-advantages for identities most similar to the self on these dimensions (e.g., relevance dimension: friend and enemy; valence dimension: friend and admired figure). This pattern of results suggests that the self may serve as an anchor for the processing of non-self identities along these key social dimensions.

Interactions between relevance-sensitivity and valence-sensitivity effects significantly predicted the self-advantage only in the standardised accuracy data and only for the friend and detested-figure comparisons (see Appendix 4.2.2). Relative to the friend (i.e., positive, high relevance), sensitivity to either relevance or valence was sufficient to diminish the self-advantage over the friend; above-average sensitivity on a second dimension had little additional impact on the self-advantage magnitude (see Figure 4.5). Relative to the detested figure (i.e., negative, low relevance), large co-occurring relevance- and valence-sensitivity effects disproportionately increased the self-advantage magnitude (see Figure 4.6). Apart from these interactions, the standardised accuracy data showed the same pattern as the standardised RT data.

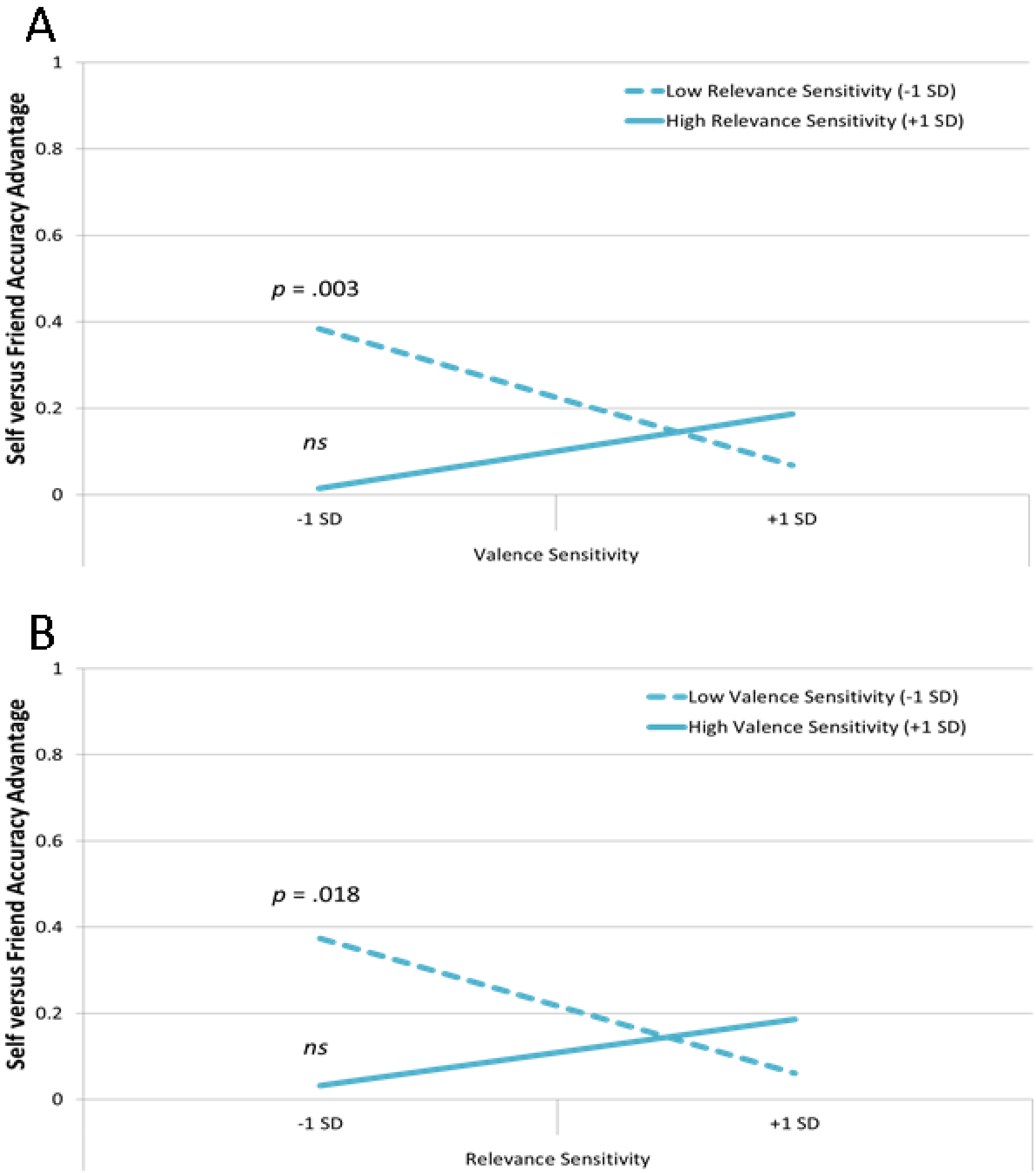
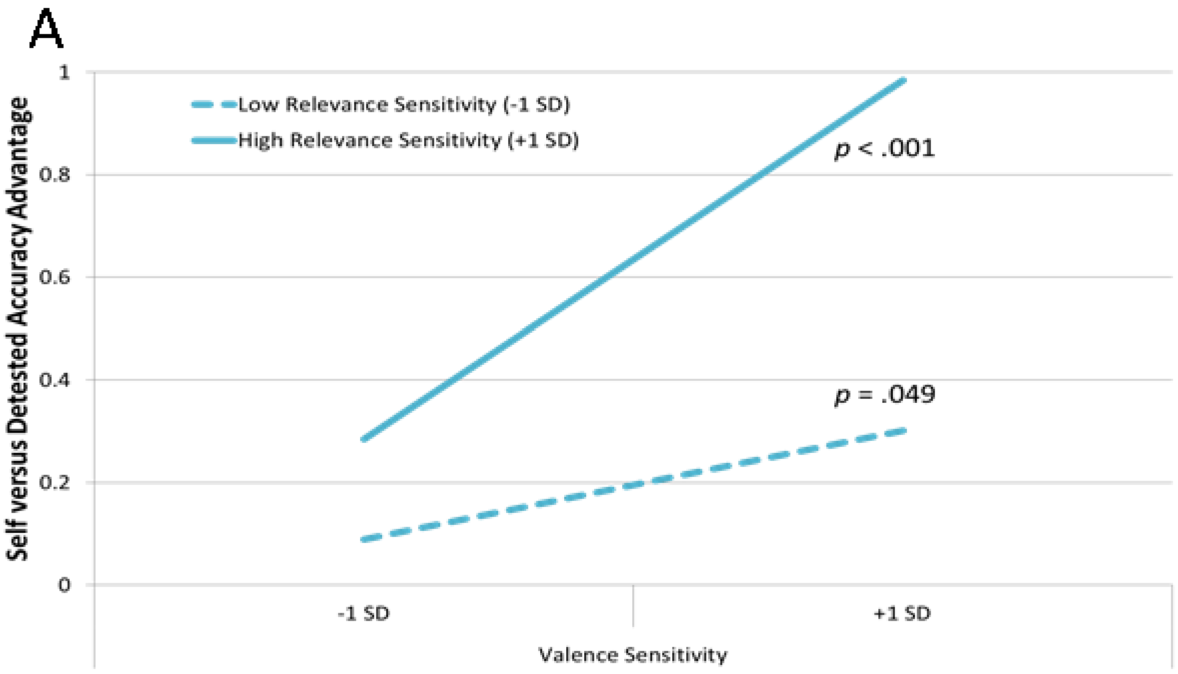


Figure 4.5. Simple slopes analysis for the Relevance × Valence interaction in the prediction of the self-versus-friend accuracy advantage. Panel A shows the interaction with relevance sensitivity as the moderator. Panel B shows the interaction with valence sensitivity as the moderator. Projected accuracy advantages are presented at -1 SD (Low) and +1 SD (High) from the group mean for each factor.



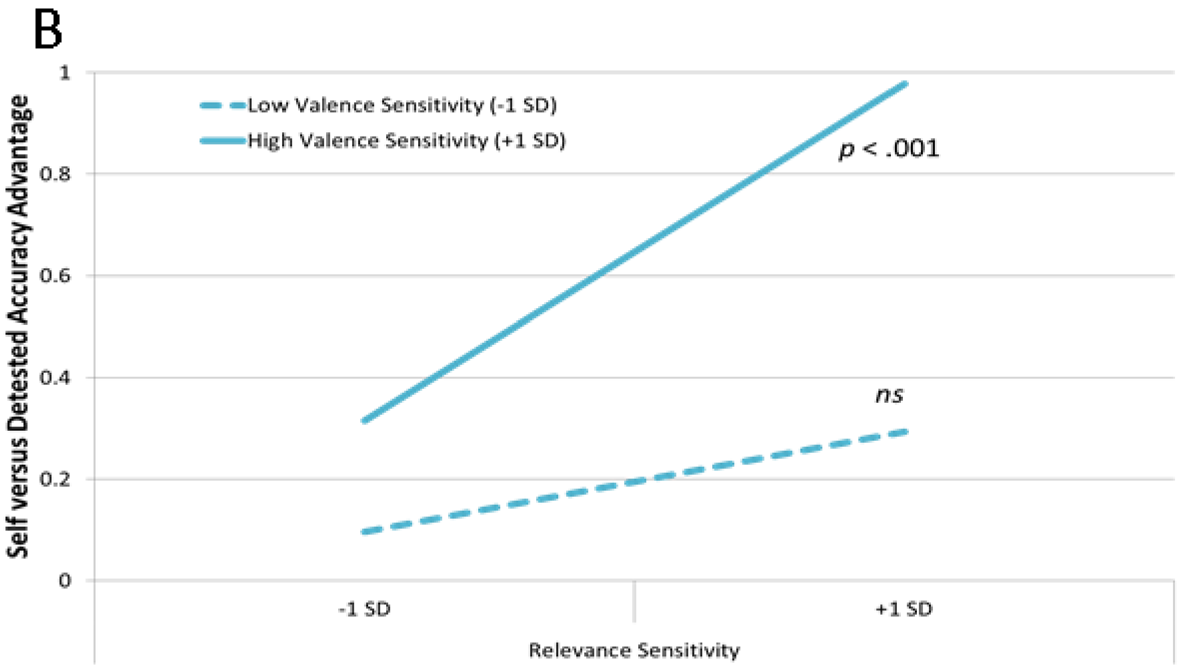


Figure 4.6. Simple slopes analysis for the Relevance × Valence interaction in the prediction of the self-versus-detected accuracy advantage. Panel A shows the interaction with relevance sensitivity as the moderator. Panel B shows the interaction with valence sensitivity as the moderator. Projected accuracy advantages are presented at -1 SD (Low) and +1 SD (High) from the group mean for each factor.

4.2.4. Discussion

Existing models of person perception (e.g., Fiske, Cuddy, & Glick, 2007; Fiske, Cuddy, Glick, & Xu, 2002; Zebrowitz, 2011) have characterised unknown individuals along multiple dimensions to accurately predict perceivers' affective and cognitive responses. The current study takes a similar approach to the self, highlighting the importance of day-to-day relevance and valence dimensions in predicting performance for both self and others. Relevance and valence independently contributed to behavioural performance, particularly in the accuracy results, although a similar marginally significant pattern was observed for RTs. Results for the self shape replicate and extend previous research on the prioritisation of self-tagged stimuli (Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012, 2013). Critically, these results suggest that self-tagging advantages result not from a domain-general tendency to prioritise positive valence and/or relevant stimuli. Indeed, results suggest that sensitivity to either dimension for non-self identities does not necessarily translate to increased prioritisation of the self. Instead of preserving or increasing the self-advantage, sensitivity to valence and/or relevance (for non-self identities) *reduces* the self-advantage magnitude relative to identities close to the self on either dimension. This finding provides initial support for the idea that self-tagging effects stem from the self's anchoring position at the extreme end of positivity and relevance gradients.

The independence of relevance and valence effects found in the current study is consistent with findings in the emotion literature. Appraisal-based theories of emotion (Sander, Grandjean, & Scherer, 2005; Scherer, 2001) posit that high-relevance stimuli (i.e., those pertinent to frequent or salient goals) influence attention independent of stimulus valence (Briggs & Martin, 2009; Brosch et al., 2008; Fields & Kuperberg, 2012; Güroğlu et al., 2008). Relatedly, valence effects are often found independent of concurrent relevance effects (e.g., Fields & Kuperberg, 2012; Güroğlu et al., 2008). Such valence effects are frequently facilitative for negative stimuli (see Frischen et al., 2008; Kensinger, 2009; Rozin & Royzman, 2001; Vuilleumier, 2005, for reviews). However, this is not always the case, especially if positive stimuli are relatively more arousing (Anderson, 2005). Although we did not assess this in the present research, it is possible that the present valence effect may be due to a higher arousal value for positive non-self identities.

For the main analyses, it is worth noting that we failed to find evidence of an overall Relevance × Valence interaction in the processing of non-self identities. Mindful of the difficulties in interpreting null findings, we speculate that this may be due to the decontextualised social stimuli used in this study. Previous studies examining the processing of relevance and valence do not present each condition as a unique individual(s) (e.g., friend, enemy, admired figure, and detested figure), but rather as a combination of emotional and self-relevance cues. For example, Strathearn and Kim (2013) use the following conditions: happy own baby, unhappy own baby, happy unknown baby, unhappy unknown baby. The same two identities are crossed with emotional context, potentially affording specific response tendencies (Zebrowitz, 2011). Relevance × Valence interactions are said to reflect adaptive responding to current goals (e.g., Mazzietti & Koenig, 2014; Vogt et al., 2011) or chronic goals such as threat management (e.g., M. M. Bradley, Codispoti, Cuthbert, & Lang, 2001; Briggs & Martin, 2009; N'Diaye, Sander, & Vuilleumier, 2009) and reproduction (e.g., M. M. Bradley et al., 2001; Briggs & Martin, 2009), with highly relevant negative stimuli garnering the most behavioural facilitation in the service of fight-or-flight responses. Although hard-wired responses to evolutionarily-relevant stimuli may be adaptive, such inflexible responses to unpleasant people (e.g., enemies) would be considered pathological (American Psychiatric Association, 2013). Similarly, contextually-rich primes and situations (e.g., Mazzietti &

Koenig, 2014; Vogt et al., 2011) seem more likely to afford discrete behavioural responses compared to the decontextualised social stimuli used in the current study. Further study is required to determine whether behavioural responding to unique social identities such as those used in the current study exhibits sensitivity to contextually salient goals.

Self-anchoring hypothesis. The hypothesis that the self serves as an anchor for the evaluation of others on dimensions of relevance and valence (see 4.2.1) was supported by regression models in which sensitivity to each dimension reliably predicted the self-tagging advantage magnitude (see Appendix 4.2.2), but not mean performance for the self (see Appendix 4.2.3). For example, participants showing relatively large valence-sensitivity effects showed a diminished self-tagging effect magnitude in comparison to positive identities (i.e., friend and admired figure) and an enhanced self-tagging effect magnitude relative to negative identities (i.e., enemy and detested figure). The same tendency was observed for relevance-sensitivity effects, with increasing relevance-sensitivity diminishing self-advantages to relevant others (i.e., friend and enemy) and enhancing self-advantages to non-relevant others (i.e., admired and detested figures). Critically, the two sensitivity effects were both significant and in opposite directions when predicting self-advantages over identities of incongruent relevance and valence level (e.g., enemy, which is high in relevance, like the self, but negative in valence, unlike the self).

We note that relevance- and valence-sensitivity interacted in predicting self-advantages for the friend (Figure 4.5) and detested figure (Figure 4.6) in the accuracy data. It is not clear why relevance- and valence-sensitivity should interact for identities in which relevance and valence levels are congruent (i.e., positive/high-relevance identities and negative/low-relevance identities). One possibility may have to do with the necessarily limited range of accuracy data. Differences between the self and friend may have been artificially compressed because performance for both identities approached ceiling levels (see Figure 4.2). Thus, the accuracy regressions should be interpreted with caution pending further research. Nonetheless, this concern is partially mitigated by regressions on the RT data (characterised by a naturally broader range compared to accuracy data), which show a similar overall pattern and no interactions for any of the non-self identities. Regardless of the source of the interactions, their general patterns do not contradict the self-anchoring account presented here. For both the friend and the detested figure, the main effects of relevance- and valence-sensitivity were significant and in the predicted directions. Moreover, all significant simple effects in the interactions were also in the expected directions (i.e., negative for the friend and positive for the detested figure; see Figures 4.5 and 4.6).

The current findings and their support for a self-anchoring model of implicit processing have implications for research on self-prioritisation in perceptual matching and other paradigms contrasting self- with other-associated stimuli (e.g., A. R. A. Conway et al., 2001; Rogers et al., 1977; Turk, Cunningham, & Macrae, 2008). Because the self-advantage appears to depend critically on the position of the other along gradients of personal relevance and valence, care must be taken in the interpretation of so-called self effects. Extant literature on the self is inconsistent regarding the relevance and valence of the identity used for self-comparisons. Studies typically rely on famous figures (e.g., Craik et al., 1999; Keenan, Freund, Hamilton, Ganis, & Pascual-Leone, 2000; Kelley et al., 2002; Sugiura, Mano, Sasaki, & Sadato, 2011) or unknown strangers (e.g., Turk et al., 2013; van den Bos et al., 2010) as the critical contrast to the self. In such studies, valence is often either ambiguous (e.g., George W. Bush may be positively or negatively viewed by American participants) or neutral (e.g., stranger). The present study suggests these self effects observed in brain and behavioural responses could be explained by differences in relevance or valence rather than a unique effect of self-perception independent of others. Even a close friend or family member, which is frequently taken to be the benchmark comparison for unique self effects (e.g., Kitayama & Uchida, 2003; Lou et al., 2004; Ochsner et al., 2005; Sugiura et al., 2012; Sui et al., 2012, 2013), may be more indicative of individual differences in the perceived positivity and relevance of the friend target rather than any self-advantage as such. These findings are consistent with symbolic interactionist accounts of the self (Andersen & Chen, 2002; S. Chen, Boucher, & Tapias, 2006; Goffman, 1959; Mead, 1934) in which the nature of the self is thought to be a construction based on the immediate social context. Nonetheless, the self's apparent role as an anchor of positivity and relevance suggests that it is more than a mere reflection of the social context; the self forms the standard against which others are implicitly registered in terms of relevance and valence. This conceptualisation of the self is consistent with accounts of trait attribution (Machunsky, Toma, Yzerbyt, & Corneille, 2014; Toma, Yzerbyt, & Corneille, 2010), self-regulation (Markus & Wurf, 1987), empathy (Decety & Jackson, 2004; Decety & Sommerville, 2003), and perspective taking (Epley et al., 2004) in which the self serves as a scaffolding for representing and interacting with the social world.

One fruitful avenue of research would be to examine exceptions to self-anchoring at the extremes of valence and/or relevance. The current study tested a normal university population, which is expected to have positive and motivationally relevant views of the self (Mezulis et al., 2005). However, there is evidence to suggest that the self is not always anchored at the extreme of positivity and relevance. A number of studies provide evidence that clinically depressed (B. Bradley & Matthews, 1983; Segal, Gemar, Truchon, Guirguis, & Horowitz, 1995; Sweeney, Anderson, & Bailey, 1986) and dysphoric (Watson, Dritschel, Jentzsch, & Obonsawin, 2008; Kuiper & Derry, 1982) individuals tend to have more negative associations with the self (but see Ingram, Smith, & Brehm, 1983). This presents the intriguing hypothesis that the self's anchoring position is reversed on the positivity dimension for depressed and dysphoric individuals. If so, then one might expect the increasing use of valence in processing non-self targets would decrease self-advantages relative to disliked individuals and increase the self-advantage relative to close friends. Such a pattern would be the inverse of the present findings obtained with a clinically normal undergraduate population.

Relatedly, the present paradigm might also be useful for disentangling the contributions of valence and relevance dimensions to the processing of superlatively positive and relevant identities (e.g., intimate family and friends). Significant (vs. non-significant) others have been shown to receive more complex representation (Andersen, Glassman, & Gold, 1998), eliciting brain activity patterns similar to those elicited by the self (Tacikowski, Brechmann, & Nowicka, 2012). Indeed, the positivity biases associated with intimate relations (such as the mother–infant relationship; Strathearn & Kim, 2013) or ageing (Streubel & Kunzmann, 2011) are intriguing exceptions to the otherwise well-documented behavioural negativity biases (see Frischen et al., 2008; Kensinger, 2009; Rozin & Royzman, 2001; Vuilleumier, 2005, for reviews). These findings suggest indirectly that extremely positive and relevant non-self stimuli (e.g., one's newborn or significant other) may serve as valence/relevance anchors, consistent with their inclusion in the self-concept (Aron et al., 1992; Aron, Aron, Tudor, & Nelson, 1991).

For the sake of design simplicity, the current study did not consider valence-neutral identities. Unlike day-to-day relevance, valence is intuitively thought to have a qualitatively distinct "neutral" midpoint between extremely positive and extremely negative. Theories of emotion (e.g., Lang, Bradley, & Cuthbert, 1997) predict that neutral stimuli are less relevant to goal states and so receive minimal processing relative to negative and positive stimuli. In other words, the full spectrum of valence-based processing is more U-shaped than linear (e.g., Briggs & Martin, 2009; Schupp et al., 2000). Given the lack of context in the present study and the size of valence effects (positive vs. negative) observed, it seems likely that neutral stimuli would fall between positive and negative stimuli in the perceptual-matching paradigm. However, further study is required to examine the role of valence-neutral identities in the domain of valence-based person perception. One means of addressing this limitation is by experimentally manipulating the valence of fictitious social targets. Relevance could be manipulated by implicitly construing the experimental context as interdependent (high relevance—anticipated interaction with target; e.g., Toma et al., 2010; Vonk, 2008) versus independent (low relevance—no anticipated interaction with target). Similarly, social targets may be construed as moral versus immoral (Cloutier & Gyurovski, 2014; Decety, Michalska, & Kinzler, 2012). Such an approach would provide a useful test of the self-anchoring hypothesis in the context of unfamiliar social entities.

Conclusion. Counter to Goffman's (1959) famous assertion that the self is merely the dynamic that we adopt in the presence of others, psychologists have long attempted to determine what, if anything, may be said about the self as such (Gillihan & Farah, 2005). The current findings suggest that the self appears to enjoy a privileged anchoring position on gradients of positivity and relevance, against which other identities are implicitly registered. The more perceivers use these dimensions in assessing others (i.e., greater sensitivity), positive and relevant identities approach the self in terms of behavioural facilitation. Ultimately, it seems the question may not be what makes the self special, but rather, what makes others special. The present findings suggest that implicit proximity to the self in terms of relevance and valence could result in self-like prioritisation even for non-self identities. We are optimistic that future work will provide additional tests of the self-anchoring hypothesis for positivity and relevance dimensions.

4.3. Experiment 7: Cross-Cultural Differences in Self–Other Mapping

4.3.1. Introduction

Results from Experiment 6 suggest that social attention may be guided by key dimensions such as personal relevance and valence and that the self may serve as an anchoring point at the extreme end of these dimensions (i.e., the most chronically relevant and positive social entity). This is consistent with the common assumption that the self is implicitly positive (Alicke & Govorun, 2005; Ma & Han, 2010) and generally relevant to chronic concerns (M. A. Conway, 2005; M. A. Conway & Pleydell-Pearce, 2000; Goffman, 1959; Leary, 1995). One open question is whether the self anchors key social dimensions universally or whether this tendency is limited to cultural contexts that highly value a positive self-concept (e.g., Western individualist cultures: Markus & Kitayama, 1991). In the present experiment, we aimed to replicate these findings in an Eastern collectivist culture characterised by relatively diminished relevance of the self-concept (Markus & Kitayama, 1991) and lower self-enhancement motivation (i.e., motivation to present the self in a positive light: Falk & Heine, 2015; Kitayama, Markus, Matsumoto, & Norasakkunkit, 1997). Additionally, we test for cultural differences in sensitivity to the dimensions of relevance and valence.

4.3.1.1. Cross-Cultural Evidence for a Unique and Positive Self

Acknowledging a general tendency in Eastern collectivist societies for diminished self-focus and self-enhancement motivation (Falk & Heine, 2015; Kitayama et al., 1997; Markus & Kitayama, 1991), some have nonetheless argued that the self may serve as an implicit foundation for social cognition across all cultural backgrounds (Gaertner, Sedikides, Vevea, & Iuzzini, 2002). Initial support for this claim can be found in the apparent universal tendency for individuals to define the self using individual-level (vs. group-level) descriptors that, to some extent, differentiate them from the group (del Prado et al., 2007; Gaertner, Sedikides, & O'Mara, 2008; Gaertner et al., 2002). It has been argued that defining the self in such terms may have adaptively highlighted the individual's unique value to the group in ancestral times, ultimately eliciting cooperation from others to overcome problems stemming from small-group living and the external environment (see Sedikides & Skowronski, 1997, 2009; Tooby & Cosmides, 1996). Consequently, it has been argued that the primacy of the individual self is the product of natural selection and is thus an intrinsic aspect of all human cultures. On these grounds, Sedikides, Gaertner, and Toguchi (2003) proposed that individuals of all cultural backgrounds should not only represent the self as a discrete individual, but also show a tendency to reinforce the positive value of the self in a culturally acceptable manner. For Japanese (vs. American) and for Americans with interdependent (vs. independent) self-construal, participants showed a greater tendency to self-enhance for collectivistic traits (e.g., "loyal") and behaviours (e.g., "defend your group's decisions"). American (vs. Japanese) and Americans with independent (vs. interdependent) self-construal instead showed a greater tendency to self-enhance for individualist traits (e.g., "self-reliant") and behaviours (e.g., "argue for your position and against the group"). Perhaps unsurprisingly, the dimensions on which participants self-enhanced were also those that were most valued by participants.

Complementing the preceding self-report research, subsequent research using methods from cognitive psychology (e.g., reaction time) has also showed that participants view the self as unique relative to others in the social context. For example, Ma and Han (2010) found evidence of self-prioritisation in both individualist and collectivist cultures in the categorisation of face orientation in self and other faces. In this study, both Chinese and

American participants responded faster to their own faces than to faces of familiar others and scrambled faces (but see Sui & Han, 2007). Interestingly, both groups showed a diminished self-advantage following a prime that threatened the positive self-concept compared to a non-threatening prime, suggesting a link between behavioural self-bias and an implicit positive self-association. Subsequent studies have since replicated the observation that individuals from collectivist contexts (viz., China) have a positively tinged self-concept. These studies further show that this effect is relatively automatic, registering approximately 270 ms following the presentation of self-relevant stimuli (Yun Chen et al., 2014; L. Wu et al., 2014). Taken together, self-report and neurocognitive findings are consistent with the notion that individuals in distinct cultural contexts are motivated to view the self as both distinct from others and generally positive, within the cultural mandates guiding self-presentation (Heine, 2005; Markus, Mullally, & Kitayama, 1997; Sedikides et al., 2003).

Finally, research using neuroimaging methods has provided some evidence that the neural substrates of self-representation transcend culture. One study found that both local Chinese students and Western international students showed greater VMPFC activity while making trait judgements for the self relative to a well-known politician (Zhu, Zhang, Fan, & Han, 2007), consistent with previous research showing the VMPFC is distinguishes between trait judgements for self versus others in Western samples (Heatherton et al., 2006; Kelley et al., 2002). Intriguingly, this same study found that Chinese and Western participants differed in their response to trait judgements about their mothers: Whereas Western participants showed greater VMPFC activity for trait judgements about the self relative to their mothers, Chinese participants did not[8]. The authors interpret this finding as consistent with an Eastern

[8] It is worth noting that this effect appears to be limited to participants' mothers, but not other close associates such as one's father or best friend (G. Wang et al., 2012).

philosophical understanding of the self as intrinsically tied to (close) others in the social context (Zhu & Han, 2008). In other words, individuals from Eastern collectivist cultures may recruit brain regions selective for the self to process close others because these close others are included in the individual's self-concept (cf. Kang, Hirsh, & Chasteen, 2010; Newman-Norlund, Ganesh, van Schie, De Bruijn, & Bekkering, 2009). This effect should be interpreted with caution, as a subsequent study showed that increased trait-level interdependence in a sample of native U.S. English speakers was associated with an *enhanced* rather than diminished difference between self and mother in the VMPFC (and precuneus/PCC: Ray et al., 2009). The authors speculate that this unanticipated finding may have resulted from American interdependent participants' greater reliance on reflected appraisals in judgements about the self, a process that is known to recruit the VMPFC (Ochsner et al., 2005). Taken together, these studies suggest the potential for a dynamic interaction between self overlap with close others and the tendency to engage in reflected self-appraisal that is mediated by culture- and individual-level differences in self-construal (Kitayama & Park, 2010). Although this potential interaction is beyond the scope of the present inquiry, we nonetheless highlight the key observation that self–other differentiation in the VMPFC is evident across geographical and cultural backgrounds. Cultural modulations notwithstanding, the globally consistent activation of this region for self-trait judgements provides further evidence that the self-concept is a universal element of the human social-cognitive toolbox.

In this section, we reviewed some evidence for the privileged position held by the self in social cognition in both individualist and collectivist contexts. On the basis of existing literature, we argued that individuals across cultures are motivated to define and present their self-concept as unique and positive. Regarding the social dimensions of relevance and valence from the preceding experiment, it is indeed plausible that the self may be situated at the extreme end of these dimensions in both Western/individualist and Eastern/collectivist cultures. By virtue of the self existing as a meaningful concept with cross-cultural empirical referents, we assume—by definition—that the self is indeed the most self-relevant social entity. As for valence, the reviewed literature suggests the existence of a robust self-positivity bias that spans geographic location and culture[9]. In the case of Eastern contexts, the self may share this privileged position with close others (viz., mother: G. Wang et al., 2012; Zhu et al., 2007), but we argue this is only insofar as that close other is included in the individual's self-concept (see Aron et al., 1992; Kang et al., 2010; Mashek, Aron, & Boncimino, 2003; Newman-Norlund et al., 2009). We now turn to cross-cultural variation in sensitivity to these social dimensions, independent of the self.

4.3.1.2. Mapping the Self and Others across Cultures

Surprisingly few studies have considered cultural variability in sensitivity to different social dimensions. One exception may be the Stereotype Content Model (SCM: Fiske et al., 2002). In brief, this model argues that universal dimensions of warmth and competence underlie the impressions we form of all individuals and social groups (see 4.5, for a more extended discussion of the SCM). At present, the predictions of the SCM have been replicated in a number of cultural contexts (Cuddy et al., 2009; Fiske et al., 2007). Findings

[9] We acknowledge that this claim is still subject to some debate. Falk and Heine (2015) provide a selective review of cross-cultural studies using relatively reliable and valid tests of implicit self-esteem. On the basis of these studies, the authors argue that Western/individualist participants have generally higher implicit self-esteem than do Eastern/collectivist participants. Nonetheless, Eastern/collectivist samples frequently showed implicit self-esteem that was positive rather than negative, albeit less so than Western/individualist participants. Moreover, the studies that were reviewed frequently relied on paradigms that may be more conducive to self-enhancement in a Western context, such as assessing the value of one's own belongings or personal decisions (see Sedikides et al., 2003, for further discussion of this limitation in the literature).

suggest that the reliance on both warmth and competence dimensions for impression formation is remarkably consistent in all cultures studied so far. Moreover, individuals tend to rate their ingroup as both relatively warm and competent. The only observed cross-cultural difference in the use of these dimensions is that Asian participants tend to rate their own groups as average (rather than high) along both dimensions, consistent with self-presentational demands for modesty in interdependent cultures (Kitayama et al., 1997; Markus et al., 1997).

Because it has been suggested that collectivism is more pertinent to the relational rather than intergroup context (Brewer & Chen, 2007), it is possible that findings from the SCM (which presents an intergroup context) underestimate cultural differences in sensitivity to social dimensions. In a cross-cultural study of perceived relationship quality, Japanese (vs. Canadian) participants more highly esteemed their close associates relative to the self (Endo, Heine, & Lehman, 2000). This tendency was enhanced in Japanese participants who judged the quality of their relationships to be better than the quality of their average peer's relationships, consistent with the notion that individuals in collectivist cultures may maintain positive self-regard by valuing close others and personal qualities that enhance the harmony of one's immediate social context (Sedikides et al., 2003). This possibility would suggest that individuals from collectivist contexts should be particularly attuned to the positive aspects of close (i.e., high-relevance) others. In support of this point, there is some evidence that collectivistic individuals are more sensitive to social distance in their approach/avoidance (Sagiv & Schwartz, 1995) and trust behaviour (C. C. Chen, Peng, & Saparito, 2002; Fukuyama, 1995).

Although the above evidence for cultural differences in sensitivity to relevance and valence relies on self-report measures, there is also some evidence using more subtle measures. In a series of studies examining response to emotional valence in speech (Ishii, Reyes, & Kitayama, 2003; Kitayama & Ishii, 2002), individuals from collectivist contexts were more sensitive to emotional valence (positive vs. negative) than to semantic meaning (positive vs. negative). The reverse was found for individuals from individualist contexts. Taking a within-culture individual-differences approach, Schirmer and colleagues (2008) found that Germans high (vs. low) in social orientation (i.e., interest in interaction with and concern for others) showed greater amygdala and OFC activity in response to emotional versus neutral tones in a series of nonsense syllables. Although high social orientation is not the same as collectivism, the two measures do have some conceptual overlap and tend to correlate (Hofstede, 1980; Varnum, Grossman, Kitayama, & Nisbett, 2010).

4.3.1.3. Present Study

In Experiment 7, we invited Chinese participants to complete the same five-identity perceptual-matching task used in Experiment 6. Although social-tagging paradigms have been used with both Chinese (Sui et al., 2013, 2014) and British (Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012) samples, this is the first attempt at a cross-cultural comparison using a social-tagging paradigm. Based on previous findings, we expected that both groups would show a robust self-tagging effect. We also anticipated that Chinese and European students would show a similar tendency to locate the self at the extreme of the valence and relevance dimensions. This prediction was made on the basis of research suggesting a universal tendency to conceptualise the self as (1) fundamentally distinct from others (del Prado et al., 2007; Gaertner et al., 2008, 2002) and (2) of positive valence (Yun Chen et al., 2014; Ma & Han, 2010; Sedikides et al., 2003; L. Wu et al., 2014). It is less clear, however, whether the two samples would differ in their overall sensitivity to relevance and valence. On the basis of previous work showing that relatively interdependent cultures/individuals are sensitive to social distance (C. C. Chen et al., 2002; Endo et al., 2000; Fukuyama, 1995; Sagiv & Schwartz, 1995) and have a greater sensitivity to emotional verbal tone (Ishii et al., 2003; Kitayama & Ishii, 2002; Schirmer et al., 2008), it is possible that Chinese participants may show a greater sensitivity to valence in others. However, this possibility is based on either self-report or auditory paradigms that are markedly different from the visual-attention paradigm used in the present study. This experiment thus provides an initial exploration of the question of whether cultural groups differ in their sensitivity to the relevance and valence of social targets.

4.3.2. Method

Participants. Forty-two students (20 female; M_{age} = 21.0 years, SD_{age} = 2.28) from Tsinghua University were recruited through the university research participation scheme and received ¥30.00 RMB (approximately £3.00 GBP) compensation for their participation. In accordance with ethical approval, participants received information on the experimental procedure and gave informed consent prior to participating. Following the completion of all tasks and surveys, participants were debriefed and compensated accordingly. Data from all participants were used in the analyses. For cross-cultural analyses, we re-used data from the 46 UK-based students from Experiment 6 (see 4.2.2).

Materials and procedure. Participants viewed the same shape stimuli and followed the same procedure detailed in Experiment 6 of the present chapter (see 4.2.2). To maintain consistency across studies, shape labels were presented in Roman rather than Chinese script.

4.3.3. Results

A 3-standard-deviation guideline was used to exclude outliers from analysis in the perceptual matching task. This was done at the participant level for response time data and at the group level for accuracy rate data. Incorrect responses (China: 19.6% of trials; UK: 19.3% of trials) and correct responses with latencies exceeding 3 standard deviations from the individual's overall mean (China: 0.2% of trials; UK: 0.4% of trials) were trimmed.

Following the structure of Experiment 6, we report three key analyses below: (1) performance for non-self shapes (4.3.3.1), (2) performance for the self shape (4.3.3.2), and (3) individual differences in sensitivity to relevance and valence (4.3.3.3). In each analysis, summarised results for the Chinese sample are reported first (see Appendix 4.3, for full analyses), followed by cross-cultural comparisons. Separate analyses are conducted for RT and accuracy.

4.3.3.1. Performance for Non-Self Shapes

Chinese sample summary. Analysis of Chinese participants' performance for non-self shapes revealed a significant main effect of valence, with generally faster and more accurate responses for positive (e.g., friend, admired figure) relative to negative (e.g., enemy, detested figure). This effect was especially pronounced on match relative to mismatch trials. Neither the effect of relevance nor the Relevance × Valence interaction were reliable. See Appendix 4.3.1, for the full analysis.

Relevant to our interest in cross-cultural differences, this sample appeared to differ from the UK-based participants reported in Experiment 6 (see 4.2.3) in two ways. As noted above, Chinese participants did not show any evidence of prioritisation along the relevance dimension. Additionally, Chinese participants showed an especially large valence effect, with effect sizes (η_p^2) ranging between .37 and .39 for match trials. By comparison, the corresponding effect sizes for UK-based participants were between .08 and .23. The following analyses provide a formal comparison of these apparent cultural differences.

Cross-cultural comparison. RT and accuracy data were analysed via separate 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVAs, with country as the between-subjects factor. Because UK-based participants were overall faster than China-based participants[10], trimmed RTs for all conditions (including mismatch trials) were standardised within subjects (Z_{RT}), following the same procedure used to facilitate comparisons between age groups in the supplementary analysis of match and mismatch trials provided in Experiment 5 (see Appendix 3.4.2). In line with Experiment 6 and previous studies (e.g., Sui et al., 2012), we focus on match trials in the main analysis. Full analyses involving mismatch trials are presented in Appendix 4.4.1

Standardised response time. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Country: UK, China) split-plot ANOVA on match-trial data revealed a main effect of valence, $F(1,86) = 29.1$, $MSE = .101$, $p < .001$, $\eta_p^2 = .258$. Overall, participants showed smaller Z_{RT}s for liked versus disliked identities. However, this effect was significantly modulated by country, $F(1,86) = 10.1$, $MSE = .101$, $p = .002$, $\eta_p^2 = .105$. Within-group contrasts showed a reliable valence effect for the China-based sample, $t(41) = 5.31$, $d = 0.819$, $p < .001$, and a marginal valence effect for UK-based sample, $t(45) = 1.91$, $d = 0.282$, $p = .062$. The effect size in the China-based sample was approximately three times greater than that observed in the UK sample. All other effects were non-significant, $p > .21$.

Accuracy. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Country: UK, China) split-plot ANOVA on match-trial accuracy data revealed a main effect of valence,

[10] In the preliminary ANOVA for RT data, the main effect of country was robust, $F(1,86) = 33.3$, $MSE = 36164$, $p < .001$, $\eta_p^2 = .279$. Overall, UK-based participants ($M_{RT} = 651$, $SE_{RT} = 9.9$) responded more quickly than their China-based counterparts ($M_{RT} = 734$, $SE_{RT} = 10.4$). As reported below, the two groups did not differ in their overall accuracy.

$F(1,86) = 36.9$, $MSE = .014$, $p < .001$, $\eta_p^2 = .301$. Both groups showed greater overall accuracy for positive compared to negative shape targets. A marginal main effect of relevance was observed across both groups, $F(1,86) = 3.44$, $MSE = .013$, $p = .067$, $\eta_p^2 = .038$, with participants showing greater accuracy for high- versus low-relevance shapes. All other effects and interactions were non-significant, $p > .15$.

Results summary. Overall, results confirm that the China-based sample showed a relatively greater preference for positive versus negative social targets. Results failed to show any group differences in the relevance effect. One unexpected finding that arose when including mismatch trials in the analysis was that UK-based participants were overall faster to respond relative to China-based participants (see Appendix 4.4.1). Perhaps more surprising is that this country effect persisted after standardising RTs according to each participant's overall response time mean and standard deviation. One explanation for this latter finding is that the two samples may have differed in their response times for the self shape, which was standardised along with the non-self shapes but was not included in the preceding analyses. If, for example, UK-based participants responded more quickly for the non-self shapes relative to the self, this would lead to smaller Z_{RT} values for non-self shapes and a relatively larger Z_{RT} value for the self shape in that sample. In the following section, we therefore test for group differences in the prioritisation of self versus non-self shapes.

4.3.3.2. Performance for the Self Shape

Chinese sample summary. Overall, results from the China-based sample followed the same pattern observed from UK-based participants in Experiment 6 (4.2.3.2). This group showed robust self-prioritisation in both RT and accuracy data relative to all four non-self shapes. Chinese participants were also faster for match trials compared to mismatch trials. A significant Trial Type × Shape Identity interaction in both the RT and accuracy data confirmed that self-prioritisation was most reliable for match trials. See Appendix 4.3.2 for full details on this analysis. Overall, the general pattern of self-prioritisation for China-based participants was consistent with findings from the UK, replicating previously observed self-tagging effects (Sui et al., 2012, 2013).

Cross-cultural comparison. In this section, we summarise formal cross-cultural comparisons of self-prioritisation in separate analyses for standardised response time and accuracy data. A full report of these analyses, which include mismatch trials, can be found in Appendix 4.4.2.

Analysis appraoch. For Z_{RT} and accuracy data, two separate analyses were conducted. First, an omnibus test examined whether group differences existed for any of the five shape identities, including the self. This was done by computing a 5 (Shape Identity: self, friend, enemy, admired, detested) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor. A second analysis specifically tested for country differences in performance for the self versus non-self shapes (average Z_{RT} for non-self shapes for each trial type). This was done by computing a 2 (Shape Identity: self, non-self) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor. This second analysis was prompted in part by the observation that Chinese participants showed overall larger Z_{RT}s for non-self shapes compared to UK participants (see 4.3.3.1). Given that mean Z_{RT} values should approximate zero in both groups, one possibility is that this main effect may have been due to a correspondingly smaller Z_{RT} for the self shape in the Chinese versus British sample.

Summary of findings. Overall, findings replicate previously observed self-tagging effects in both Western (Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012) and Eastern (Sui et al., 2013, 2014) participants. Participants in both the UK- and China-based samples showed faster and more accurate responses to self-associated shapes compared to shapes associated with others. This tendency was magnified for match relative to mismatch trials.

Cross-cultural effects were observed in the standardised RT data but not in the accuracy data. The observed effects provided some insight into the observation that Chinese participants showed overall larger standardised response times than did UK participants in the analysis of non-self identities (4.3.3.1). Relative to UK participants, Chinese participants slowed down more for disliked identities like the enemy and detested figure and sped up more for the self (on match trials).

4.3.3.3. Cross-Cultural Evidence for Self-Anchoring in Social Space

Following up on findings from Experiment 6 showing that UK participants' sensitivity to relevance and valence predicted the magnitude of self-advantages over others (see 4.2.3.3), we conducted the same analysis for the present China-based sample. This was done to determine whether the self-anchoring pattern along the dimensions of relevance and valence that was observed in Experiment 6 may extend to a different culture, particularly one with different dimensional preferences (e.g., greater preference for valence in China). Data from the China-based participants were analysed following the same procedure detailed in Experiment 6 (see 4.2.3.3). Results revealed the same pattern of findings observed that experiment (see Appendix 4.3.3, for the full analysis). In brief, participants showing greater sensitivity to valence tended to show reduced self-bias for shapes that were similar to the self on that dimension (e.g., friend and admired figure) and enhanced self-bias for shapes that were dissimilar to the self on that dimension (e.g., enemy and detested figure). This same tendency was observed for relevance sensitivity. The pattern for relevance sensitivity tended to be less reliable in the Chinese sample relative to the same pattern for valence sensitivity, with some predicted effects failing to reach statistical significance. However, any such null findings for the RT analysis were reliable in the accuracy analysis and vice versa. Also as in the UK sample, supplemental analyses showed that relevance and valence sensitivity did not affect overall performance for the self shape, which suggests that the self may serve as a fixed extreme (i.e., anchor) along both social dimensions.

In sum, it would appear that sensitivity to relevance and valence dimensions affects attentional bias to the self in a predictable fashion across cultures. Specifically, the extent of the self-tagging effect (but not overall performance for the self) depends on how sensitive participants are to the personal relevance and/or valence of other social entities.

4.3.4. Discussion

The present findings provide initial evidence that the self occupies a unique anchoring position in social perception that is relatively unaffected by putative cultural differences in relevance and/or valence in others (see 4.2.4). The replication of this finding in an Eastern collectivist context provides some compelling support for the argument that the self anchors the social space dimensions of relevance and valence, even in a cultural context thought to be characterised by diminished self-focus (Markus & Kitayama, 1991) and self-enhancement motives (Falk & Heine, 2015; Kitayama et al., 1997).

Notably, a few group differences emerged in the above analyses. First, Chinese participants showed greater sensitivity to valence (i.e., larger valence-effect magnitude) relative to UK participants. This is consistent with previous work suggesting that collectivist groups/individuals are more sensitive to emotional tone in speech (Ishii et al., 2003; Kitayama & Ishii, 2002; Schirmer et al., 2008). Nonetheless, research in this area is limited. Further research is needed to support the present finding that the valence of others is more important in collectivist contexts. For example, self-construal priming (e.g., Sui & Han, 2007) may provide additional evidence in support of this claim.

More unexpectedly, results also revealed that Chinese (vs. UK) participants were faster in responding to the self relative to their average performance for non-self shapes. This finding is puzzling in that researchers are divided on whether collectivist cultures are as likely or less likely to focus on the self. To our knowledge, no one has argued that collectivist cultures are *more* self-focused. Therefore, this finding should be interpreted with caution. One alternative explanation may be related to the normalisation approach applied to the data. Extremely large Z_{RT} values in the data may exaggerate performance for the self, which falls at the other extreme (i.e., as the smallest Z_{RT} value). For the five-identity ANOVA in which a reliable (albeit small) main effect of country was found (see 4.3.3.2), group comparisons of Z_{RT}s for each individual identity showed significant group differences for the enemy (and a non-significant trend for the detested figure) but not the self. In other words, Chinese participants showed relatively large Z_{RT} values for the disliked targets (viz., enemy, but also detested figure). These large values may be indicative of a skew in the overall distribution of RTs that is driven by negative identities rather than the self.

Limitations. The present study raised some concerns that may limit the scope of the present findings. First, we note that, in both countries, the effect of relevance was weak. Indeed, cross-cultural comparisons failed to reveal any reliable relevance effects. In light of a non-significant interaction with country in the cross-cultural analysis and a non-significant trend in the Chinese data, we can only speculate that the design may have been underpowered to detect the effect in the Chinese sample. An a priori power analysis based on Experiment 6's relevance effect size for match trials ($\eta_p^2 = .157$) suggested a sample of 60 would be required to achieve an 80% likelihood of detecting the relevance effect. Thus, the current Chinese (and British) sample may be underpowered to reliably detect this effect.

Finally, similarities between the two samples do not permit a broad generalisation to people in all possible cultural contexts. For example, both the China- and UK-based samples from the present study were recruited from universities that attract typically well-educated middle- to upper-class applicants. As for many other phenomena in social psychology that are studied primarily in university samples (Henrich, Heine, & Norenzayan, 2010), further study is required to determine whether the self's position as an anchor in social space is limited to particular social, cultural, or economic contexts or whether it is a truly universal aspect of social cognition.

Conclusion. In summary, the present study provides some initial evidence of cross-cultural similarities and differences in the context of a social-tagging paradigm. Both China- and UK-based participants showed self-tagging effects of similar magnitudes. Additionally, both groups similarly showed a tendency to anchor the dimensions of relevance and valence on the self, replicating findings from Experiment 6 in an Eastern collectivist context in which self-focus is arguably diminished. Initial evidence was also found in support of greater sensitivity to valence in Chinese participants. Although convergent evidence and replication would be helpful to verify this effect, the possibility that group differences may be explained by appealing to differential weighting of fundamental social-cognitive dimensions represents an intriguing possibility for further research.

4.4. Experiment 8: Neural Coordinates of Self and Others Using fMRI

4.4.1. Introduction

Experiments 6–7 provide evidence that social dimensions such as relevance and valence facilitate performance for non-self identities and that sensitivity to these dimensions predicts the degree of self bias. Given that the self is generally positive and relevant to day-to-day life, one interpretation of the preceding findings is that the self is processed by mechanisms that are similar as those that process non-self others—the self just happens to be the most relevant and most highly valued among all social identities (Gillihan & Farah, 2005; Mattan, Quinn, & Rotshtein, 2015). Alternatively, the self may well draw on a dedicated neural processing network. Consistent with our hypothesis that self and others are situated within the same social space characterised by dimensions such as relevance and valence (Experiments 6–7), the present fMRI study had three broad aims. First, we tested for brain regions that track relevance and valence. Second, we attempted to determine possible overlaps between regions sensitive to relevance/valence and those that are responsive to the self (viz., SAN: Sui & Humphreys, 2015). Finally, we examined whether individual differences in sensitivity to these dimensions would affect neural self-representation, consistent with the behavioural self-anchoring patterns reported in Experiments 6–7 (see Appendices 4.2 and 4.3.3). In the following sections, we consider these hypotheses in the context of key regions of interest.

4.4.1.1. Self-Attention Network (SAN)

On the basis of previous neuroimaging findings using social-tagging paradigms (e.g., Sui et al., 2013; Sui, Liu, et al., 2015), Humphreys and Sui (2015) have proposed the Self-Attention Network (SAN) as a neural network that supports perceptual prioritisation of self-relevance. As discussed in the chapter introduction (4.1.1), the SAN is comprised of three nodes that mediate attention to self-related stimuli. The VMPFC is thought to rapidly respond to self-relevance, feeding forward to the pSTS, resulting in an expectancy bias for future self-related stimuli. This bottom-up network, particularly the VMPFC, is modulated by a fronto-parietal control network (DLPFC and IPS) to allocate attentional resources in accord with task constraints. As many have previously noted (D'Argembeau, 2013; Gillihan & Farah, 2005; Mattan, Quinn, & Rotshtein, 2015; Murray, Schaer, & Debbané, 2012; Uddin, Iacoboni, Lange, & Keenan, 2007), some of the regions in the SAN (e.g., VMPFC) are often active in paradigms examining the neural response to others varying along a particular dimension (A. C. Chen, Welsh, Liberzon, & Taylor, 2010; Cloutier, Ambady, Meagher, & Gabrieli, 2012; Cloutier & Gyurovski, 2013, 2014). Although this suggests the hypothesis that these regions are more dedicated to processing social dimensions on which the self differs from others (e.g., relevance, valence) rather than the self per se, it has not yet been possible to test this hypothesis because imaging and behavioural paradigms either assess responses to the self (vs. one or two others) or to dimensions of social cognition divorced from the self, but not to both[11]. To address this gap in the literature, the present study uses an fMRI-optimised version of the social-tagging task from Experiments 6–7 to determine the extent to which the putative SAN is active for the self and for others approaching the self in their degrees of relevance and valence. If the self is indeed processed by a dedicated attentional network (e.g., Humphreys & Sui, 2015), then the BOLD response for high-relevance and positive individuals should be qualitatively distinct from that observed for the self. On the other hand, if relevance and valence do strongly contribute to the self bias in behaviour and in the brain (e.g., Mattan,

[11] One notable exception to this trend is the growing literature on subjective social status (Cloutier & Gyurovski, 2013, 2014; Fiske, 2010; Ly, Haynes, Barter, Weinberger, & Zink, 2011).

Quinn, & Rotshtein, 2015), then regions showing sensitivity to these dimensions should also be responsive to the self. Finally, based on the self-anchoring effects observed in Experiments 6–7, we expected that participants with greater behavioural sensitivity to the relevance and valence dimensions should show smaller differences in their neural representations of the self and the high-relevance and positive friend shape.

4.4.1.2. Hippocampus

Although not a part of the SAN, we also focused on the hippocampus in the present study. The hippocampus has long been implicated in processes involving learning and forming new memories (L. R. Squire, 1992), playing an especially important role in recollection (Eichenbaum, Yonelinas, & Ranganath, 2007). We expected that hippocampal activity would show a relationship with behavioural performance for recently learned shape identities in the matching task. Notably, the hippocampus has been identified as a region that is more responsive to others than for the self in previous research on social tagging (see Sui et al., 2013). In light of the self's role in facilitating learning and memory (M. A. Conway, 2005; M. A. Conway & Playdell-Pearce, 2000; Markus, 1977; Markus & Wurf, 1987; H. Wang, 2015), this finding suggests that the hippocampus may show greater activity for shape identities that are more difficult to remember (e.g., detested figure vs. self). One additional motivation for examining hippocampal response comes from evidence that the hippocampus maps memory-based physical navigation (Kumaran & Maguire, 2005; Maguire, Frackowiak, & Frith, 1997) and self-centric social relations (Tavares et al., 2015). Tavares and colleagues (2015) found that hippocampal activity increased as a function of an interaction partner's distance from the self (operationalised as differences in power and affiliation). In light of the reviewed findings, we expected greater hippocampal activity in response to identities that are distant from the self on the dimensions of relevance and valence.

4.4.2. Method

Participants. Thirty participants (18 female; M_{age} = 22.0 years, SD_{age} = 3.53) were recruited from the University of Birmingham online participant pool to complete this study for cash or course credit. Data from the first six participants (3 female; M_{age} = 22.7 years, SD_{age} = 3.67) were not usable as the computerised matching task was not fully optimised to fMRI (i.e., stimulus presentation frequency was greater than 0.5 Hz). The final sample of 24 participants completed all tasks. All participants gave informed consent and received a thorough safety screen prior to participating in the imaging portion of the study.

Tasks and pre-scan training. Immediately prior to the scanning session, participants completed a number of tasks to prepare them for the in-scanner tasks. As in Experiments 6–7, participants first completed the social distance task in Microsoft PowerPoint (see 3.2.2 and Appendix 3.1, for details). This was done to introduce the four non-self identities used in the experiment (plus the self). Participants then completed two training tasks, presented in order below. The first task is an fMRI-optimised version of the social-tagging paradigm used in the preceding two chapters. Full details on fMRI optimisation are provided in Appendix 4.5.

As in Experiments 6–7, the training followed a similar incremental display time decrease over 4 to 5 blocks of 12 trials, to a minimum duration of 200 ms[12]. Before completing the second training task, participants completed a brief computerised survey in which they viewed randomly presented two-dimensional configurations of the same five

[12] Note that the minimum duration used in the scanner was 400 ms, but the training minimum of 200 ms was used to ensure participants would perform well with a slightly slower minimum duration.

identity-tagged shapes from the social-tagging paradigm, rating each for the degree to which it represented their relations and the degree to which they liked the configuration using a visual analogue scale (from 1 to 100). The second training task was an fMRI adaptation of the social-distance task. In brief, participants viewed a sequence of configurations (from the preceding computerised survey) and responded by button press only when the present configuration matched the immediately preceding configuration (i.e., 1-back task). Participants completed 117 trials for this training task. Data for the computerised survey and the social distance task are not reported here. However, these task descriptions are provided as data for both the social-tagging and social-distance tasks were collected at intervals during the fMRI portion of this experiment. For both the social-tagging and social-distance tasks, the experimenter ensured that participants felt confident in both tasks before proceeding to the scanner.

fMRI experiment and parameters. The fMRI session consisted of two key tasks. Participants completed three sequences of the social-tagging task (9.25 min: see Appendix 4.5 for further details) and three sequences of the social-distance task (6.07 min). These functional scan sequences were completed in intervals; the first sequence was always the social-tagging task. After all functional scans were complete, we acquired a T1 anatomical image for each participant. Finally, after all scans were acquired, participants completed a short demographic questionnaire outside the scanner. Participants were then thanked, compensated, and debriefed.

We used a Phillips 3T Achieva system to acquire BOLD, T2* contrast-weighted EPIs during the functional scans. We acquired 38 oblique slices, 2 mm thick with a 1-mm gap with an in-plane resolution of 2.5 × 2.5 mm, 80° flip angle, 34.5-ms echo time, and 2,400-ms slice repetition time. Images were acquired in ascending order using an eight-channel phase array coil with a sense factor of 2.05. To minimise susceptibility artefacts, slices were aligned to the AC–PC axis of each participant (Deichmann, Gottfried, Hutton, & Turner, 2003). For each participant, we also acquired a magnetic field map and T1 anatomical image for image unwarping and segmentation, respectively.

Pre-processing and analysis. EPIs from each participant's three scanning sequences were pre-processed and analysed using SPM12 (www.fil.ion.ucl.ac.uk/spm). Images from each participant were unwarped and realigned to the participant's mean EPI to correct for motion and motion-by-distortion interactions (Andersson, Hutton, Ashburner, Turner, & Friston, 2001). Following segmentation into grey-matter and white-matter tissue probability maps (Ashburner & Friston, 2005), realigned and unwarped EPI sequences were normalised to a template optimally fitted to the 24-participant sample via DARTEL normalisation (Ashburner, 2007). For analysis, DARTEL-normalised images were then transformed to the MNI template and smoothed with an 8-mm FWHM kernel (Ashburner & Friston, 1999).

To estimate the BOLD responses for each condition, each trial was considered as an event, and the stimulus time series was convolved separately with the canonical hemodynamic response function (HRF) and its temporal and dispersion derivatives. A GLM modelled each of the three scan sequences separately. In each scan sequence, we modelled the three basis functions (canonical HRF and temporal/dispersion derivatives) for each condition in the 2 (Trial Type: match, mismatch) × 5 (Shape Identity: friend, enemy, admired, detested, self) design. For each condition, we also modelled non-redundant parametric modulators for trial-level RT and accuracy data. Finally, for each scan sequence, we modelled the six movement parameters, a sequence-specific constant, and a set of harmonic regressors (built into SPM12) capturing slow fluctuation of the signal (effectively serving as a high-pass filter of 1/128Hz). Individual beta images reflecting the unmodulated HRF for each of the five shapes (match trials only) in each session were subsequently averaged across session (yielding 5 images per participant) and submitted to second-level analysis.

Two second-level analyses were conducted. First, group-level responses to relevance, valence, and the self were analysed in SPM12 using a one-way within-subjects ANOVA design with five levels (friend, enemy, admired, detested, self). Second, an individual differences analysis examined the extent to which behavioural sensitivity to relevance and valence predicted greater neural activity for the self (e.g., relative to the friend). For this analysis, we computed Self > Friend, Self > Enemy, Self > Admired, and Self > Detested contrasts for each participant at the first level. We then analysed each set of contrast images (e.g., Self > Friend) separately in SPM12 at the second level using an ANCOVA design, entering each participant's normalised relevance sensitivity and valence sensitivity scores as covariates. These sensitivity scores were computed from the behavioural data, following the formulas from Experiment 6 (see Appendix 4.2.1). However, in this case, we normalised efficiency (i.e., RT divided by accuracy) mean scores for each condition. This was done in order to combine both RT and accuracy data into a single individual differences analysis[13].

4.4.3. Results

4.4.3.1. Summary of Behavioural Results

Results from the behavioural data replicated previous findings in a UK sample (see Experiment 6). Full statistics for the analysis of RT and accuracy data are provided in Appendix 4.6. Overall, participants were faster and more accurate for match compared to mismatch trials. For non-self shapes, participants showed significant facilitation for both

[13] We note that efficiency scores would not have been justified in Experiments 7–8 due to very low accuracy in some conditions (Bruyer & Brysbaert, 2011). However, in the present study, all 24 participants scored greater than 87% correct in any given condition, with group-level means for all five conditions exceeding 95%.

relevance (RT data only) and valence (RT and accuracy data). Participants were also faster and more accurate for the self compared to all other identities. All of the above effects were modulated by response, with more reliable effects for match versus mismatch trials, consistent with previous research (Sui et al., 2012, 2013; see also Experiments 6–7).

4.4.3.2. fMRI Group-Level Analysis

In the first fMRI analysis, we report on neural activity in response to relevance, valence, and the self at the group level. We focused on clusters in which at least 100 contiguous voxels surpassed a height threshold of $T(1,92) > 1.99$ (i.e., $p < .025$, uncorrected). The expected cluster size by chance (k) was 32 voxels. Results for the group-level analysis are summarised in Table 4.2.

Neural sensitivity to relevance and valence. Results showed sensitivity to relevance and valence in fronto-parietal regions. Low-relevance (vs. high-relevance) identities elicited larger responses in the left MFG and right angular gyrus (part of the IPL). No suprathreshold clusters were observed for the opposite contrast. Positive (vs. negative) identities elicited larger responses in the right SMG (part of the IPL) and bilateral SFG. No suprathreshold clusters were observed for the reverse comparison. These main effects contrasts are illustrated in Figure 4.7. Based on Figure 4.7C, it is worth noting that regions showing overall sensitivity to relevance and valence were relatively unresponsive to the self.

Table 4.2

Group-Level Contrasts for Relevance and Valence, Experiment 8

Contrast	Area	Cluster Extent	Peak $T(1,92)$	MNI Coordinates		
Relevance: High > Low	None Above Threshold					
Relevance: Low > High	L MFG	169	3.46	-42	30	42
	R Angular Gyrus	102	2.90	42	-63	42
Valence: Pos > Neg	R SMG	156	3.76	48	-33	42
	Bilateral SFG	715**	3.57	-12	12	45
Valence: Neg > Pos	None Above Threshold					
Friend – Enemy > Admired – Detested	L Precentral/MFG	260	3.49	-42	-6	57
	R IFG/MFG	408†	3.48	42	39	12
	R Temporal Pole	102	2.85	39	12	-21
Admired – Detested > Friend – Enemy	L Hippocampus	641**	4.17	-33	-66	3
	L Anterior Insula/Putamen	135	3.77	-33	27	12
	R Hippocampus	324	3.74	36	-54	3
	R Caudate/Thalamus	229	3.25	15	15	3

† Family-wise error-corrected $p = .06$, ** Family-wise error-corrected $p < .01$
MFG = Middle Frontal Gyrus, SMG = Supramarginal Gyrus, SFG = Superior Frontal Gyrus, IFG = Inferior Frontal Gyrus

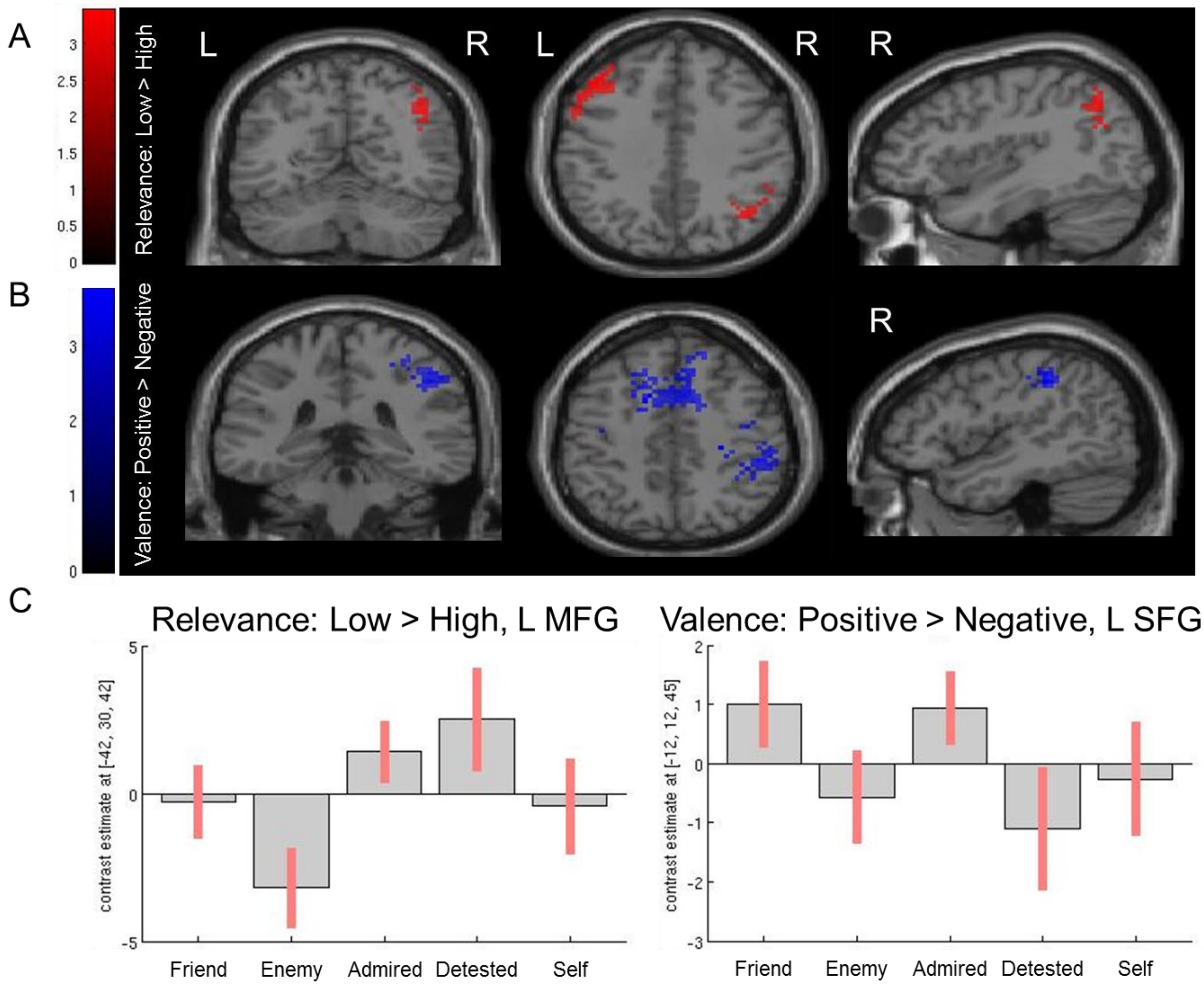


Figure 4.7. Brain regions showing overall response to low versus high relevance (left MFG and right angular gyrus) and to positive versus negative valence (right SMG and bilateral SFG) are depicted in Panels A and B, respectively. Peak voxel activity for the most reliable cluster in each contrast is depicted in Panel C. Contrast estimates for the self are provided for comparison.

Two contrasts were computed to determine regions sensitive to the interaction of relevance and valence. A stronger response to positive valence for high-relevance identities (i.e., Friend – Enemy > Admired – Detested) was observed in the left precentral/middle frontal gyri, the right IFG and MFG, and the right temporal pole. A stronger response to positive valence for low-relevance identities (i.e., Admired – Detested > Friend – Enemy) was observed in the bilateral hippocampus (extending to the left insular cortex). Additional clusters were found in the left anterior insula/putamen and the right caudate/thalamus.

Interactions are illustrated in Figure 4.8. Again, it is worth noting from Figure 4.8C that these regions did not tend to show sensitivity to the self.

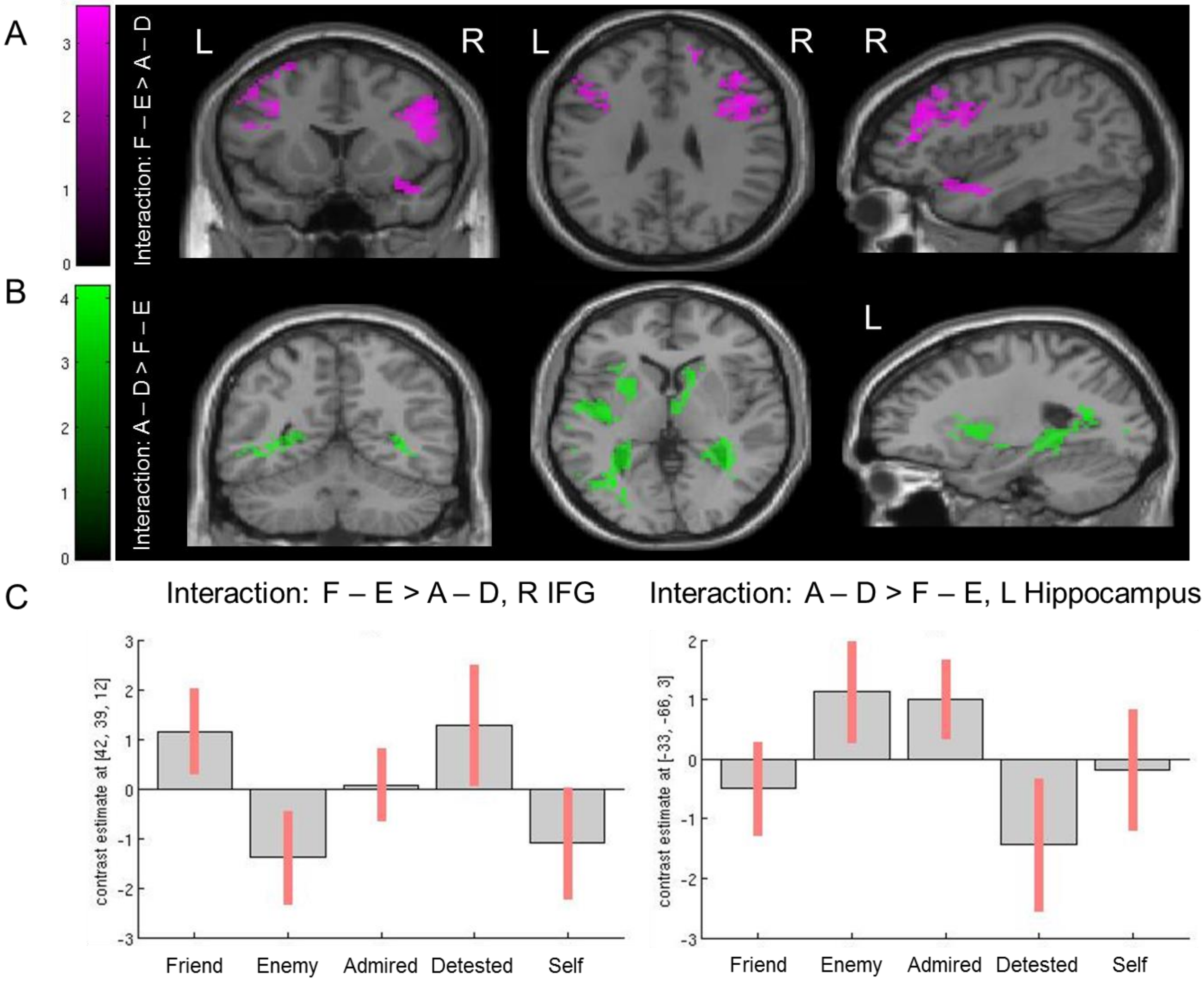


Figure 4.8. Brain regions showing overall greater sensitivity to friends and detested figures are depicted in Panel A. Regions responsive to mixed identities (i.e., enemy and admired figure) are depicted in Panel B. Peak voxel activity for the most reliable cluster is presented in Panel C. Contrast estimates for the self are provided for comparison. F = Friend, E = Enemy, A = Admired, D = Detested.

Neural sensitivity to self versus others. No suprathreshold increases were observed for the self relative to any of the four non-self identities or for the self relative to the average non-self response. The lack of enhanced responses to the self versus others was unexpected. Using a similar task, Sui and colleagues (2013) reported increased responses to the self versus a stranger in the left pSTS and VMPFC. Although the current study does not have a stranger, we nevertheless tested whether these regions showed at least numerically preferential response to the self. We thus used the coordinates provided by Sui and colleagues (2013) to compute the contrast Self > (Friend + Enemy + Admired + Detested)/4. For the left pSTS (MNI: -58,-62,14), the largest response was for the self, with the non-self identities clustering around zero, $T(1,92) = 0.97$, *ns*. For the VMPFC (MNI: -6,54,4), the largest response was for the friend, with the self and other non-self identities clustering around zero, $T(1,92) = -0.18$, *ns*. Contrasts for areas more sensitive to others compared to the self revealed suprathreshold activity in the bilateral IPL, but only for the Admired > Self contrast: left IPL (MNI: -33,-51,42), peak $T(1,92) = 3.10$, $p_{uncorrected} = .001$; right IPL (MNI: 48,-36,36), peak $T(1,92) = 3.00$, $p_{uncorrected} = .002$. Neither cluster survived family-wise error correction. We note that these same regions were also observed in the other Non-Self > Self contrasts, albeit at lower thresholds. This is consistent with previous findings from Sui and colleagues (2013), who reported bilateral inferior parietal activity in their Stranger > Self contrast.

4.4.3.3. fMRI Individual Differences Analysis

In this second analysis, we report on regions that predict greater neural activity for the self versus others as a function of individual differences in behavioural sensitivity to relevance and valence. Because applying the same voxel-level threshold from the preceding analysis yielded clusters of over 1000 voxels, we increased the height threshold to a more conservative level: $T > 2.83$ ($p < .005$, uncorrected). The extent threshold was maintained from the preceding analysis at 100 voxels. This marked increase in reliability suggests that individuals varied substantially in how they approached the task at the neurocognitive level. Results for this individual differences analysis are reported in Table 4.3.

Table 4.3

Interactions between Valence Sensitivity and Self–Other Bias, Experiment 8

Contrast	Correlation Direction	Area	Cluster Extent	Peak $T(1,21)$	MNI Coordinates		
Self > Friend	Positive	R SFG	136*	5.51	27	18	27
		L IFG	148*	5.30	-57	30	15
		L IPL/POS	141*	4.21	-24	-42	33
		VMPFC	234**	3.79	3	48	12
	Negative	No Results					
Self > Admired	Positive	L IPL/POS	187**	4.50	-45	-45	45
	Negative	No Results					

Note. Relevance sensitivity was also included as a covariate, but yielded no effects.

* Family-wise error-corrected $p < .05$

** Family-wise error-corrected $p < .01$

Because the friend is most similar to the self in terms of relevance and valence, we first chose to examine the extent to which individual differences in sensitivity to relevance and valence predicted neural differentiation of self and the friend. We reasoned that this contrast would provide a strong test between two competing hypotheses. On the one hand, if greater relevance/valence sensitivity were to reduce the self–friend difference, this would provide support at the neural level for the self-anchoring hypothesis offered in Experiments 6–7. On the other hand, if greater relevance/valence sensitivity were to *increase* the difference between self and friend, this would provide some evidence against the self-anchoring hypothesis (at least at the neural level). Such a finding would also support the notion that the self is differentiated from close others, even in participants who are most likely to treat self and other similarly at the behavioural level. For completeness, separate analyses were also conducted to determine whether relevance and valence sensitivity predict performance for the self relative to the enemy, admired figure, and detested figure.

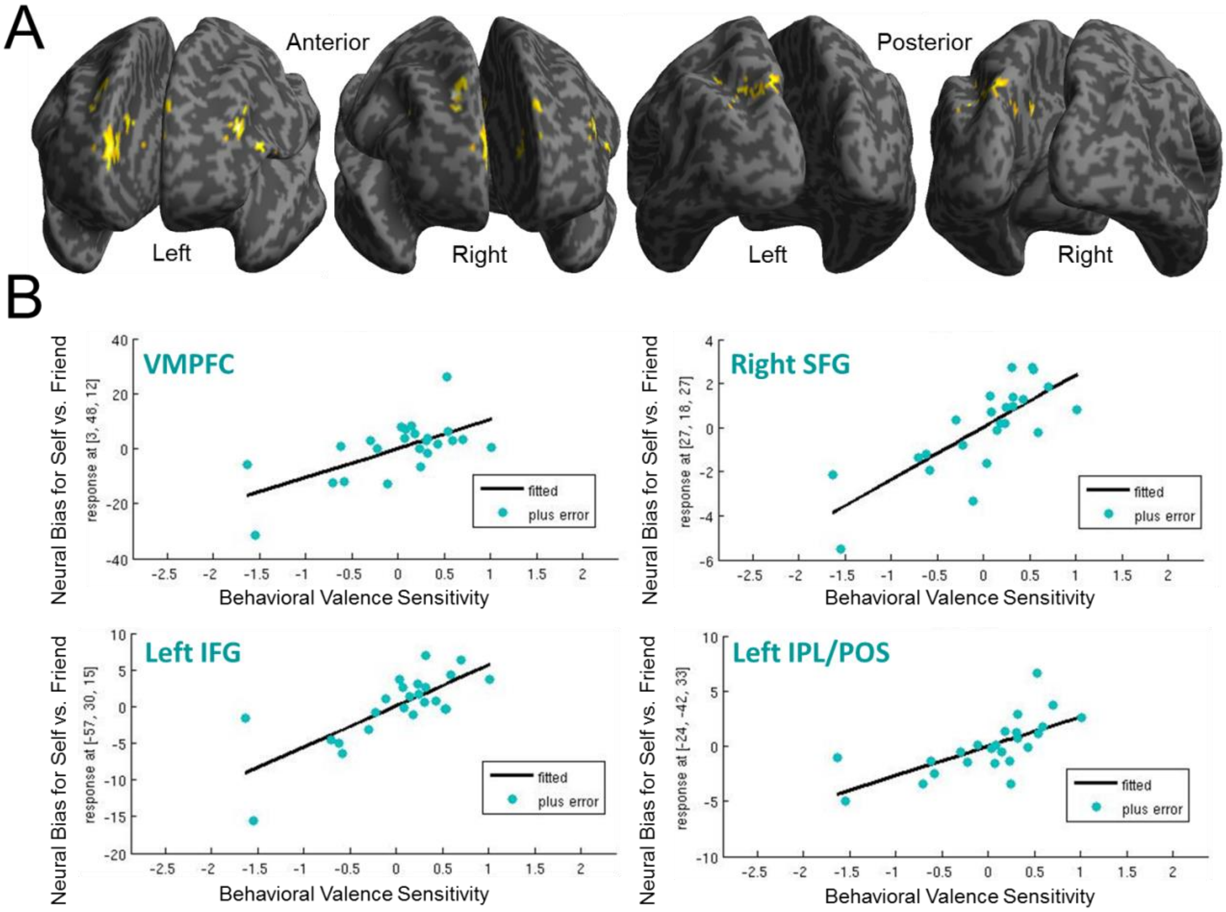


Figure 4.9. Inflated brain illustrations of correlations between behavioural valence sensitivity and neural differentiation of the self compared to the friend shape (Panel A). In all four regions (VMPFC, right SFG, left IFG, and left IPL/POS, behavioural valence sensitivity increased neural response bias for the self relative to the friend. Note that all clusters survived family-wise error correction, $p < .05$.

The only significant predictor for neural differentiation of self versus friend was behavioural valence sensitivity. Valence sensitivity correlated positively with activity in four regions: right SFG, left IFG, left IPL (extending to the parieto-occipital sulcus: POS), and VMPFC. In other words, as behavioural valence sensitivity increased, these regions increased their response for the self relative to the friend. See Figure 4.9 for an illustration of this effect. The left IPL (extending to the POS) also showed this correlation between behavioural valence sensitivity and the extent to which the self was differentiated from the admired shape at the neural level. No additional suprathreshold relationships were observed between behavioural relevance/valence sensitivity indices and neural differentiation of the self versus other identities.

4.4.4. Discussion

In the present study, we aimed to determine whether there is any overlap in brain regions that process relevance and valence when perceiving others and those that process the self, particularly in the SAN and the hippocampus. Based on the prediction that the self is processed in the brain as an anchor for relevance and valence, we expected to observe activity for the self (vs. others) in the same or similar regions that are also sensitive to these social dimensions. Consistent with this prediction, we found relevance- and valence-sensitive regions in the right inferior parietal region, proposed to be a dorsal aspect of the SAN. Across participants, we observed increased responses to non-self shapes relative to the self shape in bilateral IPL, replicating findings from Sui and colleagues (2013). In contrast to the aforementioned study, the response to the self relative to others in the SAN was unexpectedly weak. Follow-up tests revealed some prioritisation of the self in the left pSTS, albeit at low reliability. In contrast, the VMPFC showed greater overall response to the friend rather than to the self, again at low reliability. The absence of regions sensitive to the self versus others may be due to differences between the five-identity paradigm used in this study and the three-identity version used by Sui and colleagues (see 4.4.4.1, for further discussion).

Nonetheless, we did observe that neural responses to the self (vs. friend and admired figure) were modulated by behavioural valence sensitivity. Specifically, VMPFC, right SFG, left IFG, and left IPL/POS showed increased neural preference for the self as a function of increased behavioural valence sensitivity. This neural effect contrasted with previous reports of self-anchoring (see 4.2.3.3 and Appendix 4.3.3) whereby increasing valence sensitivity was associated with *diminished* behavioural differentiation of the self from close others. Taken together, these results suggests neural self-representation is unique from the representation of close others, even in participants who show similar behavioural responses to self and close others. We conclude with a call for further research into how the neural processing of social dimensions is related to self-representation.

In the following sections, we discuss group-level effects of self, relevance, and valence, followed by a discussion of the neural Relevance × Valence interaction. Finally, we discuss the effects of behavioural valence sensitivity on neural self-prioritisation. In this discussion, we focus on clusters in the SAN as well as any clusters reaching a FWE-corrected threshold of $p < .05$.

4.4.4.1. Main Effects

Somewhat unexpectedly, we did not observe reliable neural differentiation of the self at the group level. This contrasts with previous neuroimaging work showing relatively robust neural differentiation of the self in the SAN (Sui et al., 2013; Sui, Liu, et al., 2015; see Humphreys & Sui, 2015, for a review). One possible explanation for the present weak self-effects may be due to the social context of the present five-identity perceptual-matching paradigm. In paradigms presenting three identities varying along a single orthogonal dimension (e.g., Sui et al., 2013), the self is indeed likely to be salient. However, by increasing the number of non-self identities (and orthogonal social dimensions), it is possible that the self's salience relative to others is reduced. At present, this possibility remains speculative, but future work systematically varying the number of non-self identities within participants may help to better understand the extent to which neural and behavioural self-prioritisation effects depend on the broader social context.

Although neural preference for the self was weak, contrasts did identify regions more sensitive to others (versus the self) in the fronto-parietal network, most reliably in the bilateral IPL. This same region has been implicated in visual attention (Behrmann, Geng, & Shomstein, 2004; Calder et al., 2007). As in previous work (see Sui et al., 2013), one interpretation is that involvement of the fronto-parietal network in processing others (vs. the self) reflects greater recruitment of attentional resources when processing others who may be more difficult to remember and/or less anticipated than the self shape. However, contrary to this interpretation, we observed an overlapping region in the right IPL (viz., SMG) that was more responsive to valence, in this case showing greater activity for putatively easier positive identities[14]. Thus, the IPL (specifically, the SMG) may be involved in the attentional prioritisation of those we like, but not necessarily the self. A second cluster that showed enhanced response to positive identities was observed in the bilateral SFG, including the frontal eye field. The neural sensitivity to positive valence in the SFG is consist with previous reports associating this region with positive emotional states such as laughter (Fried, Wilson, MacDonald, & Behnke, 1998) and romantic relationship satisfaction (Xu et al., 2011). The frontal eye field is typically implicated with allocation of attention (see R. F. Squire, Noudoost, Schafer, & Moore, 2013, for a review). Based on activity in these fronto-parietal regions (i.e., SMG/SFG), it appears that participants may have directed more top-down attentional resources to shapes with positive associations. We speculate that this attentional prioritisation may have been accompanied by a spontaneous recollection of the self's relationship to that person (mediated by the SFG). However, the precise relationship between these regions in response to well-liked individuals remains to be explored.

[14] Inclusively masking the Admired > Self contrast with the Positive > Negative contrast (mask threshold of $p < .05$, uncorrected; height threshold of $p < .025$, uncorrected) yielded a 42-voxel cluster (MNI: -51,-33,51), peak $T(1,92) = 2.69$, $p_{uncorrected} = .004$.

The High-Relevance > Low-Relevance contrast did not reveal any suprathreshold clusters. However, the Low-Relevance > High-Relevance contrast did reveal two clusters in the fronto-parietal attentional network, one in the left MFG (i.e., DLPFC) and another in the right angular gyrus. These clusters did not survive family-wise error correction. It is nonetheless worth noting that these clusters were adjacent to the fronto-parietal locations identified in the Positive > Negative contrast. Taken together, these results suggest that processing of low-relevance (vs. high-relevance) stimuli may have been more taxing on attentional processes, ultimately eliciting greater involvement of fronto-parietal regions.

4.4.4.2. Relevance × Valence Interaction

Two separate sets of regions were sensitive to the Relevance × Valence interaction. Regions showing greater differentiation of valence for high-relevance compared to low-relevance identities (Friend – Enemy > Admired – Detested) included the bilateral MFG (extending to the precentral gyrus on the left and the IFG on the right) and the right temporal pole. Only the right IFG/MFG cluster approached significance after family-wise error correction, and so we focus our interpretation on this region. As mentioned previously, the MFG (i.e., DLPFC) is one top-down aspect of the SAN (Humphreys & Sui, 2015), suggesting that participants preferentially allocated attention to positive (vs. negative) high-relevance identities and to negative (vs. positive) low-relevance identities. However, the presence of the right IFG (with local peaks in the *pars opercularis*, Brodmann's Area 44 and *pars triangularis*, Brodmann's Area 45) suggests an alternative interpretation. These regions have both been implicated in the cognitive control of decision-related processes (Levy & Wagner, 2011), particularly in paradigms in which participants must choose between two viable responses of similar frequency (e.g., match or mismatch: note that participants were not told that match trials were more frequent). It is not clear why identities closest (friend) and most distant (detested) from the self would have elicited greater attentional control during response selection. One possibility is that these identities were heuristically biased toward match and mismatch responses, respectively (see Race, Shanker, & Wagner, 2009, for a discussion of response bias on IFG activity). If so, participants may have regularly recruited this region to correct for this tendency, especially in the case of the detested figure on match trials (see Figure 4.8C). In support of this possibility, we observed crossover Trial Type × Valence interactions in the behavioural data, suggesting the potential for a positive-match/negative-mismatch response bias, although this was not modulated by relevance.

Turning now to the inverse interaction contrast (Admired – Detested > Friend – Enemy), we found significant activity in limbic/subcortical regions. Of particular interest, the tendency to show greater responses to positive (vs. negative) low-relevance identities compared to positive (vs. negative) high-relevance identities was found bilaterally in the hippocampus, with the left hippocampus surviving family-wise error correction. Given the hippocampus's role in the recall of spatial relations (Kumaran & Maguire, 2005; Maguire et al., 1997) and the episodic tracking of the self's relationship with others along dimensions of power and affiliation (Tavares et al., 2015), it is noteworthy that identities who were mixed with respect to valence and relevance (i.e., enemy and admired figure) recruited this region more than identities rating high or low on both dimensions (i.e., friend and detested figures). One possibility is that these identities are somehow more difficult to localise in social maps, presumably due to the conflicting influences from the relevance and valence dimensions. On the assumption that such social maps are self-centric (see Tavares et al., 2015), it seems plausible that participants may have found it comparatively easier to socially localise the friend and detested figures relative to enemy and admired figures. The present results are the first to specifically examine the role of dimensional conflict on the hippocampal representation of non-self identities.

Finally, we note that hippocampal parameter estimates for the self tended to be moderate, unlike the non-self identities which generally trended toward the positive or negative extreme (see Figures 4.7C and 4.8C). This is consistent with previous social tagging research showing that the hippocampus tends to be more responsive to others than to the self (Sui et al., 2013). This same pattern was also observed in other regions from the group-level analysis, suggesting that the self is not processed merely as an extremely positive/relevant social entity. If this were true, we would expect the self to trend with the friend, albeit showing a perhaps more exaggerated effect. Instead it appears that the neural response to others may be largely independent of self-perception in the regions highlighted in the group-level analysis of relevance and valence effects. In the final analysis presented below, we specifically tested whether responses to the self (vs. others) show any correlation with relevance and valence sensitivity at the level of individual differences.

4.4.4.3. Valence Sensitivity and Neural Self Bias.

In this final analysis, we found that participants with larger behavioural valence sensitivity effects showed the greatest neural sensitivity to the self in the VMPFC, IFG, SFG, and IPL/POS. In the same participants who responded more efficiently to liked (vs. disliked) shapes, we observed *enhanced* neural response to the self relative to the friend. Notably, this pattern was observed in the VMPFC, which unexpectedly failed to show an overall preference for the self across participants. Response to the self versus the admired figure showed a similar pattern, but only in the IPL/POS. Behavioural valence sensitivity did not predict neural self-differentiation relative to either of the negative identities. Taken together, these findings argue against an account of self-anchoring of the valence dimension at the neural level, which would predict the opposite effect (i.e., *reduced* neural response to the self relative to the friend as a function of valence sensitivity). For this reason, the present findings are counterintuitive. Participants who show the greatest behavioural sensitivity to valence are also most likely to show the smallest behavioural difference between self and other positive identities (e.g., friend and admired figure: cf. 4.2.3.3 and Appendix 4.3.3). Yet, at the neural level, these same participants show the greatest degree of neural differentiation between the self and other positive identities.

One possible interpretation of these findings is that, at the representational level, participants who are behaviourally sensitive to valence may have to expend more resources at the neural level to differentiate the putatively unique (Brewer, 1991; Leonardelli, Pickett, & Brewer, 2010) and positive (Ma & Han, 2010) self-concept from non-self competitors. Such an interpretation is consistent with activity observed in the VMPFC, a region that has been implicated both in explicit self-reflection (D'Argembeau et al., 2007, 2008; Flagan & Beer, 2013; Heatherton et al., 2006; Kelley et al., 2002; Kim & Johnson, 2012b; Mitchell et al., 2005; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006; Murray et al., 2012; Northoff & Bermpohl, 2004; Northoff et al., 2006; Ochsner et al., 2005; Philippi, Duff, Denburg, Tranel, & Rudrauf, 2012) and in the assessment of people highly related to the self (Flagan & Beer, 2013; Kim & Johnson, 2014; Krienen, Tu, & Buckner, 2010; Mitchell et al., 2006; Ochsner et al., 2005; Zhu et al., 2007). Relevant to the present findings, Sugiura and colleagues (2012) manipulated social context (operationalised as the number of unique faces presented in a block) and examined responses to faces for the self, a friend, and a control. Results revealed that high (vs. low) social context increased the neural response to the self face in the VMPFC as well as an occipito-parietal region (near the IPL/POS). The parallel between these studies suggests a possible link between behavioural valence sensitivity and greater salience of the social context, with a concomitant increase in neural differentiation of the self from close associates.

Another self-related region observed in this analysis was the right SFG. In the present study's group-level analysis, this same region was more active for positive compared to negative identities, but not for the self. Although this region has been linked to positive emotional states (Fried et al., 1998; Xu et al., 2011) and attention (R. F. Squire et al., 2013), the SFG has also been implicated in introspective self-awareness, particularly when this is contrasted with engagement in a challenging sensorimotor task (Goldberg, Harel, & Malach, 2006). One interpretation is that highly valence-sensitive participants are even more self-aware when viewing the self shape, consistent with their presumed propensity for distinguishing the self from other positive individuals in the paradigm (see above discussion of VMPFC response).

Beyond the VMPFC and SFG, another region showing reliably greater response to the self relative to the friend as a function of behavioural valence sensitivity was the left IFG (*pars triangularis*, Brodmann's Area 45). An extensive neuroimaging (fMRI and PET) literature suggests that this region is implicated in the cognitive control of memory (Badre & Wagner, 2007), particularly at the post-retrieval decision stage where the perceiver must select between conflicting options (Race et al., 2009; Thompson-Schill, D'Esposito, Aguirre, & Farah, 1997) or select against an especially prepotent response (D'Esposito, Postle, Jonides, & Smith, 1999; Jonides et al., 2000; Thompson-Schill et al., 2002)[15]. As noted

[15] It is worth noting that the right IFG has also been implicated in cognitive control. However, it seems that the left region is most frequent in studies that use verbal (vs. non-verbal) stimuli (see Levy & Wagner, 2011). Thus, the present left-laterality indirectly supports the possibility that young-adult participants are particularly attuned to the label rather than the shape in this paradigm (see Appendix 3.4.2 for corresponding behavioural evidence).

above, the analysis of behavioural data suggested a prepotent "match" response for positive non-self identities (see the Trial Type × Valence crossover interaction in Appendix 4.6.1). This same pattern was not clearly observed for the self, which was always prioritised relative to others, even if not reliably so. On the basis of this apparent prepotent response for positive shapes, we speculate that the left IFG may have been less active on friend-match trials as highly valence-sensitive participants followed the prepotent "match" response. In other words, participants with high behavioural valence sensitivity may have adopted a relatively more liberal response threshold for positive non-self others than for the self. Although the present behavioural data do not speak to this possibility, the use of trial-level decisional analysis such as drift diffusion models (R. Ratcliff & McKoon, 2008; R. Ratcliff, 1978) or an analysis of the neural response to mismatch trials may provide a means of exploring this possibility in future work.

A final region showing greater responses to the self relative to the friend as a function of valence sensitivity was the IPL, extending to the POS. Spanning white matter near the precuneus to dorsomedial extrastriate cortex (V6), the relationship of this cluster to the prioritisation of the self relative to the friend is unclear. In previous research, the V6 has shown sensitivity to motion patterns that are intelligible (vs. unintelligible) from the participant's own reference frame (i.e., "egomotion compatible": Cardin & Smith, 2010). This same region is connected via the dorsal visual stream to the adjacent parietal lobe and arm-related regions of the premotor cortex, suggesting it may be involved in the coordination of motor responses (Galletti, Kutz, Gamberini, Breveglieri, & Fattori, 2003; Pitzalis, Fattori, & Galletti, 2012). Therefore, it is possible that the present POS region aided in the facilitation of rapid button presses to the matched self shape in participants who were highly valence-sensitive. It is not clear why such participants would show more activity in this region compared to participants who are less valence-sensitive, as valence sensitivity has not been observed to speed overall responses to the self. To the contrary, differences in RTs for the self versus the friend are relatively *smaller* in highly valence-sensitive participants (see Appendices 4.2 and 4.3.3 for evidence from Experiments 6 and 7, respectively). Given that the role of the V6 in human static visual cognition is largely unexplored, we are reluctant to speculate further on the role of this region in the present findings.

Finally, we note that a similar pattern of increased self-differentiation as a function of valence sensitivity was observed for the Self > Admired contrast. This pattern was found to be reliable only in the left IPL. Notably, this same region showed the generally *greater* activity for the admired figure relative to the self in the group-level analysis, suggesting that behavioural valence sensitivity may diminish an otherwise large response in the left IPL to admired but personally unknown others. However, given the role of the IPL in visual attention (Behrmann et al., 2004; Calder et al., 2007), one would expect enhanced behavioural valence sensitivity to result in *enhanced* (rather than diminished) IPL activity for the admired figure relative to the friend. It therefore seems more likely that this apparent decrease in IPL activity for the admired figure is due to an increase in activity for the self rather than a decrease for the admired figure. Such a response pattern would be consistent with the notion that highly valence-sensitive individuals may nonetheless meaningfully distinguish between the self and close competitors at the neural level.

4.4.4.4. Summary of Key Findings and Conclusions

The present fMRI study represents an initial investigation into the neural correlates involved in the representation of self and others varying along two orthogonal dimensions hypothesised to foster the perceptual prioritisation of socially tagged shapes (i.e., relevance and valence). Specifically, we aimed to determine whether these dimensions were prioritised in the same brain regions previously observed to respond preferentially to the self. We also assessed the representation of these dimensions in the hippocampus, which is thought to support an awareness of the self's relationship to others (Tavares et al., 2015). Finally, we examined what, if any, regions showed a relationship between sensitivity to relevance and valence and self-prioritisation.

Overall, we found that areas implicated in top-down attention to the self (see Humphreys & Sui, 2015) showed some sensitivity to the relevance and valence, most notably the MFG (i.e., DLPFC) and, to a lesser extent, the inferior parietal lobe. However, the ventral aspects of the SAN (VMPFC and pSTS) did not show sensitivity to relevance or valence. Surprisingly, the SAN did not reliably respond to the self shape in the present paradigm. One possible explanation for this may be a relative reduction in the self's salience in social contexts that may be structured along multiple orthogonal social dimensions such as personal relevance and valence. This possibility remains to be systematically explored.

Another critical observation from the present study is that the bilateral hippocampus was especially sensitive to the interaction between relevance and valence. Generally, results showed larger hippocampal response magnitudes for identities with mixed levels of valence and relevance (e.g., the enemy, which was negative but highly relevant) compared to identities that were comparatively consistent (e.g., the friend, which was highly positive and relevant). On the basis of the hippocampus's role in tracking the social distance from the self to others (Tavares et al., 2015), we argue that mixed identities like the enemy and admired figure may have been more ambiguous in terms of their distance from the self, resulting in greater recruitment of the hippocampus. The opposite interaction contrast revealed a marginally significant cluster in frontal control regions (i.e., right MFG and IFG). It is unclear why these regions may respond more to the friend and detested figures. On the basis of previous literature and Trial Type × Valence crossover interactions in the behavioural data, we speculate that this may be linked to a chronic correction against prepotent "match" and "mismatch" decision biases for these identities, respectively. In the future, a more in-depth analysis of mismatch trials or the use of decision modelling approaches may provide on promising means of examining this issue.

Finally, we found evidence that highly valence-sensitive participants showed *increased* rather than *decreased* neural differentiation of the self relative to the friend and admired figure. This pattern was observed within a self-representational network comprised of the VMPFC and SFG as well as regions related to decisional control (left IFG) and action execution (POS). We argue that this pattern of results suggests that, at the representational level, highly valence-sensitive participants may be especially likely to distinguish the self from otherwise close competitors. Although this pattern is not predicted by the hypothesis that the self is represented as a superlatively relevant and positive entity (D'Argembeau, 2013; Gillihan & Farah, 2005; Mattan, Quinn, & Rotshtein, 2015; Murray et al., 2012), it is consistent with the dominant view that the self is uniquely represented in the brain (e.g., Heatherton et al., 2006; Humphreys & Sui, 2015; Kelley et al., 2002; Sui et al., 2013). Further (indirect) support for this latter view was also found in the general observation that the neural response to the self did not tend to track with neural response to the friend. In regions showing effects of relevance and/or valence, neural responses for the self tended to fall near the average neural response for non-self shapes.

Taken together, the present findings suggest that the prioritisation of self and others may rely on common top-down attentional regions (viz., DLPFC and inferior parietal regions). However, the neural representation of the self is qualitatively distinct from those approaching the self along a given social dimension, such as valence. Such a distinct neural representation is not necessarily incompatible with the idea that performance for others is anchored on the relationship of others to the self. Indeed, a qualitatively distinct representation may be an essential aspect of a putative processing anchor (see Epley et al., 2004; Legrand & Ruby, 2009; Sass & Parnas, 2003, for variations on this theme). One open question for future research will be to more clearly determine the degree to which self-specific regions such as the VMPFC may be related to the prioritisation of others varying along a common social dimension, such as valence. We are hopeful that the present method of examining the self in within a multiple-dimensional social context will open new horizons in the way we understand both the self and others.

4.5. General Discussion

4.5.1. Chapter Summary

The three experiments presented in this chapter represent the first series of experiments examining perception and attention to the self and others along common social-cognitive dimensions. Overall, we found that perceivers tend to prioritise positive and (to a lesser extent) personally relevant identities, suggesting these dimensions indeed contribute to perceptual prioritisation. We argue that these dimensions are likely confounded in self-processing, potentially contributing to previously observed self-prioritisation effects. Nonetheless, we do find evidence that self-prioritisation is more than the sum of the self's relevance and valence. Initial evidence for this was found in the analyses of behavioural relevance- and valence-sensitivity reported in Experiments 6–7. Participants who generally prioritised valence in others did not show enhanced prioritisation of the self. To the contrary, relative self-prioritisation bias decreased in these participants. This suggests that the self is more than a superlatively relevant and positive entity, but rather a possible anchor for the processing of others varying along these dimensions. Additional evidence for the self's distinctiveness from socially proximal others was found in the fMRI experiment reported in Experiment 8. Here, we found that participants with the greater behavioural sensitivity to valence also showed the largest neural differentiation of the self in prototypical "self" regions such as the VMPFC and SFG, but also in attentional control and perceptual regions such as the IFG, IPL, and parieto-occipital region. Because this tendency was only observed in comparisons of the self with proximal others along the valence dimension, we speculate that the above regions may support differentiating the self-concept from others, independent of potential confounds of the self such as relevance and valence.

4.5.2. Implications for the Self and Social Cognition Literatures

Current thinking on the self (e.g., "self-module") is dominated by Western dualistic conceptualisations in which the self is unique and independent of others. Our approach transforms this view by wedding Eastern thought (Zhu & Han, 2008) and cognitive accounts of conceptual interdependence (Goldstone, 1996) to develop a more theoretically fruitful view of the self that goes beyond self–other differences to highlight similarities in the processing of self and others. Regarding the self, there is evidence of robust self-advantages in multiple cognitive domains. However, the reasons for such advantages are opaque. The present approach therefore offers one means of isolating the contributions of latent dimensions to the prioritisation of the self (and others). This approach also has the potential to enrich social cognition research. Existing multidimensional models of social perception sometimes overlook the self (Fiske et al., 2007; Todorov, Said, Engell, & Oosterhof, 2008). However, the present chapter suggests that the processing of these dimensions may critically relate to self-representation (e.g., self-anchoring, self-distinctiveness). Although the precise relationship remains to be investigated, the present work nonetheless highlights the importance of including the self within the social milieu.

One possible area for expansion of the present approach may be to examine additional established dimensions in social cognition. The present work focused on the dimensions of relevance and valence on the theoretical grounds that these dimensions may be particularly linked to perceptual self-prioritisation (see 4.1.1). However, these dimensions are not the only dimensions on which self and other may differ. Other important social dimensions from the social cognition literature include warmth, competence, trustworthiness, dominance, and social status (see Fiske, 2010; Fiske et al., 2007; Todorov et al., 2008, for reviews). Some of these dimensions (e.g., warmth and trustworthiness) are closely related to our definition of valence. However, we did not explicitly examine dimensions related to competence or social status. One critical theoretical difference for these unexamined dimensions is that the self is unlikely to serve as an anchor along these dimensions. For example, it is an unavoidable reality of status hierarchies that most individuals will not possess high status. Given that prioritisation of the self is robust (see Humphreys & Sui, 2015, for a review), it is unlikely that high-status targets would elicit greater prioritisation than the self. Nonetheless, there is considerable evidence to suggest that high-status targets do capture attention (Dalmaso, Pavan, Castelli, & Galfano, 2011; Ma & Han, 2009; N. J. Ratcliff, Hugenberg, Shriver, & Bernstein, 2011), especially if they are personally relevant (Ma & Han, 2009). We therefore expect that sensitivity to this dimension should diminish the difference between self and high-status individuals, driven primarily by increased attention to the high-status other.

Notably, personal relevance or frequency of interaction is not commonly studied as a dimension of social cognition (but see Bales, 1999). In the present research, we did not observe a very large effect of relevance, especially in comparison to valence. It is perhaps unsurprising given that the dimension of warmth/valence is thought to be primary to other social dimensions such as competence (Fiske et al., 2007). It is possible that a more salient social context affording some action may lead to more robust relevance effects (e.g., seeing one's own happy/sad infant's face compared to an unfamiliar infant's happy/sad face: Strathearn & Kim, 2013). However, in the arguably more ambiguous context of association learning used in the present research, it appears that the behavioural (and neural) response to frequent versus infrequent contact is relatively weak. Future work may examine the relationship between the relevance dimension and other dimensions not explored in the current work, such as social status.

Another exciting avenue for future research may be to examine group-level differences in the prioritisation of different social-cognitive dimensions. Experiment 7 provided evidence that individuals from an Eastern collectivist context showed greater sensitivity to valence. Although the functional significance of this culture-specific valence sensitivity remains to be explored (see 4.3.4 for discussion), these findings suggest that the study of culture (or any other social group) may benefit from a greater focus on basic social-cognitive dimensions such as relevance and valence, among others. Of clinical relevance, one possible direction for future research may be to examine the degree to which differential social-cognitive weightings may be characteristic of a given clinical disorder. For example, depression is thought to be associated with heightened self-focus (Ingram, 1990). Thus, depressed individuals may show enhanced perceptual responses to the self but possibly also to highly self-relevant others. Depressed individuals also typically show greater attentional biases to negative stimuli (Wenzlaff, Rude, Taylor, Stultz, & Sweatt, 2001) as well as a negative self-concept (Tarlow & Haaga, 1996). Taken together, these tendencies in depressed individuals may lead to a potentially very different pattern of attentional prioritisation. Given the presumed negative self-concept in depression, replication within a clinical or at-risk group would provide a strong test of the self's role as an anchor along the valence dimension.

4.5.3. Methodological Considerations

In the present section, we consider two potential limitations to the current approach. One concern regards our preferred approach of inviting participants to select a single representative for each of the four conditions. The use of limited stimuli is common in social psychological research. However, one issue is that the use of such limited stimuli may reduce the generalisability of the results (Judd, Westfall, & Kenny, 2012; Westfall, Judd, & Kenny, 2015). This concern is mitigated to some extent when one considers that the number of stimulus exemplars varied across participants. In other words, the friends, enemies, and famous figures chosen by each participant were unique to that participant. Therefore, across the participant sample, the number of stimuli was in fact large. It is thought that such stimulus diversity may help to improve the generalisability of findings, albeit at the cost of increased error variance (Westfall et al., 2015; Westfall, Kenny, & Judd, 2014). Although the present analyses do not permit a fine-grained analysis of variance attributable to stimuli, analyses of existing data using mixed linear models have demonstrated this trade-off (Judd et al., 2012). This may have been especially problematic in the fMRI study where group-level effects were quite weak. However, it also gives some assurance that reliable findings will in fact generalise.

A second concern arises from the relatively unconstrained way in which participants selected their four non-self identities. Specifically, this creates some ambiguity in the interpretation of our relevance/valence sensitivity findings. It is not clear whether what we call sensitivity reflects intrinsic differences in perception and attention or rather a greater tendency to think of extreme exemplars for each category. Let us take for an example two individuals differing in valence sensitivity. The highly valence-sensitive individual may have selected extreme identities (e.g., mother vs. a repulsive neighbour) and the less valence-sensitive individual may have selected less extreme identities (e.g., a well-liked supervisor vs. mildly annoying colleague). It may still be argued that these different individuals are indeed sensitive to valence on some level (e.g., chronic salience of the valence dimension). However, it is an empirical question whether the two individuals would in fact differ in their intrinsic attentional prioritisation of the valence dimension had they chosen more analogous identities. This may also explain why putative sensitivity to relevance and valence in non-self identities did not translate to enhanced self-prioritisation (but fMRI results contradict this interpretation). These important questions await further study. Nonetheless, the present findings contribute to the literature as an initial inquiry into the impact of individual differences in valence sensitivity (at some level) on attentional bias for the self.

4.5.4. Conclusion

In summary, this chapter has provided evidence that dimensions of social relevance can enhance the perceptual prioritisation of others. Evidence for the valence dimension in particular appears to be simultaneously reliable across cultures and sensitive to group-level differences. Critically, sensitivity to these dimensions does not appear to affect overall performance for the self. In fact, individual differences in sensitivity to relevance and valence were found to reduce relative self-bias. This suggests that individual differences in self-bias critically depend on the personal significance of the non-self comparison rather than presumed sensitivity to relevance, valence, or the self, per se. We interpret this pattern as a tendency for the self to anchor social attention along relevance and valence dimensions from its privileged position as highly positive and relevant. This interpretation highlights the uniqueness of the self-concept (Brewer, 1991; Leonardelli et al., 2010). Neural correlates of the self's uniqueness were also found in the fMRI study, which showed that relevance and valence dimensions only partially overlapped with the SAN. Moreover, behavioural valence sensitivity tended to enhance neural self-differentiation relative to close competitors (e.g., friend). Taken together, the findings from the present chapter argue against the possibility that perceivers process learned self-associations as they would process putatively proximal non-self others, as has been previously suggested (D'Argembeau, 2013; Gillihan & Farah, 2005; Mattan, Quinn, & Rotshtein, 2015; Uddin et al., 2007). We argue instead that the self serves as a unique reference point in gauging the attention afforded to others varying in relevance and valence. It is hoped that future work may build upon the present approach of combining self- and social-cognition within the same experimental paradigm, ultimately revealing insights into both areas.

CHAPTER 5: GENERAL DISCUSSION

5.1. Summary and Significance of Empirical Findings

In Chapter 1, we began with a brief review of self-biases in memory and attention, culminating in three key questions, each of which was addressed in one of the three empirical chapters. Broadly, each of these chapters aimed to further understand the perceptual and attentional benefits of novel self-associations (i.e., "self-tagging") and, by extension, the perceived self. In this section we summarise the key findings from each chapter, highlighting their significance for the broader literature.

We first asked in Chapter 2 whether self-tagging effects extend to higher-level social cognition, namely, VPT. Prior to the present research, effects of novel self-associations had not been examined in the context of VPT. In several replications, we found evidence that self-tagged (vs. non-self) perspectives were prioritised when they are signalled as the target perspective. The findings from Chapter 2 were also methodologically significant. Results from both the 3PP-3PP and 1PP-3PP tasks suggested that differences in gaze cue salience can have an important impact on VPT performance. Whereas 1PP-3PP paradigms with salient third-person gaze cues sometimes yield evidence of a computational bias for 3PP (e.g., Samson et al., 2010), our 1PP-3PP paradigm reliably showed a robust computational bias for 1PP. Because some degree of gaze cuing difference is inevitable in 1PP-3PP paradigms, our novel 3PP-3PP paradigm is an important tool for researchers wishing to fully control for gaze cuing differences between any two 3PPs of interest. Although the present work has focused on responses to a self- versus other-associated perspective, this paradigm may be adapted for the study of questions related to the intergroup context. For example, a researcher interested in visual attention to the perspectives of ingroup versus outgroup members may find performance on the 3PP-3PP task to be a reliable dependent (or independent) variable (see 5.2 for further discussion).

In Chapter 3, we further refined the 3PP-3PP task, eliminating the use of low-reliability false-response trials (see Experiment 4). Using this more efficient paradigm, we tested whether VPT is sensitive to individual differences in social-cognitive motivation. Consistent with theory that empathic individuals are relatively flexible perspective-takers with some degree of sensitivity for the self–other distinction (Decety & Jackson, 2004), we found that empathy was associated with a more flexible ability to manage conflicting 3PPs, especially when targeting the self-associated perspective. Using the original version of the 1PP-3PP and 3PP-3PP tasks (from Experiment 3), we also found some evidence that older adults are more sensitive to the self-relevant perspective. Consistent with previous reports of age-related (first-person) egocentrism (Henry et al., 2013; Moran, 2013; von Hippel & Henry, 2012), older participants showed a computational and selection bias for 1PP. However, we also found that older adults may have a greater sensitivity to self-relevance among 3PPs, particularly in contexts involving 1PP. This is consistent with the idea that older adults are particularly motivated by self-relevant aspects of different cognitive tasks (Hess et al., 2001; Hess, 2014). Taken together, these findings suggest that VPT tasks such as those developed in the present thesis do tap into more than visual-spatial ability and executive control, but are indeed related to social-cognitive ability and motivation.

In Chapter 4, we examined whether interpersonal dimensions such as relevance and valence may help to explain the self-tagging effects observed both in the literature and in the preceding chapters. We found that these dimensions contribute to perceptual prioritisation. The valence effect was most reliable and was particularly enhanced in a Chinese sample. The reasons underlying this cultural difference are still poorly understood, but future research on group differences to these social dimensions represents a fruitful avenue for future research. Despite the above effects of relevance and valence, the self nonetheless showed a qualitatively distinct character. We count the following findings as evidence of the self's unique representation and against the interpretation that the perceived self is processed solely by the same mechanisms that process other high-relevance and positive entities. First, sensitivity to relevance and valence was not reliably related to performance for the self, as might be expected if the self were processed as a superlatively positive and relevant identity. Instead, relevance and valence sensitivity decreased behavioural self-advantages in distinct cultural contexts, suggesting the self may serve as a unique anchor or upper bound for these dimensions. This interpretation is consistent with other accounts of self-anchoring effects in social cognition (e.g., Epley et al., 2004). Second, neural responses to the self did not track with those elicited by a relevant and positive non-self identity (i.e., friend). Third, neural responses to relevance and valence only partially mapped onto the SAN (see Humphreys & Sui, 2015). This overlap was only found in the more domain-general fronto-parietal attention regions. Fourth, behavioural sensitivity to valence *increased* neural differentiation of the friend but only relative to its closest competitors on the valence dimension (i.e., the friend and admired figure). This was despite the fact that highly valence-sensitive participants are the most likely to show diminished self-advantages in behaviour. We interpret this finding as evidence that highly valence-sensitive perceivers are motivated to maintain a unique and positive neural representation of the self (Brewer, 1991; Leonardelli et al., 2010), which may otherwise be obscured when presented with very positive non-self identities.

5.2. Future Directions

5.2.1. Visual Perspective Taking and the Intergroup Context

The present work, as summarised in the preceding section, provides some foundations for future research into self and interpersonal biases in perception and attention. As mentioned above, the use of social-tagging in VPT opens the use of such paradigms to the intergroup context. Already, there is considerable evidence that active perspective taking (i.e., conscious reflection on the experience of a dissimilar individual) can reduce stereotyping of others (Galinsky & Ku, 2004; Galinsky & Moskowitz, 2000), as well as implicit race bias and avoidance behaviour (Todd, Bodenhausen, Richeson, & Galinsky, 2011). This process is thought to be mediated by an enhanced overlap between self and other (Galinsky, Wang, & Ku, 2008; Ku, Wang, & Galinsky, 2010). Although this research primarily relies on explicit abstract perspective-taking manipulations, there is also evidence that the adoption of embodied virtual visual perspectives may also help to reduce to reduce negative stereotype activation (Yee & Bailenson, 2006; but see Groom, Bailenson, & Nass, 2009).

In light of evidence reviewed above and our findings that VPT is linked to social processes (Chapter 3), the VPT paradigms developed in this work may serve as versatile tools in stereotyping and prejudice research. On the one hand, these paradigms may be used as relatively concrete perspective-taking manipulations (e.g., train participants to adopt only the outgroup avatar's perspective). However, the same paradigms may also serve as an implicit measure of bias. For example, do outgroup biases (e.g., prejudice, avoidance, stereotype endorsement) correlate with an ingroup bias in the 3PP-3PP and 1PP-3PP paradigms? If so, would this relationship manifest at the explicit level (i.e., main effect of target perspective) or at the implicit level (i.e., differential interference effects of conflicting distractor avatars)?

What mechanisms may mediate this relationship? As far as we are aware, these questions remain to be explored in a systematic fashion.

One additional benefit of using the present paradigms to address these questions is that they may be less likely to elicit strong self-presentational concerns compared with more explicit assessments of prejudice. This is advantageous in the contemporary context, where the assessment of prejudice is often confounded by self-presentational concerns (Plant & Devine, 1998). If self-presentational concerns are somehow primed, we anticipate that they may influence the explicit level of perspective taking (i.e., effect of target perspective) but not implicit perspective taking (i.e., interference effects). In sum, the VPT tasks developed in the present work may provide a useful means of studying intergroup processes while potentially avoiding some of its pitfalls (e.g., self-presentational concerns).

5.2.2. Integrated Model of Social Cognition for Self and Others

In this section, we outline future research directions based primarily on findings from Chapter 4. Our aim is to briefly sketch the outlines of an innovative approach to social cognition that focuses on how the self and others are processed along common interpersonal dimensions such as relevance and valence. Consistent with our present findings and similar approaches in both social psychology (Fiske et al., 2007; Todorov et al., 2008) and neuroscience (Bromberg-Martin, Matsumoto, & Hikosaka, 2010; Kahnt, Park, Haynes, & Tobler, 2014), we propose that all social stimuli (including the self) are evaluated along basic dimensions associated with affect and motivation/agency. These dimensions may be characterised as a hypothetical multi-dimensional space with three orthogonal dimensions representing contact frequency, valence, and power dimensions (see Figure 5.1). Valence refers to evaluations originating from the affective network. Contact frequency is the extent of day-to-day contact, similar to our running definition of personal or day-to-day relevance.

Finally, power reflects the ability to achieve desired ends (similar to the competence dimension in existing social-cognitive models: see Fiske et al., 2007; Todorov et al.,2008)[16]. These latter two dimensions are associated with motivation vis-à-vis goal attainment. We anticipate that, within social contexts, cognitive and perceptual prioritisation will be associated with increased rank along any of the three dimensions. Consistent with our behavioural work, we anticipate that self and others rating high (vs. low) on any given dimensions should be prioritised in behaviour. However, it is less clear how the self is processed along these dimensions in the brain.

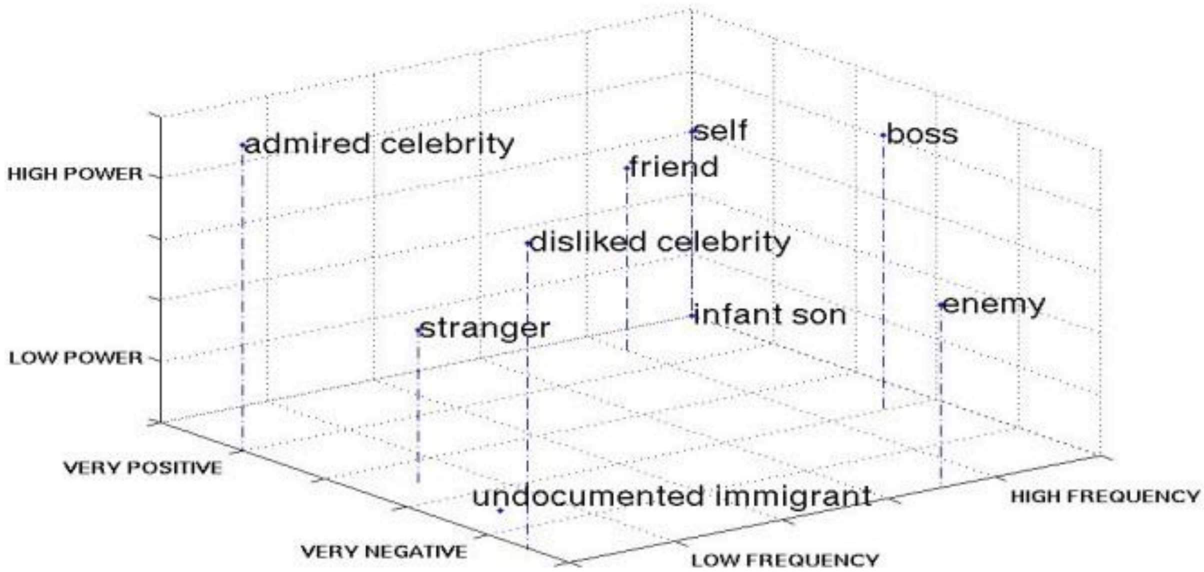


Figure 5.1. Three-dimensional depiction of the hypothetical social space that includes the self and others. We argue that perceptual and attentional prioritisation increase as a function of increasing frequency, power, and positivity. Individual differences in the weightings of these dimensions remain to be explored.

Our fMRI study provides a starting point in addressing this question. First, neural response to the self tended not to track with the overall response to positive non-self

[16] Power was added as a third dimension to bring the present work more in line with existing approaches exploring interpersonal dimensions in social cognition (Fiske, 2010; Fiske et al., 2007; Todorov et al., 2008). Such approaches stress the importance of competence, power, or agency as a critical determinant of impression formation.

identities; indeed, responses to the self generally fell between responses to positive and negative identities in brain regions sensitive to valence (Figures 4.7 and 4.8). Second, neural response to the self was enhanced compared to other positive identities as behavioural sensitivity to valence increased. Taken together, these findings suggest that, although the self may vary along interpersonal dimensions, its neural signature is not easily defined solely by its presumed position as extremely relevant and positive. Follow-up studies are needed to more precisely characterise the relationship between neural self-representation and the processing of interpersonal dimensions. One possibility is that the regions processing attention to interpersonal dimensions may only come online when explicit comparisons with the self are required, a hypothesis that was not tested in the present work.

Another question that remains open to further study is the extent to which individual and group differences exist in the relative weightings given to these three social dimensions. In the cross-cultural study reported in Experiment 7 (see 4.3), we found that Chinese participants showed greater valence sensitivity than UK-based participants. Notably, this greater sensitivity to valence was not tied to any cultural differences in performance for the self, suggesting this effect is more related to other-focused processes. We have speculated that greater sensitivity to valence in Eastern collectivist groups may be linked to a motivation to maintain social harmony (Markus & Kitayama, 1991); nonetheless, behavioural correlates of attentional bias to different interpersonal dimensions remain to be explored. Additionally, the present findings do not speak to situations where the self may be characterised as low on any given dimension. In this case, it remains to be seen whether this reduces attentional prioritisation of the self and potentially disrupts the phenomenon of self-anchoring reported in Chapter 4. Studying the behavioural and neural sensitivity to the self in individuals with low self-esteem or depression may further our understanding of how novel self-associations are learned and, in turn, affect subsequent attentional priority. Additionally, due to inherent social hierarchies, studying self-prioritisation in participants of low status addresses the same question in a psychologically healthy population.

In summary, the present model highlights the importance of bringing the self into the study of interpersonal dimensions. Although this approach is still in its infancy, the model and future directions proposed here are transformative in two ways: (1) They challenge conventional accounts of self–other representation. Abandoning the idea of a self-specific brain mechanism, we hypothesise that neural responses to self and others are processed by partially overlapping networks responsible for the processing of key interpersonal dimensions. Further empirical work is needed to further clarify the relationship between the self and interpersonal dimensions in different behavioural paradigms as well as in the brain. (2) The present approach opens a new way to study group and individual differences, potentially providing a common approach to the study of social cognition across cultural lines. Such an approach may also benefit our understanding of differences within cultural groups (e.g., low vs. high self-esteem).

5.3. Conclusion

The work presented in this thesis aimed to provide a clearer understanding of the special nature of the self as perceived in the outside world. In particular, we asked whether our tendency to prioritise novel self-associations may have anything to do with our interest in others who are similar to or affiliated with the self. Across all studies, our predominant interpretation is that attention to the self is a form of motivated or top-down processing. Within the context of VPT, motivated processing of self-relevant targets is modulated by the perceiver's characteristic motivations (e.g., empathic tendency, age) in addition to perceptual aspects of the paradigm (e.g., gaze cue salience). We also tested the alternative interpretation that our preference for self-associations may be related to the self's role as one of the most well-liked and personally relevant individuals in our social context. Although we found evidence that interpersonal dimensions such as positivity and day-to-day relevance enhanced processing of others, sensitivity to these dimensions did not appear to enhance performance for the self. To the contrary, in two cultural contexts, it diminished the otherwise robust bias toward the presumably relevant and positive self. Finally, an fMRI study provided further evidence that self-related processing is at least partly separable from these dimensions—enhanced behavioural sensitivity to valence increased neural differentiation of the self relative to close competitors in regions previously tied to self-representation (e.g., VMPFC and SFG).

In summary, the present work highlights the attentional benefits of the self in visual social cognition as well as the self's unique position along key interpersonal dimensions such as relevance and valence. Due to the novel approach adopted in this work, many of these findings are tentative. For this reason, we have concluded with a discussion of possible future research directions. To guide this research, we propose a hypothetical integrated model of social cognition for the self and others. Undoubtedly, future work will prompt refinements of the proposed model. Nonetheless, we anticipate that the overall approach of examining both self and others along common interpersonal dimensions will prove abundantly fruitful in delineating the nature of self-representation and social cognition more broadly.

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APPENDICES

1. Author's Note

Appendices are numbered sequentially within each chapter. For example, Appendix 2.1 is the first appendix for Chapter 2. Appendix 3.5 is the fifth appendix for Chapter 3.

2.1. 3PP-3PP Pilot Task Design for Experiment 1

In the design of the true trials (i.e., trials where the prompt matched the subsequent scene), the following guidelines were applied: (1) Experimental condition (i.e., self-congruent, self-incongruent, other-congruent, other-incongruent) and prompt veracity (i.e., true or false) were equally represented across trials. There were also an equal number of one-, two-, and three-dot prompts; no trial displayed more than four dots, thus keeping the paradigm within the subitisable range (see Kaufman et al., 1949; Trick & Pylyshyn, 1994). (2) The target avatar always faced toward the centre. (3) Gaps of two vacant dot locations between presented dots were avoided where possible. When not possible, large-gapped configurations were balanced for symmetry within condition. (4) No two trials involved the same configuration of target avatar, target position/gaze, dot display, and prompt number. (5) For added variability, half of the trials had two barriers present and half had only one barrier present. (6) One dot always appeared on the lateral side of a barrier, thus rendering the first-person perspective incongruent on all trials. (7) Lastly, mismatch trials were derived from a corresponding match trial by eliminating exactly one dot, avoiding any novel dot configurations.

In total, there were overall 49 virtual rooms displaying different numbers of dots (1–4) in different locations, and number of dividing walls (1 or 2). The two avatars randomly appeared on the left or the right side of the screen.

2.2. 3PP-3PP Task Design Modifications for Experiment 2

Revised design guidelines were implemented to create behaviourally relevant peripheral spaces and eliminate potential confounds. Key changes included the following: (1) One-dot prompts were excluded from the design because the paradigm constraints would necessarily result in the non-target avatar seeing more dots than the target avatar on false trials. (2) The target avatar was equally likely to be gazing toward the shared space or toward one of the lateral spaces. (3) For greater simplicity, both barriers were always present, unlike in the original design. (4) The expanded layout of the 3D environment in the current study enabled the first-person perspective to be held constant by presenting four dots on all trials. See Figure 2.3 for examples of the updated virtual room stimuli.

In the re-design of the matching trials (i.e., trials where the prompt matched the subsequent scene), the following guidelines were applied: (1) Experimental conditions (i.e., self-congruent, self-incongruent, other-congruent, other-incongruent) were equally represented across trials. There were also an equal number of two- and three-dot prompts. (2) All trials displayed a total of four dots, thus keeping the paradigm within the subitisable range (see Kaufman, Lord, Reese, & Volkmann, 1949; Trick & Pylyshyn, 1994) and holding the first-person perspective constant. (3) The target avatar was equally likely to be gazing toward the shared space or toward one of the lateral spaces. (4) Gaps of two vacant dot locations between presented dots were avoided where possible. When not possible, large-gapped configurations were balanced for symmetry within condition. (5) No two trials involved the same configuration of target avatar, target position/gaze, dot display, and prompt number. (6) Finally, an equal number of mismatch trials were derived from a corresponding match trial by eliminating exactly one dot, avoiding any novel dot configurations.

2.3. Mismatch Trial Analyses for Experiment 2

The 2 × 2 repeated-measures ANOVA for mismatch trials resulted in a significant main effect of perspective congruence, $F(1,41) = 4.28$, $MSE = 88235$, $p = .045$, $\eta_p^2 = .095$, with more efficient performance for congruent than incongruent trials. The main effect of target perspective and the Target Perspective × Perspective Congruence interaction were both non-significant, $F(1,41) = 0.398$, $p = .53$, and $F(1,41) < 0.001$, $p = .99$, respectively.

A formal comparison between match and mismatch trials was carried out using a 2 (Trial Type: match, mismatch) × 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA on efficiency scores. A significant main effect of perspective congruence was observed, $F(1,41) = 9.59$, $MSE = 70067$, $p = .004$, $\eta_p^2 = .190$, with greater efficiency for congruent compared to incongruent trials. A marginal effect of trial type was also found, $F(1,41) = 3.16$, $MSE = 78669$, $p = .083$, $\eta_p^2 = .072$, with numerically greater efficiency for prompt–scene matches than mismatches. The main effect of target perspective was non-significant, $F(1,41) = 1.10$, $p > .30$. However, a marginal Trial Type × Target Perspective interaction was found, $F(1,41) = 3.84$, $MSE = 24118$, $p = .057$, $\eta_p^2 = .086$. In summary, congruency effects were observed in both the matched and mismatch trials; the interaction trend suggested greater efficiency for the Self avatar only in the match trials (see Table 2.4 for descriptive statistics).

2.4. Mismatch Trial Analysis for Experiment 3

2.4.1. 3PP-3PP Task

The 2 × 2 repeated-measures ANOVA for mismatch trials replicated the results of Experiment 2. We observed a significant main effect of perspective congruence, $F(1,39) = 4.13$, $MSE = 42621$, $p = .049$, $\eta_p^2 = .096$, with more efficient performance for congruent than incongruent trials. The main effect of target perspective and the Perspective Congruence × Target Perspective interaction were both non-significant, $F(1,39) = 1.69$, $p = .20$ and $F(1,39) = 2.99$, $p = .09$, respectively.

A formal comparison between match and mismatch trials was computed using a 2 (Trial Type: match, mismatch) × 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA on efficiency scores. This analysis revealed a marginal effect of perspective congruence, $F(1,39) = 3.66$, $MSE = 38851$, $p = .063$, $\eta_p^2 = .086$, with numerically greater efficiency for congruent compared to incongruent trials. A significant effect of trial type was also found, $F(1,39) = 6.85$, $MSE = 52546$, $p = .013$, $\eta_p^2 = .149$, with greater efficiency for prompt–scene matches than mismatches. The main effect of target perspective was also significant, $F(1,39) = 5.38$, $MSE = 24059$, $p = .026$, $\eta_p^2 = .121$, with greater efficiency for the Self avatar compared to the Other avatar. The Trial Type × Target Perspective interaction was not significant, $F(1,39) = 0.25$, $p = .622$. Target perspective was marginally modulated by perspective congruence, $F(1,39) = 3.58$, $MSE = 18099$, $p = .066$. An inspection of the means shows a trend of greater interference from the Self avatar on the Other avatar compared to the reverse case (see Table 2.6 for descriptive statistics).

2.4.2. 1PP-3PP Task

The same three-way ANOVA for mismatch trials resulted in a significant main effect of perspective congruence, $F(1,39) = 19.2$, $MSE = 9850$, $p < .001$, $\eta_p^2 = .330$, with more efficient performance for congruent than incongruent trials. A significant effect for target perspective, $F(1,39) = 106$, $MSE = 10925$, $p < .001$, $\eta_p^2 = .731$, showed more efficient judgements for 1PP relative to the Other avatar. The Perspective Congruence × Target Perspective interaction was significant, $F(1,39) = 38.9$, $MSE = 10793$, $p < .001$, $\eta_p^2 = .499$ (cf. 1PP-3PP match trials analysis). Contrasts revealed reliable interference from 1PP on the 3PP, $t(39) = 6.20$, $d = 0.980$, $p < .001$, and an inverse interference effect from 3PP on the 1PP, $t(39) = 2.05$, $d = 0.325$, $p = .047$. Consistent with the main effect of target perspective, participants were significantly more efficient for 1PP compared to 3PP on congruent trials, $t(39) = 3.54$, $d = 0.560$, $p = .001$, and incongruent trials, $t(39) = 10.2$, $d = 1.61$, $p < .001$. Finally, the Avatar Identity × Perspective Congruence interaction was non-significant, $F(1,39) = 2.22$, $p = .144$ (cf. 1PP-3PP match trials analysis). All other main effects and interactions were non-significant for mismatch trials, all $p > .52$.

A formal comparison of the match and mismatch trials was computed using a 2 (Trial Type: match, mismatch) × 2 (Target Perspective: 1PP, 3PP) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Avatar Identity: Self, Other) repeated-measures ANOVA on efficiency scores. Results revealed a reliable main effect of perspective congruence, $F(1,39) = 81.5$, $MSE = 9883$, $p < .001$, $\eta_p^2 = .676$, with greater efficiency for congruent compared to incongruent trials. A reliable effect of target perspective was also found, $F(1,39) = 86.2$, $MSE = 12203$, $p < .001$, $\eta_p^2 = .688$, with greater efficiency for 1PP than 3PP. A significant Target Perspective × Perspective Congruence interaction, $F(1,39) = 31.8$, $MSE = 9351$, $p < .001$, η_p^2

= .449, revealed greater interference from 1PP on the 3PP, $t(39) = 10.2$, $d = 1.61$, $p < .001$, than from 3PP on the 1PP, $t(39) = 2.60$, $d = 0.410$, $p = .013$.

The Trial Type × Target Perspective interaction was also significant, $F(1,39) = 17.6$, $MSE = 14084$, $p < .001$, $\eta_p^2 = .311$. As reported above, in both matched and mismatch trials, 1PP was more efficient than the 3PP, but this effect was larger for mismatch trials. The interaction of trial type and perspective congruence, $F(1,39) = 4.84$, $MSE = 16422$, $p = .034$, $\eta_p^2 = .110$, is consistent with the larger effect of perspective congruence for matched relative to mismatch trials. The three-way interaction of Trial Type × Target Perspective × Perspective Congruence, $F(1,39) = 10.6$, $MSE = 13003$, $p = .002$, $\eta_p^2 = .214$, reflected the fact that the effect of congruence was reliably modulated by target perspective but only in the mismatch trials. Finally, the Trial Type × the Avatar Identity × Perspective Congruence interaction, $F(1,39) = 9.65$, $MSE = 5413$, $p = .004$, $\eta_p^2 = .198$, confirmed that the presence of the Self avatar reliably modulated the congruence effect, but only for match trials. All other terms were non-significant, all $p > .21$. As in the 3PP-3PP task (Experiments 2–3), the overall pattern of results across match and mismatch trials was similar, with some effects being more pronounced for one condition as opposed to the other, but no cross-over interactions were observed.

3.1. Social Distance Task Description and Figure

This task was completed on Microsoft PowerPoint (Microsoft Corporation, Redmond, Washington). Participants first provided their own name as well as the name of a close friend and a family member. They were told that a final person, Jamie, represents someone they do not personally know. After providing all the required names, participants moved circles representing each identity into a designated field (see Figure S1 below). Participants were given no instructions regarding the order in which to move the circles and were free to move the circles as many times as desired until they were satisfied with the final arrangement.

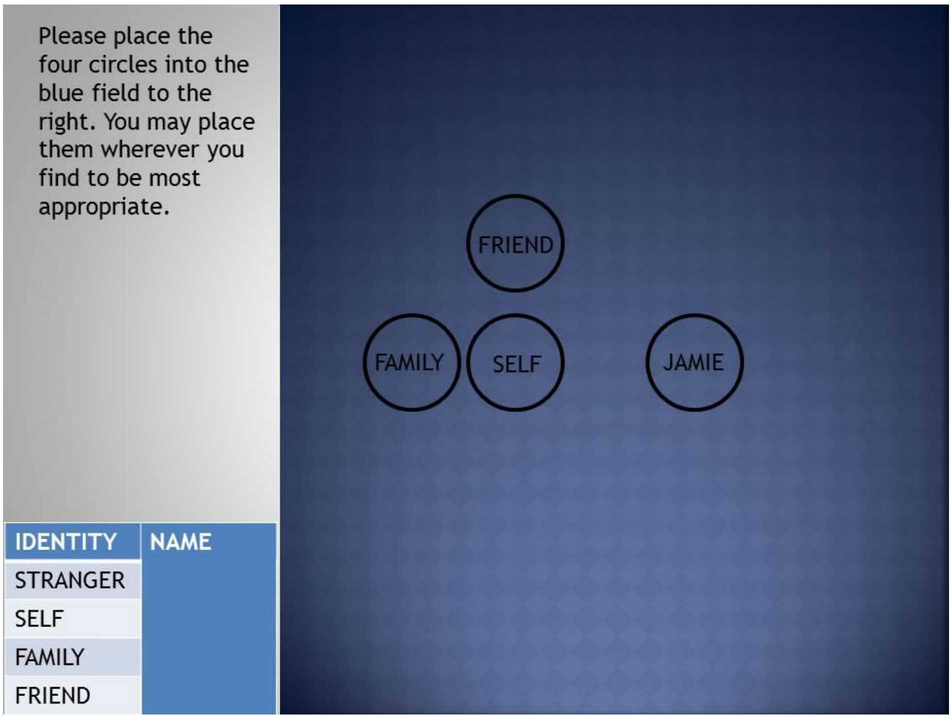

Figure S1. Example of a completed social distance map. Prior to being moved by the participant, all circles start off in the grey field on the left, just below the upper block of text. Names have been obscured to protect the identity of the participant.

3.2. Analysis of RT and Accuracy Data for Experiment 4

3.2.1. Perspective-Taking Task Replication

Data trimming and outlier exclusion procedures followed those used in the main text for Experiment 4 (see 3.2.3).

RT analysis. Results from the Target Perspective × Perspective Congruence ANOVA revealed a significant effect of perspective congruence, $F(1,40) = 59.3$, $MSE = 3287$, $p < .001$, $\eta_p^2 = .597$, with faster responses for congruent compared to incongruent trials (see Table 3.1). Overall, no reliable differences in response times were observed for the Self and Other avatars, all other $p > .39$.

Accuracy analysis. Results from the Target Perspective × Perspective Congruence ANOVA revealed significant effects of perspective congruence, $F(1,40) = 328$, $MSE = .002$, $p < .001$, $\eta_p^2 = .891$, and target perspective, $F(1,40) = 21.0$, $MSE = .002$, $p < .001$, $\eta_p^2 = .344$. Descriptive statistics are provided in Table 3.1. Overall, participants were more accurate for congruent compared to incongruent trials and for the Self avatar compared to the Other avatar. A significant Target Perspective × Perspective Congruence interaction was also observed, $F(1,40) = 27.2$, $MSE = .001$, $p < .001$, $\eta_p^2 = .404$. Post hoc *t*-tests revealed a larger perspective-congruence effect when the Other avatar was the target, $t(40) = 17.5$, $d = 2.74$, $p < .001$, compared to when the Self avatar was the target, $t(40) = 10.6$, $d = 1.66$, $p < .001$. This difference appears to be driven by a reliable self-prioritisation effect for incongruent trials, $t(40) = 6.12$, $d = 0.956$, $p < .001$, but not for congruent trials, $t(40) = 0.263$, $p = .79$.

Overall, RT and accuracy results replicate previous findings (Mattan, Quinn, Apperly, et al., 2015; Chapter 2). Participants were faster and more accurate on congruent than incongruent trials. In accuracy (as in efficiency data: 3.2.3), participants also prioritised the

Self over the Other avatar, especially on incongruent trials. In other words, participants showed less interference when adopting the Self avatar's perspective. Notably, this Target Perspective × Perspective Congruence interaction was not reliable in a previous version of this task (Mattan, Quinn, Apperly, et al., 2015; see also Chapter 2).

3.2.2. Empathy and VPT

Global empathy and each subscale were included as covariates in separate 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANCOVAs. To condense reporting of results, ANCOVA statistics are summarised in Table S1. Accuracy data did not correlate with the IRI global empathy measure or any of its subscales, and so we report only the results of the RT analysis here. Bonferroni-corrected contrasts were used to explore reliable interactions.

Global empathy. A marginal main effect of empathy score suggested overall faster response times as a function of higher empathy score. A marginal Perspective Congruence × Empathy interaction was also observed, reflecting a negative relationship between empathy scores and perspective-congruence effect magnitude. However, unlike in the efficiency analysis (see 3.2.3), these effects were both subsumed within a reliable Target Perspective × Perspective Congruence × Global Empathy interaction. Critically, the three-way interaction showed that empathy was related to smaller perspective-congruence effects (i.e., $M_{\text{incongruent}} - M_{\text{congruent}}$) only when the Self avatar was the target, $r(39) = -.410$, $p = .008$, explaining 16.8% of the variability. The same relationship was not reliable when the Other avatar was the target, $r(39) = -.129$, $p = .42$. In other words, empathy was associated with relatively less susceptibility to distraction when adopting the Self (vs. Other) avatar's perspective. See Figure S2 for an illustration of this interaction.

To supplement the follow-up correlations above, we examined the same interaction at each level of perspective-congruence, testing the relationship between empathy and self-prioritisation (i.e., $M_{\text{Other}} - M_{\text{Self}}$). Empathy scores were associated with decreased prioritisation of the Self avatar on congruent trials, $r(39) = -.537$, $p < .001$, but not on incongruent trials, $r(39) = 0.097$, $p = .55$. All significant post-hoc correlations survive Bonferroni correction for multiple comparisons, $\alpha/4 = .0125$.

Table S1

ANCOVA Summaries for Empathy Subscales: RT Data, Experiment 4

Analysis	IRI Covariate	Effect	$F(1,39)$	*MSE*	η_p^2
Response Time (RT)	Global Empathy (Emp-G)	Emp-G [neg]	3.85 †	48023	.090
		TP × Emp-G	1.06	591	.034
		PC × Emp-G	3.93 †	3062	.092
		TP × PC × Emp-G	4.33 *	764	.100
	Perspective Taking (Emp-PT)	Emp-PT [neg]	3.65 †	48241	.086
		TP × Emp-PT	0.38	606	.010
		PC × Emp-PT	5.86 *	2930	.131
		TP × PC × Emp-PT	3.83 †	773	.089
	Empathic Concern (Emp-EC)	Emp-EC [neg]	3.89 †	47968	.091
		TP × Emp-EC	0.30	607	.008
		PC × Emp-EC	5.50 *	2954	.124
		TP × PC × Emp-EC	5.60 *	742	.126
	Fantasy (Emp-F)	Emp-F [neg]	2.36	49751	.057
		TP × Emp-F	2.44	575	.059
		PC × Emp-F	3.63 †	3084	.085
		TP × PC × Emp-F	1.58	816	.039
	Personal Distress (Emp-PD)	Emp-PD	0.00	52752	.000
		TP × Emp-PD	3.67 †	559	.086
		PC × Emp-PD	1.05	3283	.026
		TP × PC × Emp-PD	0.07	848	.002

Note. TP = Target Perspective. PC = Perspective Congruence.
* $p < .05$. † $p < .07$. [neg] Negative correlation with mean RT.

In summary, global empathy scores were associated with a trend for better overall perspective-taking performance (as in the efficiency analysis) and a significant reduction in interference from the Other avatar when the Self avatar was the target perspective (unlike the efficiency analysis). This reduction in interference when adopting the Self avatar's perspective can be also explained as a reduced tendency to prioritise the Self avatar's over the Other avatar's perspective when both avatars held the same view.

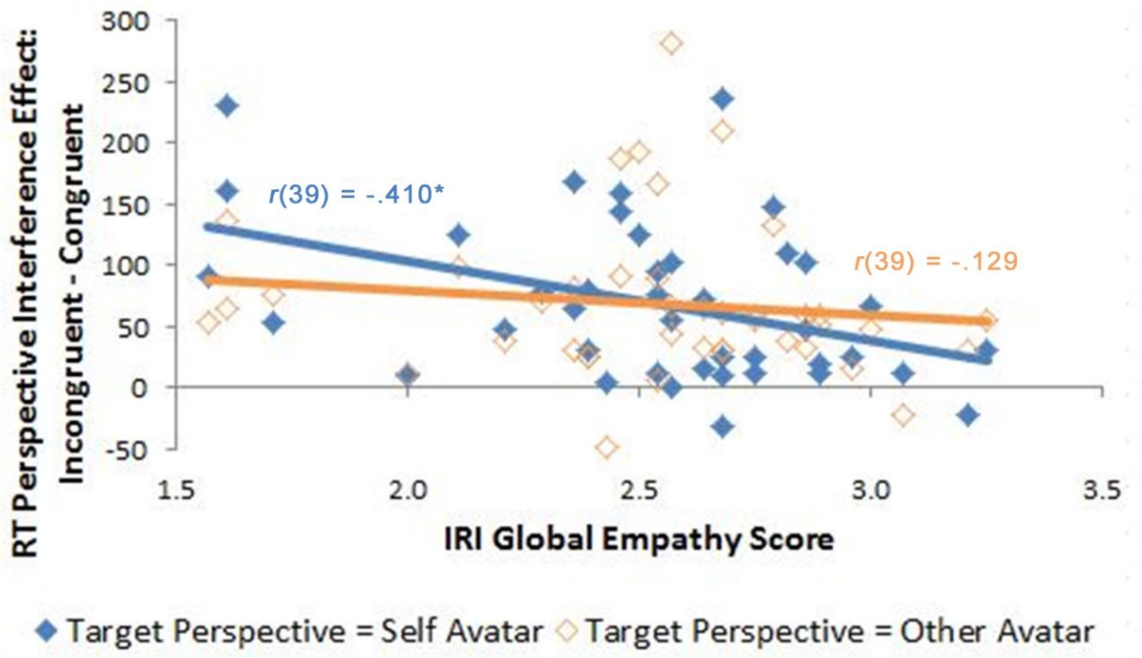

Figure S2. Visualisation of untransformed RT data for the Target Perspective × Perspective Congruence interaction as a function of IRI global empathy. Significant interactions for overall empathy (and the empathic-concern subscale, not pictured) were associated with less susceptibility to distraction when the Self (vs. Other) avatar was the target perspective. * $p < .0125$ (i.e., Bonferroni-corrected α).

Empathy subscales. Results for the perspective-taking, fantasy, and empathic-concern subscales were similar to those reported for the global empathy score. All three covariates showed trending main effects characterised as negative correlations with overall response latency. The same measures also correlated negatively with the magnitude of the perspective-congruence effect (significant: perspective taking, empathic concern; marginal: fantasy). In other words, these measures were associated with overall better performance and a relatively smaller cost of selecting between conflicting perspectives (see also efficiency analysis: 3.2.3).

For the empathic-concern and perspective-taking subscales, the negative correlation with the perspective-congruence effect was modulated by target perspective, although this effect was only marginal for the perspective-taking subscale. For the empathic-concern subscale, the significant three-way interaction accounted for 22% of the total variance. Post-hoc contrasts revealed that higher empathy scores on either subscale were associated with smaller perspective-congruence effects when the Self avatar was the target (empathic concern: $r[39] = -.471$, $p = .002$; perspective taking: $r[39] = -.455$, $p = .003$). The same relationship was unreliable when the Other avatar was the target (empathic concern: $r[39] = -.156$, $p = .33$; perspective taking: $r[39] = -.190$, $p = .23$).

Examining the same interaction at each level of perspective-congruence, we found that empathic-concern and perspective-taking scores were associated with decreased prioritisation of the Self avatar relative to the Other avatar on congruent trials (empathic concern: $r[39] = -.318$, $p = .043$; perspective taking: $r[39] = -.245$, $p = .11$) compared to incongruent trials (empathic concern: $r[39] = .263$, $p = .097$; perspective taking: $r[39] = .234$, $p = .14$). However, unlike the analysis for the global empathy covariate, only the first set of contrasts survived Bonferroni correction for multiple comparisons, $\alpha/4 = .0125$.

Finally, as in the global empathy analysis (see also efficiency analysis in the main text: 3.2.3), the personal-distress subscale showed a qualitatively distinct pattern compared to the perspective-taking, fantasy, and empathic-concern subscales. Unlike these measures, personal distress did not reliably interact with perspective congruence. Additionally, personal distress was the only measure to show an overall trend for reduced prioritisation of the Self avatar (i.e., marginally smaller target-perspective effect).

In summary, empathy (viz., perspective-taking and empathic-concern subscales) were reliably associated with reduced susceptibility to distraction from distractor perspectives, regardless of target perspective, consistent with the analysis of efficiency means reported in the main text (3.2.3). Critically, empathic concern was the only subscale to reliably modulate the Target Perspective × Perspective Congruence interaction. Consistent with the global empathy analysis, high empathic concern was associated with less susceptibility to distraction when adopting the Self (vs. Other) avatar's perspective. The perspective-taking subscale showed a similar albeit non-significant trend. Finally, the personal-distress analysis yielded a distinct pattern of results, showing a marginal negative correlation with Self avatar prioritisation (i.e., main effect of target perspective).

3.3. Cognitive Assessment Data for Experiment 5

Table S2

Demographic and Cognitive Measures for Older Participants, Experiment 5

Assessment	Measure	*N*	*M*	*SD*	Max	Min	Cut-Off
Demographics	Age	31	71.1	6.0	83	60	N/A
	Years of education	31	12.7	2.7	18	10	N/A
OCS	Picture naming	26	3.9	0.3	4	3	Less than 3
	Semantics	26	3.0	0.0	3	3	Less than 3
	Orientation	26	4.0	0.0	4	4	Less than 4
	Visual field	26	4.0	0.0	4	4	Less than 4
	Sentence reading	26	15.0	0.0	15	15	Less than 14
	Number writing	26	3.0	0.0	3	3	Less than 3
	Computation	26	4.0	0.2	4	3	Less than 3
	Broken hearts cancellation	26	47.5	2.6	50	42	Less than 42
	Imitation	26	12.0	0.2	13	12	Less than 8
	Verbal recall/ recognition memory	26	3.9	0.3	4	3	Less than 3
	Episodic recognition	26	4.0	0.0	4	4	Less than 3
	Executive score	26	-0.7	1.4	6	-2	Greater than 4

Note. Cut-off scores for the OCS are taken from Demeyere et al., 2015.

3.4. Supplementary Analysis for Experiment 5

3.4.1. Introduction

All tasks used in the experiment presented in the main text required participants to respond according to whether target stimuli were matched or mismatched to a given response criterion. We provide brief descriptions here to remind the reader of these tasks. Full details on each task are available in the main text. In brief, the avatar identity-matching task required participants to respond based on whether an avatar image (e.g., blue avatar) matched its accompanying label (e.g., “OTHER”). The perspective-taking tasks (1PP-3PP and 3PP-3PP) both required participants to respond based on whether the trial prompt (e.g., “Your avatar” [will see] “3” [dots]) was consistent (i.e., true or false) with the subsequently presented virtual room. In all three tasks, each response type occurred with equal probability. As discussed in the main text, performance on these three tasks is typically more reliable for trials requiring a match/true compared to a mismatch/false response. Hence, main analyses for the avatar identity-matching and perspective-taking tasks focussed on “match” and “true” trials, respectively. To provide a fuller account of the data, we provide analyses here that include match/true and mismatch/false trials together in the same analysis.

All three task analyses reported below were conducted on the same younger and older samples described in the main text. RT data were re-standardised at the trial level for each participant to include mismatch/false-response trials in the computation of Z-scores. Untransformed RT data are provided in Appendix 3.5., and transformed RTs and corresponding accuracy data are reported in Tables S3−S5, all found in this present section.

3.4.2. Avatar Identity-Matching Task

To condense reporting of results, standardised RT and accuracy data for the avatar identity-matching task are reported in Table S3 (for unstandardised RTs, see Appendix 3.5.).

Table S3

Descriptive Statistics for the Avatar Identity-Matching Task: Match/Mismatch Trials, Experiment 5

Response index	Age group	Avatar image	Matched label		Mismatched label	
Z_{RT}	Younger	Self	-.402	(0.073)	.226	(0.054)
		Other	.250	(0.062)	.274	(0.046)
	Older	Self	-.462	(0.076)	.137	(0.056)
		Other	.222	(0.064)	.340	(0.047)
Accuracy	Younger	Self	.946	(0.009)	.851	(0.020)
		Other	.735	(0.031)	.927	(0.022)
	Older	Self	.961	(0.010)	.917	(0.020)
		Other	.775	(0.033)	.898	(0.023)

Note. Standard errors of the mean are provided in parentheses

Response latency. Z-transformed RTs were analysed using a 2 (Response: match, mismatch) × 2 (Avatar Identity: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. Consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012), the ANOVA revealed overall faster responses for match compared to mismatch trials, $F(1,54) = 72.3$, $MSE = .091$, $p < .001$, $\eta_p^2 = .572$, and for the Self avatar compared to the Other avatar, $F(1,54) = 58.8$, $MSE = .150$, $p <$

.001, $\eta_p^2 = .521$, especially for match trials, (Response × Avatar Identity interaction: $F(1,54) = 39.1$, $MSE = .105$, $p < .001$, $\eta_p^2 = .420$). No effect of age group was observed for standardised response latencies, all $p > .37$.

Accuracy. The same three-way split-plot ANOVA was also performed on participants' accuracy scores. Results revealed more accurate performance for mismatch compared to match responses, $F(1,54) = 7.34$, $MSE = .015$, $p = .009$, $\eta_p^2 = .120$, and for the Self compared to the Other avatar, $F(1,54) = 36.3$, $MSE = .011$, $p < .001$, $\eta_p^2 = .402$, especially for match trials (Response × Avatar Identity interaction: $F(1,54) = 64.6$, $MSE = .011$, $p < .001$, $\eta_p^2 = .545$). Critically, the Response × Avatar Identity interaction was further modulated by age group in a three-way interaction, $F(1,54) = 4.52$, $MSE = .011$, $p = .038$, $\eta_p^2 = .077$. To better understand age differences in preference for the Self avatar, we conducted separate follow-up ANOVAs for match and mismatch trials.

Match trials. As in the main text analysis, results revealed a robust main effect of avatar identity, $F(1,54) = 71.3$, $MSE = .015$, $p < .001$, $\eta_p^2 = .569$, with more accurate performance for the Self avatar ($M = .953$) compared to the Other avatar ($M = .755$). No effects of age were observed, all $p > .25$. Rather robust prioritisation of self-associated stimuli on match trials is consistent with previous findings in young-adult samples using the same (Mattan, Quinn, Apperly, et al., 2015) or similar (e.g., Sui et al., 2012, 2013) perceptual-matching paradigms.

Mismatch trials. Unlike for match trials, reliable self-prioritisation was not observed for mismatch trials, $F(1,54) = 3.32$, $p = .074$. In fact, there was an overall trend for greater accuracy for the Other avatar ($M = .912$) compared to the Self avatar ($M = .884$). Critically, a reliable Avatar Identity × Age Group interaction was observed, $F(1,54) = 9.06$, $MSE = .007$, $p = .004$, $\eta_p^2 = .144$. Contrasts testing for age differences in performance for the Self and Other avatars revealed that older participants were more accurate for Self avatar relative to younger adults (M_{older} = .917, $M_{younger}$ = .851), $t(54) = 2.30$, $d = 0.625$, $p = .026$. No reliable difference was observed between groups for the Other avatar, (M_{older} = .898, $M_{younger}$ = .927), $t(54) = 0.910$, $p = .37$. A separate set of contrasts within each age group showed that only younger adults showed a reliable effect of avatar identity for mismatch trials, $t(28) = 3.88$, $d = 0.720$, $p = .001$, with greater accuracy for the other avatar compared to the Self avatar. Older adults showed similar performance for the Self and Other avatars for mismatch trials, $t(26) = 0.750$, $p = .46$.

Discussion. In summary, younger and older adults showed superior performance for the trials involving avatar-label matches compared to avatar-label mismatches and for the Self avatar compared to the Other avatar. This latter effect was magnified on match trials in particular. These findings are consistent with previous work on social tagging showing that participants prioritise the self when learning novel self-associations (e.g., Frings & Wentura, 2014; Mattan, Quinn, Apperly, et al., 2015; Sui et al., 2012, 2013).

Notably, this experiment builds on previous findings by showing that older adults were relatively more resistant to errors on mismatch trials for the Self avatar: Whereas older adults performed similarly for both avatars on mismatch trials, younger adults were less accurate for the Self avatar relative to the Other avatar. One intriguing interpretation is that older adults may be equally attuned to the self-relevance of the avatar and the label, showing similar performance whenever either appears (i.e., Self mismatch or Other mismatch, respectively) relative to when neither appears (i.e., Other match). Indeed, of all conditions, older participants performed most poorly for the other match trials (see Table S1). In contrast, younger adults may be more sensitive to self-relevance of the label rather than the avatar, showing better performance whenever the self label was present (i.e., Self match and

Other mismatch) relative to when the other label was present (i.e., Self mismatch and Other match, respectively). As can be seen in Table S1, younger adults were most accurate on Self match and Other mismatch trials (which present either self or putatively high-relevance friend labels) compared to Other match and Self mismatch trials (which present either friend or low-relevance other labels). In summary, older adults were similarly sensitive to the presence of relatively novel (i.e., Self avatar) and existing (i.e., self label) associations, whereas younger adults are more sensitive to the latter than the former. This pattern is consistent with previous work showing that older adults are more sensitive to self-relevance in different experimental paradigms (Yiwei Chen, 2004; Germain & Hess, 2007; Hess et al., 2001; Hess, 2005, 2014). Further research is needed to better understand the mechanisms supporting attention to established versus novel self-associations as a function of age.

3.4.3. 3PP-3PP Task

To condense reporting of results, standardised response latencies and accuracy descriptive statistics are reported in Table S4 (for unstandardised RTs, see Appendix 3.5). Following convention, we report all significant effects in this section. However, only significant statistics pertaining to age are included in the text, consistent with the current study's focus on age effects. All other significant statistics from 3PP-3PP task ANOVAs are summarised in Table S5.

Response latency. Z-transformed RTs were analysed using a 2 (Trial Type: true, false) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. Replicating previous findings (Mattan, Quinn, Apperly, et al., 2015), all main effects were significant, with the exception of age group. Younger and older participants were faster for true than for false trials, for congruent versus incongruent trials, and for the

Self avatar compared to the Other avatar (i.e., self-prioritisation effect, see Supplementary Table 6 for descriptive statistics).

Relevant to our hypotheses on social-cognitive ageing, a significant three-way Perspective Congruence × Target Perspective × Age Group interaction was found, $F(1,56) = 5.15$, $MSE = .078$, $p = .027$, $\eta_p^2 = .084$. To better understand this interaction, separate 2 (Target Perspective: self, other) × 2 (Age Group: younger, older) split-plot ANOVAs were computed for congruent and incongruent trials (see also Figure S3).

Table S4

Descriptive Statistics for the 3PP-3PP Task: True/False Trials, Experiment 5

Response index	Age group	Trial Type	Perspective congruence	Self avatar		Other avatar		Self-prioritisation
Z_{RT}	Young	True	Congruent	-.223	(.050)	-.108	(.058)	.115
			Incongruent	-.080	(.049)	.014	(.071)	.094
		False	Congruent	.029	(.050)	.028	(.060)	.000
			Incongruent	.125	(.059)	.287	(.063)	.162
	Old	True	Congruent	-.188	(.050)	.030	(.058)	.218
			Incongruent	-.041	(.049)	.049	(.071)	.090
		False	Congruent	-.062	(.050)	.154	(.060)	.216
			Incongruent	.060	(.059)	.076	(.063)	.016
Accuracy	Young	True	Congruent	.864	(.021)	.830	(.019)	.034
			Incongruent	.828	(.025)	.774	(.026)	.054
		False	Congruent	.815	(.023)	.825	(.025)	-.011
			Incongruent	.780	(.025)	.802	(.022)	-.022
	Old	True	Congruent	.869	(.021)	.828	(.019)	.041
			Incongruent	.841	(.025)	.821	(.026)	.019
		False	Congruent	.804	(.023)	.815	(.025)	-.011
			Incongruent	.834	(.025)	.841	(.022)	-.006

Note. Standard errors of the mean are provided in parentheses

Congruent trials. For congruent trials, participants prioritised the Self avatar over the Other avatar. Critically, this effect was modulated by age, $F(1,56) = 6.10$, $MSE = .030$, $p = .017$, $\eta_p^2 = .098$, with older adults showing greater self-prioritisation, $t(28) = 4.30$, $d = 0.797$,

$p < .001$, compared to younger adults, $t(28) = 1.41$, $p = .17$. The self-prioritisation effect for older adults appears to have been driven by their relatively large standardised RTs for the Other avatar's perspective compared to younger adults, $t(56) = 2.88$, $d = 0.757$, $p = .006$. Younger and older adults did not significantly differ in their standardised performance for the Self avatar's perspective, $t(56) = 0.608$, $p = .55$.

Incongruent trials. The same analysis for incongruent trials showed only a significant prioritisation of the Self avatar over the Other avatar. Younger and older adults did not reliably differ in their prioritisation of the Self avatar, $F(1,56) = 0.948$, $p = .33$.

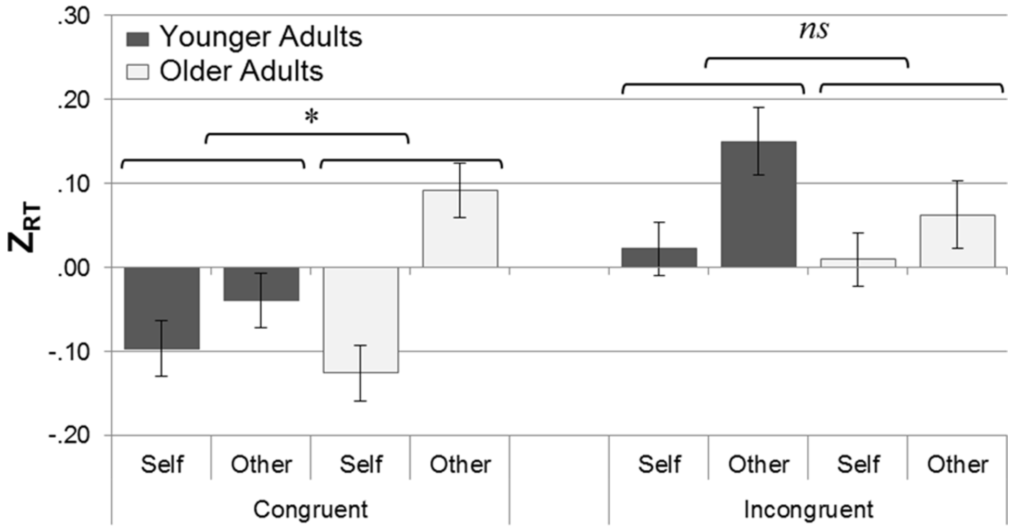

Figure S3. Illustration of the Perspective Congruence × Target Perspective × Age Group interaction in the ZRT data in the 3PP-3PP task. For ease of presentation, data are collapsed across trial type. Both younger and older adults show evidence of Self avatar prioritisation. Relative to younger adults, older adults show a larger self-prioritisation effect (i.e., Self vs. Other), but only for congruent trials (left).

Accuracy. The same three-way split-plot ANOVA was also performed on participants' accuracy scores. Accuracy scores revealed a trend for self-prioritisation ($p = .089$). Target perspective significantly interacted with trial type, with significant self-prioritisation for true trials, $t(57) = 3.57$, $d = 0.469$, $p = .001$, but not for false trials, $t(57) = 1.29$, $p = .20$. No main effects or interactions were found for the age group or any other factor, all $p > .12$.

Table S5

ANOVA Summaries for the 3PP-3PP Task: True/False Trials, Experiment 5

Data	Analysis	Effect	$F(1,56)$	*MSE*	*p*	η_p^2
Z_{RT}	Omnibus	Trial type (TT)	12.440	.225	.001	.182
		Target perspective (TP)	21.747	.069	.000	.280
		Perspective congruence (PC)	9.689	.129	.003	.147
		PC × TP × Age	5.152	.078	.027	.084
	Congruent only*	TP	17.877	.030	.000	.242
		TP × Age	6.095	.030	.017	.098
	Incongruent only*	TP	5.534	.043	.022	.090
Accuracy	Omnibus	TP	2.992	.006	.089	.051
		TT × TP	12.176	.006	.001	.179

Note. * Follow-up analyses collapsed across the avatar identity factor. AI = Avatar Identity, PC = Perspective Congruence, TP = Target Perspective, TT = Trial Type

Discussion. As in the main text analysis, results confirmed previous reported effects, showing an enhanced computational advantage for Self avatar (Mattan, Quinn, Apperly, et al., 2015) and superior performance for trials in which both perspectives were congruent (Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012). These effects were more reliable in the response latency data compared to accuracy data.

More interestingly, analysis of response latencies revealed that older adults were more biased toward the Self avatar on congruent trials, but not on incongruent trials. This suggests that older adults showed an age-specific self-prioritisation effect at the stage of perspective computation (i.e., congruent trials). In light of this finding, future work on social-cognitive ageing should consider not only age differences in perspective selection (see Moran, 2013, for a review), but also perspective computation. Contrary to our predictions, older adults showed no evidence of poorer perspective-selection performance compared to younger adults. However, it is worth noting that the Self avatar's advantage at the perspective-computation stage for older adults disappeared by the perspective-selection stage; both age groups showed similar self-prioritisation on incongruent trials, suggesting age-related difficulties in perspective selection (e.g., German & Hehman, 2006; Henry et al., 2013; Moran et al., 2012) may mask motivation-related biases manifesting at earlier stages of perspective taking.

We note that the Perspective Congruence × Target Perspective × Age Group interaction was not observed in the analysis of true trials only presented in the main text. In the absence of an interaction with trial type in this supplementary analysis, we can only speculate regarding the cause of this discrepancy. One possibility is that false trials in the 3PP-3PP task are less susceptible to the confounds that have been widely acknowledged in 1PP-3PP tasks (Mattan, Quinn, Apperly, et al., 2015; Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010), and therefore improve the signal to noise ratio. In both tasks, false trials present scenes in which neither perspective matches the prompt, leading to the same behavioural response (viz., “false”). Nonetheless, participants perform differently in each case. In the 3PP-3PP task, false trials result in reliably slower RTs (Mattan, Quinn, Apperly, et al., 2015, Experiment 2; see also present supplementary analysis). However, in the 1PP-3PP task (see Appendix 3.4.4.), participants were reliably *faster* for false trials, suggesting these trials are particularly easy (benefitting older adults in particular). This is contrary to the notion that false trials should engage a more thorough re-checking process (see Mattan, Quinn, Apperly, et al., 2015). One reason for this may be that false trials in the 1PP-3PP task always present fewer dots than are presented in the prompt, allowing participants to strategically reject the prompt based on a simple computation of the number of dots present in the virtual room (see Samson et al., 2010). For example, if the prompt predicts three (or two) dots and only two (or one) are visible, then no perspective computation or selection is required. The reliability of false trials in VPT paradigms represents an important methodological question that merits further research. If false trials are found to be reliable in future iterations of the 3PP-3PP task, this could considerably improve the power and efficiency of the paradigm.

3.4.4. 1PP-3PP Task

To condense reporting of results, standardised response latency and accuracy descriptive statistics are reported in Table S6 (for unstandardised RTs, see Appendix 3.5.). Following convention, we report all significant effects in this section. However, only significant statistics pertaining to age are included in the text, consistent with the current study's focus on age effects. All other significant statistics from the 1PP-3PP task omnibus ANOVA are summarised in Table S7. All significant follow-up ANOVA statistics are provided in Table S8.

Response latency. Z-transformed RTs were analysed using a 2 (Trial Type: true, false) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: first-person, third-person) × 2 (Avatar Identity: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor. We start by reporting effects across younger and older participants before detailing effects that were modulated by age.

Age-independent effects. Significant main effects were consistent with previous findings from younger adults (Mattan, Quinn, Apperly, et al., 2015; Surtees & Apperly, 2012), with faster overall performance for congruent compared to incongruent trials and for the first- versus third-person perspective. Contrary to a previously observed null effect of trial type (Mattan, Quinn, Apperly, et al., 2015), participants were faster overall for false compared to true trials. All main effects were implicated in higher order interactions, as detailed below.

Table S6

Descriptive Statistics for the 1PP-3PP Task: True/False Trials, Experiment 5

Response index	Age group	Trial Type	Perspective congruence	Avatar identity	First-person		Third-person		1PP bias	Mean
Z_{RT}	Younger	True	Congruent	Self	-.203	(.079)	-.044	(.077)	.160	-.123
				Other	-.283	(.071)	.007	(.071)	.290	-.138
			Incongruent	Self	-.077	(.068)	.424	(.071)	.501	.174
				Other	-.136	(.063)	.495	(.096)	.631	.179
		False	Congruent	Self	-.203	(.061)	.080	(.065)	.283	-.061
				Other	-.180	(.049)	-.010	(.054)	.170	-.095
			Incongruent	Self	-.251	(.054)	.535	(.078)	.786	.142
				Other	-.278	(.056)	.359	(.071)	.637	.041
	Older	True	Congruent	Self	-.249	(.079)	-.018	(.077)	.231	-.133
				Other	-.100	(.071)	.305	(.071)	.405	.102
			Incongruent	Self	.014	(.068)	.514	(.071)	.500	.264
				Other	.037	(.063)	.568	(.096)	.530	.302
		False	Congruent	Self	-.268	(.061)	-.032	(.065)	.237	-.150
				Other	-.423	(.049)	-.144	(.054)	.279	-.283
			Incongruent	Self	-.480	(.054)	.550	(.078)	1.030	.035
				Other	-.380	(.056)	.528	(.071)	.908	.074
Accuracy	Younger	True	Congruent	Self	.952	(.018)	.948	(.018)	.004	.950
				Other	.897	(.019)	.905	(.026)	-.009	.901
			Incongruent	Self	.832	(.024)	.897	(.026)	-.065	.864
				Other	.845	(.027)	.862	(.027)	-.017	.853
		False	Congruent	Self	.922	(.022)	.894	(.024)	.028	.908
				Other	.935	(.017)	.915	(.020)	.020	.925
			Incongruent	Self	.950	(.018)	.853	(.025)	.097	.902
				Other	.957	(.014)	.871	(.026)	.086	.914
	Older	True	Congruent	Self	.918	(.018)	.888	(.018)	.030	.903
				Other	.892	(.019)	.901	(.026)	-.009	.897
			Incongruent	Self	.927	(.024)	.797	(.026)	.129	.862
				Other	.892	(.027)	.819	(.027)	.073	.856
		False	Congruent	Self	.914	(.022)	.892	(.024)	.022	.903
				Other	.909	(.017)	.905	(.020)	.004	.907
			Incongruent	Self	.948	(.018)	.823	(.025)	.125	.886
				Other	.948	(.014)	.870	(.026)	.078	.909

Note. Standard errors of the mean are provided in parentheses

Consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015, Experiment 2), a significant Trial Type × Target Perspective interaction showed a larger first- over third-person advantage for false trials, $t(57) = 17.5$, $d = 2.30$, $p < .001$, compared to true trials, $t(57) = 7.60$, $d = 0.998$, $p < .001$. Also, consistent with a previously observed Perspective Congruence × Target Perspective interaction (Mattan, Quinn, Apperly, et al., 2015), a larger first-person advantage was observed for incongruent trials, $t(57) = 19.7$, $d = 2.58$, $p < .001$, than for congruent trials, $t(57) = 6.57$, $d = 0.862$, $p < .001$. This Perspective Congruence × Target Perspective interaction was further modulated in a three-way interaction with trial type. Separate 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: first-person, third-person) follow-up ANOVAs were conducted for true- and false-prediction trials. For both true and false trials, results revealed superior performance for congruent versus incongruent trials and for first- versus third-person trials. In both cases, greater first-person prioritisation was observed on incongruent trials, but this effect was twice as large for false trials ($\eta_p^2 = .624$) compared to true trials ($\eta_p^2 = .290$).

Unlike in previous research (cf. Mattan, Quinn, Apperly, et al., 2015), trial type also interacted with avatar identity, resulting in a cross-over pattern. For true trials, participants performed better when the Self avatar compared to the Other avatar was present, $t(57) = 2.09$, $d = 0.274$, $p = .041$. For false trials, participants performed better when the Other avatar compared to the Self avatar was present, $t(57) = 2.49$, $d = 0.327$, $p = .016$. This pattern was further modulated by target perspective (Trial Type × Target Perspective × Avatar Identity interaction). Separate 2 (Trial Type: true, false) × 2 (Avatar Identity: self, other) follow-up ANOVAs were conducted for first-person and third-person trials, collapsing across the perspective congruence and age group factors. For the first-person perspective, results revealed only a main effect of trial type, with faster responses for false trials. For the third-person perspective, results revealed only a significant Trial Type × Avatar Identity cross-over interaction, with better performance for the Self avatar on true trials, $t(57) = 2.25$, $d = 0.296$, $p = .028$, and better performance for the Other avatar on false trials, $t(57) = 2.44$, $d = 0.320$, $p = .018$. In sum, the novel Trial Type × Avatar Identity cross-over interaction was specific to trials in which the third-person perspective was the target.

In summary, both younger and older participants prioritised the first- over the third-person perspective, an effect that was magnified for false and incongruent trials. Avatar identity (associated with the third-person perspective) had opposing effects depending on trial type. Relative to the Other avatar, the Self avatar facilitated performance on true trials and hindered performance on false trials.

Age effects. A significant Trial Type × Age Group interaction, $F(1,56) = 5.00$, $MSE = .457$, $p = .029$, $\eta_p^2 = .082$, showed that the unexpected advantage for false over true trials was driven by older adults. In line with the main effect of trial type, older adults showed significantly faster performance on false ($M = -.081$) compared to true trials ($M = .134$), $t(28) = 3.84$, $d = 0.714$, $p = .001$. Consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015), younger adults did not show a reliable effect of trial type, $t(28) = 0.237$, $p = .81$. Consistent with the analysis of true trials only in the main text, a significant Avatar Identity × Age Group interaction was also observed, $F(1,56) = 4.28$, $MSE = .089$, $p = .043$, $\eta_p^2 = .071$, showing that older adults were slower compared to younger adults when the Other avatar was present ($M_{older} = .049$, $M_{younger} = -.003$), $t(56) = 2.53$, $d = 0.664$, $p = .014$. No difference was found between younger and old on trials where the Self avatar was present ($M_{older} = .003$, $M_{younger} = .033$), $t(56) = 1.38$, $p = .17$.

Finally, age was implicated in two four-way interactions, both involving the trial type and perspective congruence factors: (1) Trial Type × Perspective Congruence × Target

Perspective × Age Group (see Figure S5), $F(1,56) = 5.18$, $MSE = .096$, $p = .027$, $\eta_p^2 = .085$, and (2) Trial Type × Perspective Congruence × Avatar Identity × Age Group (see Figure S4), $F(1,56) = 8.88$, $MSE = .085$, $p = .004$, $\eta_p^2 = .137$. Consistent with analyses for the 3PP-3PP task and the present study's focus on the perspective-computation and perspective-selection stages, we conducted follow-up ANOVAs at each level of the perspective congruence factor. To condense the reporting of follow-up ANOVAs, the results reported below focus on effects that characterise the above four interactions. However, all significant follow-up ANOVA statistics can be found in Table S8.

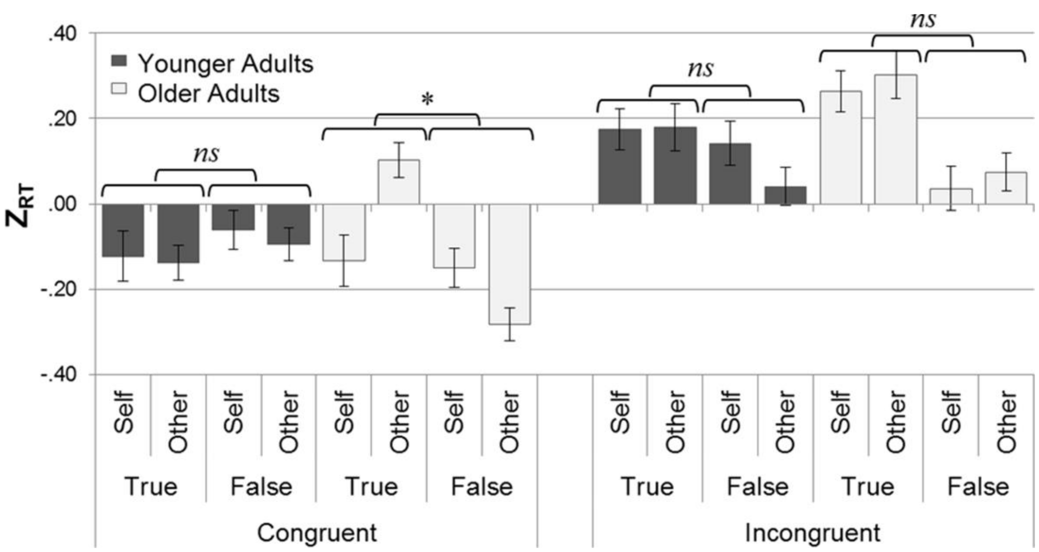

Figure S4. Illustration of the Trial Type × Perspective Congruence × Avatar Identity × Age Group interaction in the Z_{RT} data in the 1PP-3PP task. For ease of presentation, data are collapsed across target perspective. Older (vs. younger) adults show an especially large Self avatar prioritisation effect (i.e., Self vs. Other) for true congruent trials (left).

Congruent trials. For congruent trials, the Trial Type × Target Perspective interaction was non-significant, $F(1,56) = 0.194$, $p = .66$. The three-way interaction with age was also non-significant, $F(1,56) = 0.211$, $p = .65$. The Trial Type × Avatar Identity interaction was significant, $F(1,56) = 11.0$, $MSE = .100$, $p = .002$, $\eta_p^2 = .164$, showing a cross-over pattern consistent with the Trial Type × Avatar Identity from the initial analysis (i.e., bias for the Self avatar on true trials and for the Other avatar on false trials). However, this interaction was further modulated by age group (see Figure S4), $F(1,56) = 8.91$, $MSE = .100$, $p = .004$, $\eta_p^2 = .137$. Follow-up ANOVAs within each age group show that this interaction pattern was only reliable for older adults, $F(1,28) = 23.6$, $MSE = .084$, $p < .001$, $\eta_p^2 = .458$, and not younger adults, $F(1,28) = 0.046$, $p = .83$.

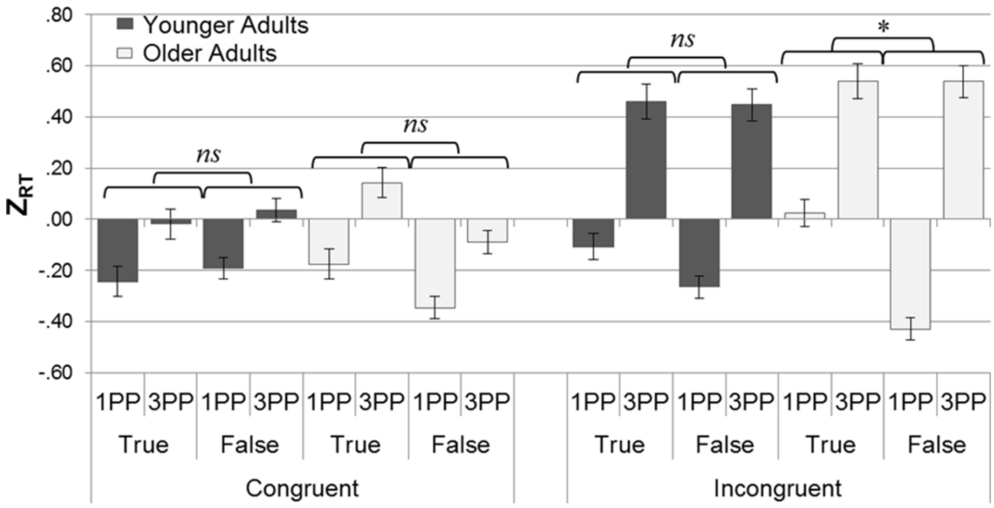

Figure S5. Illustration of the Trial Type × Perspective Congruence × Target Perspective × Age Group interaction in the ZRT data in the 1PP-3PP task. For ease of presentation, data are collapsed across avatar identity. Older (vs. younger) adults show an especially large first-person prioritisation effect (i.e., 1PP vs. 3PP) for false incongruent trials (right).

Incongruent trials. For incongruent trials, the Trial Type × Target Perspective was significant, $F(1,56) = 14.2$, $MSE = .184$, $p < .001$, $\eta_p^2 = .202$, showing a larger first-person advantage for false compared to true trials, similar to the Trial Type × Target Perspective from the original analysis. This two-way interaction was marginally modulated by age (see Figure S5), $F(1,56) = 3.74$, $MSE = .184$, $p = .058$, $\eta_p^2 = .063$. Follow-up ANOVAs within each age group show that this interaction pattern was only reliable for older adults, $F(1,28) = 15.1$, $MSE = .198$, $p = .001$, $\eta_p^2 = .350$, and not for younger adults, $F(1,28) = 1.81$, $p = .19$. Older adults showed significant first-person prioritisation for both true, $t(28) = 5.31$, $d = 0.986$, $p < .001$, and false trials, $t(28) = 16.2$, $d = 3.02$, $p < .001$, showing a particularly large effect for the latter. The Trial Type × Avatar Identity interaction was non-significant, $F(1,56) = 1.21$, $p = .28$. The three-way interaction with age was also non-significant, $F(1,56) = 1.22$, $p = .27$.

Age effects summary. A number of interactions with age provided some important caveats to the age-independent findings reported above. First, the RT advantage for the first-person perspective on false incongruent trials was driven by older adults. This suggests that older adults showed a first-person perspective-selection bias. Second, older adults were significantly slower than younger adults when the Other (vs. Self) avatar was present in the scene. When the Self avatar was present, both age groups performed comparably. Third, younger and older adults both prioritised the Self avatar on true trials and the Other avatar on false trials. However, this pattern was only reliable for congruent (and not incongruent) trials and was driven primarily by older adults, suggesting a perspective-computation bias for the Self avatar in this age group, irrespective of target perspective (cf. Mattan, Quinn, Apperly, et al., 2015). We note here that this computation bias for the self in older adults was not modulated by perspective congruence in the main text.

Accuracy. As for the standardised RT data, accuracy scores were analysed using a 2 (Trial Type: true, false) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Target Perspective: first-person, third-person) × 2 (Avatar Identity: self, other) × 2 (Age Group: younger, older) split-plot ANOVA, with age group as the between-subjects factor.

Age-independent effects. Significant main effects were consistent with previous findings from younger adults (e.g., Mattan, Quinn, Apperly, et al., 2015, Experiment 2; Surtees & Apperly, 2012), with more accurate performance for congruent compared to incongruent trials and for the first- versus third-person perspective. Similar to the response latency results, participants showed marginally greater accuracy for false compared to true trials (p = .062). All main effects were implicated in higher order interactions, as detailed below.

Consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015, Experiment 2) and the RT analysis above, a significant Trial Type × Target Perspective interaction showed a larger first- over third-person advantage for false trials, $t(57) = 5.40$, $d = 0.709$, $p < .001$, than for true trials, $t(57) = 1.25$, $p = .22$. Similar to results reported by Mattan and colleagues, trial type also interacted with perspective congruence, characterised by a reliable congruence effect for true trials, $t(57) = 4.57$, $d = 0.601$, $p < .001$, but not for false trials, $t(57) = 0.928$, $p = .36$. Also consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015, Experiment 2; current experiment's RT analysis), target perspective interacted with perspective congruence, resulting in a larger first-person advantage for incongruent trials, $t(57) = 4.89$, $d = 0.642$, $p < .001$, than for congruent trials, $t(57) = 1.31$, $p = .19$.

Consistent with the RT analysis reported above, trial type also marginally interacted with avatar identity (p = .052), resulting in an apparent cross-over pattern. For true trials, participants showed a trend for greater accuracy for the Self avatar compared to the Other avatar, $t(57) = 1.73$, $p = .089$. For false trials, the opposite trend emerged, although this was far from significance, $t(57) = 1.56$, $p = .125$. Unlike in the RT analysis reported above, the Trial Type × Avatar Identity interaction was not reliably modulated by target perspective.

Across younger and older adults, accuracy results were largely consistent with findings from the analysis of Z-transformed RT data. Participants were more accurate for the first- over third-person perspective, an effect that was larger for false versus true trials and for incongruent versus congruent trials. Relative to the presence of the Other avatar, the presence of the Self avatar facilitated true responses and hindered false responses. However, the latter effect was of relatively low reliability, especially compared to the RT analysis.

Age effects. A significant Target Perspective × Age Group interaction, *F*(1,56) = 6.02, *MSE* = .014, *p* = .017, η_p^2 = .097, showed that the first-person perspective was prioritised over the third-person perspective, especially for older adults, *t*(28) = 4.50, *d* = 0.835, *p* < .001, compared to younger adults, *t*(28) = 1.92, *d* = 0.356, *p* = .066. This finding is consistent with evidence of egocentric (i.e., first-person bias) identified in the main text analysis of true trials only.

The Target Perspective × Age Group interaction was significantly modulated in a three-way interaction with trial type, *F*(1,56) = 4.85, *MSE* = .018, *p* = .032, η_p^2 = .080. Follow-up ANOVAs were computed at each level of trial type. Results showed that the Target Perspective × Age Group interaction was reliable for true trials, *F*(1,56) = 9.09, *MSE*= .005, *p* = .004, η_p^2 = .140, but not for false trials, *F*(1,56) = 0.001, *p* = .98. The Target Perspective × Age Group interaction was also significantly modulated in a three-way interaction with perspective congruence, *F*(1,56) = 7.28, *MSE* = .011, *p* = .009, η_p^2 = .115. Follow-up ANOVAs were computed at each level of perspective congruence. Results showed that the Target Perspective × Age Group interaction was reliable for incongruent trials, *F*(1,56) = 10.0, *MSE*= .004, *p* = .002, η_p^2 = .152, but not for congruent trials, *F*(1,56) = 1.70, *p* = .20. In summary, separate three-way interactions showed that older adults prioritised the first- over third-person to a greater extent than younger adults, especially for true (vs. false) trials and for incongruent (vs. congruent) trials. These findings accord with the main text analysis of true trials only.

Age effects summary. As in the analysis of Z-transformed RT data, a number of interactions with age in the accuracy data provided some important caveats to age-independent findings. Older adults were more accurate for the first- (vs. third-) person perspective to a greater extent than younger adults. This effect that was only reliable for true trials and not false trials. (It is worth noting that this age effect was reliable for both true and false trials in the RT analysis, although the effect was larger for false trials.) Finally, the age group difference in first-person prioritisation was also especially notable for incongruent compared to congruent trials, consistent with the main text analysis of true trials only.

Table S7

ANOVA Summaries for the 1PP-3PP Task: True/False Trials, Experiment 5

Data	Effect	*F*(1,56)	*MSE*	*p*	η_p^2
Z_{RT}	Trial type (TT)	6.778	.457	.012	.108
	Target perspective (TP)	236.603	.220	.000	.809
	Perspective congruence (PC)	127.382	.125	.000	.695
	TT × TP	4.847	.219	.032	.080
	PC × TP	110.796	.098	.000	.664
	TT × Avatar identity (AI)	10.753	.083	.002	.161
	TT × Age	4.995	.457	.029	.082
	AI × Age	4.283	.089	.043	.071
	TT × PC × TP	16.442	.096	.000	.227
	TT × TP × AI	4.344	.136	.042	.072
	TT × PC × TP × Age	5.176	.096	.027	.085
	TT × PC × AI × Age	8.877	.136	.004	.137
Accuracy	TT	3.627	.028	.062	.061
	TP	22.556	.014	.000	.287
	PC	15.560	.014	.000	.217
	TT × TP	5.156	.018	.027	.084
	TT × PC	10.761	.011	.002	.161
	PC × TP	13.857	.011	.000	.198
	TT × AI	3.926	.016	.052	.066
	TP × Age	6.017	.014	.017	.097
	TT × PC × TP	2.956	.013	.091	.050
	TT × TP × Age	4.847	.018	.032	.080
	PC × TP × Age	7.276	.011	.009	.115
	TT × PC × TP × Age	3.170	.013	.080	.054

Note. AI = Avatar Identity, PC = Perspective Congruence, TP = Target Perspective, TT = Trial Type

Table S8

Follow-up ANOVAs for the 1PP-3PP Task: True/False Trials, Experiment 5

Data	Collapsed Factors	Follow-Up Analysis	Effect	*F*	*df*	*MSE*	*p*	η_p^2
Z_{RT}	AI, Age	True only	PC	74.05	1,57	.072	.000	.565
			TP	57.79	1,57	.166	.000	.503
			PC × TP	23.27	1,57	.045	.000	.290
		False only	PC	43.45	1,57	.065	.000	.433
			TP	307.12	1,57	.055	.000	.843
			PC × TP	94.66	1,57	.055	.000	.624
	PC, Age	1PP only	TT	12.27	1,57	.158	.001	.177
		3PP only	TT × AI	11.35	1,57	.064	.001	.166
	None	Congruent only	TP	42.84	1,56	.179	.000	.433
			TT × Age	7.54	1,56	.248	.008	.119
			TT × AI	10.97	1,56	.100	.002	.164
			TT × AI × Age	8.91	1,56	.100	.004	.137
		Young: Congruent only	TP	25.04	1,28	.118	.000	.472
		Old: Congruent only	TT	13.65	1,28	.172	.001	.328
			TP	20.11	1,28	.239	.000	.418
			TT × AI	23.63	1,28	.084	.000	.458
		Incongruent only	TT	7.98	1,56	.357	.007	.125
			TP	395.69	1,56	.140	.000	.876
			TT × TP	14.18	1,56	.184	.000	.202
			TT × TP × Age	3.74	1,56	.184	.058	.063
		Young: Incongruent only	TP	235.16	1,28	.101	.000	.894
		Old: Incongruent only	TT	8.83	1,28	.342	.006	.240
			TP	178.58	1,28	.179	.000	.864
			TT × TP	15.11	1,28	.198	.001	.350
Accuracy	PC, AI	True only	TP × Age	9.09	1,56	.005	.004	.140
		False only	TP	28.65	1,56	.003	.000	.338
	TT, AI	Congruent only	None					
		Incongruent only	TP	27.71	1,56	.004	.000	.331
			TP × Age	10.04	1,56	.004	.002	.152

Note. AI = Avatar Identity, PC = Perspective Congruence, TP = Target Perspective, TT = Trial Type

Discussion. As in the 3PP-3PP task, response latency and accuracy data for the 1PP-3PP task were generally consistent, although effects were overall more reliable for the RT data. Taken together, results from this task were largely consistent with previous findings using similar 1PP-3PP paradigms: participants showed robust prioritisation of the first- (vs. third-) person perspective (e.g., Keysar et al., 2000; Mattan, Quinn, Apperly, et al., 2015; Surtees & Apperly, 2012; Vogeley et al., 2004) for congruent (vs. incongruent) perspectives (e.g., Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012), and for false (vs. true) trials. Also consistent with previous findings (Mattan, Quinn, Apperly, et al., 2015), participants showed greater first-person prioritisation on incongruent trials, especially when this configuration was inconsistent with the trial prompt's prediction (i.e., for false trials). In the RT data, this three-way interaction was further modulated by age group, providing evidence that, for older adults, this effect is particularly pronounced. Although the accuracy data showed a trending increase in the same three-way interaction effect for younger rather than older adults, it did not reach statistical significance. Considered in the context of Samson's model of VPT (Ramsey et al., 2013; Samson et al., 2010), older adults' enhanced first-person prioritisation on incongruent trials suggests an egocentric bias during perspective selection, consistent with previous claims based on classic theory-of-mind tasks (German & Hehman, 2006; Moran et al., 2012; Moran, 2013). This finding is discussed in greater detail in the main text. Critically, this first-person selection bias appears to have been aided by older adults' overall bias to respond more quickly and accurately for trials requiring a "false" judgement. Implications for these findings are addressed in greater detail below.

Departing from previous findings using the 1PP-3PP paradigm (Mattan, Quinn, Apperly, et al., 2015), the RT data from the 1PP-3PP task also revealed a number of novel effects involving avatar identity. A significant Trial Type × Avatar Identity interaction (see also accuracy data) revealed that both younger and older adults performed better for true trials when the Self (vs. Other) avatar was present and for false trials when the Other (vs. Self) avatar was present. However, a three-way interaction with target perspective showed that this cross-over interaction was specific to trials in which the third-person perspective was the target. The avatar identity factor also interacted with age group, with older adults showing greater prioritisation of the Self avatar compared to younger adults. This finding was driven by older (vs. younger) adults being relatively slower for trials in which the Other avatar was present. The Avatar Identity × Age Group interaction was further modulated in a four-way interaction with trial type and perspective congruence. This interaction showed that the tendency to prioritise the Self avatar on true trials and the Other avatar on false trials was only reliable for congruent (and not incongruent) trials. Moreover, this pattern was driven primarily by older adults, suggesting a perspective-computation bias for the Self avatar in this age group, irrespective of target perspective (cf. Mattan, Quinn, Apperly, et al., 2015). Further discussion of this finding can be found in the main text. However, we note here that the observed computational bias for older adults appears to be supported by the presence of opposing response biases for the Self and Other avatars (see Trial Type × Avatar Identity interaction) in both age groups and a response bias in older adults for false versus true trials (see Trial Type × Age Group interaction).

True/false response biases. Notably, true/false responses were unexpectedly implicated in all interactions involving self-prioritisation in the 1PP-3PP task. In this task, older participants showed superior performance for the first-person perspective on false incongruent trials. This first-person selection bias in older adults appears to be supported by (1) greater prioritisation of the first-person perspective on false trials (see Trial Type × Target

Perspective interaction) in both age groups, and (2) a response bias in older adults for false versus true trials (see Trial Type × Age Group interaction). It is unclear why the first-person prioritisation bias in older adults was specific to a given response (i.e., trial type). We speculate that older and younger adults may have operated strategically on false trials to rapidly reject the salient first-person perspective (see Geng & Diquattro, 2010). Such a strategy may have been especially helpful for older adults who are more prone to difficulties in the perspective-selection stage (German & Hehman, 2006; Moran et al., 2012; Moran, 2013).

Also in the 1PP-3PP task, older participants also showed superior performance for the Self avatar compared to the Other avatar on true congruent trials. We note that, in the main text analysis, this self bias in older adults is not reliably modulated by perspective congruence. If, as discussed above, false trials in the 1PP-3PP are indeed less reliable than true trials, this raises the possibility that the older adults' self bias may also extend to incongruent trials. This would suggest that older adults' self bias at the perspective-computation stage may carry over into the cognitively more taxing perspective-selection stage. In either case, the Self avatar bias in older adults appears to be supported by (1) a cross-over interaction in both age groups characterised by greater prioritisation of the Self avatar on true trials and the Other avatar on false trials (see Trial Type × Avatar Identity interaction), and (2) an overall bias in older adults for trials in which the Self (vs. Other) avatar was present (see Avatar Identity × Age Group interaction). At face value, it would appear that the Self and Other avatars are associated with prepotent affirmative and negative responses, respectively, possibly reflecting the self's generally high expectancy value (Sui et al., 2014) and/or positive valence (Alicke & Govorun, 2005). Although older adults do tend to show a relative bias for positive over negative stimuli (A. E. Reed & Carstensen, 2012; A.

E. Reed et al., 2014), we note that a similar pattern of age-related response bias in Self avatar prioritisation was unreliable in the 3PP-3PP task. Future research is needed to clarify the role of response biases in VPT tasks. The development of a simplified paradigm avoiding the use of true/false trials may also be helpful (e.g., Mattan, Rotshtein, & Quinn, in press; or see Experiment 6 of the present work).

3.5. Mean Untransformed Data for Experiment 5

3.5.1. Avatar Identity-Matching Task

Table S9

Untransformed RTs: Avatar Identity-Matching Task, Experiment 5

Age group	Avatar image	Matched label		Mismatched label	
Younger	Self	660	(42.7)	769	(43.4)
	Other	776	(46.5)	804	(50.6)
Older	Self	1011	(44.3)	1199	(45.0)
	Other	1241	(48.2)	1286	(52.5)

Note. Standard errors of the mean are provided in parentheses

3.5.2. 3PP-3PP Task

Table S10

Untransformed RTs: 3PP-3PP Task, Experiment 5

Age group	Trial Type	Perspective congruence	Self avatar		Other avatar		Self-prioritisation
Younger	True	Congruent	785	(52.6)	823	(53.9)	38
		Incongruent	811	(46.2)	832	(59.9)	21
	False	Congruent	833	(48.0)	834	(53.0)	1
		Incongruent	852	(47.2)	889	(53.3)	37
Older	True	Congruent	1238	(54.5)	1313	(55.9)	75
		Incongruent	1278	(47.9)	1341	(62.1)	63
	False	Congruent	1269	(49.7)	1355	(54.9)	86
		Incongruent	1317	(48.9)	1331	(55.3)	14

Note. Standard errors of the mean are provided in parentheses

3.5.3. 1PP-3PP Task

Table S11

Untransformed RTs: 1PP-3PP Task, Experiment 5

Age group	Trial Type	Perspective congruence	Avatar identity	First-person	Third-person	First-person prioritisation	Average
Younger	True	Congruent	Self	620 (37.9)	636 (37.9)	16	628
			Other	607 (37.4)	643 (44.8)	36	625
		Incongruent	Self	642 (34.5)	729 (47.3)	87	685
			Other	630 (41.6)	747 (53.9)	117	689
	False	Congruent	Self	605 (33.5)	661 (35.0)	56	633
			Other	610 (25.3)	646 (32.5)	36	628
		Incongruent	Self	585 (25.3)	747 (42.4)	162	666
			Other	596 (28.3)	702 (42.4)	106	649
Older	True	Congruent	Self	939 (39.3)	1030 (39.3)	91	984
			Other	985 (38.8)	1137 (46.4)	152	1061
		Incongruent	Self	1014 (35.8)	1208 (49.0)	194	1111
			Other	1036 (43.1)	1225 (55.8)	189	1130
	False	Congruent	Self	933 (34.7)	1011 (36.3)	78	972
			Other	873 (26.2)	974 (33.7)	101	923
		Incongruent	Self	865 (26.2)	1199 (43.9)	334	1032
			Other	890 (29.3)	1197 (43.9)	307	1044

Note. Standard errors of the mean are provided in parentheses

4.1. Mismatch Trial Analyses for Experiment 6

4.1.1. Performance for Non-Self Shapes

Response time. Analysis of mismatch-trial RTs revealed no significant effects, all $p > .19$. All means and standard errors for RT data are found in Table 4.1.

To conduct a formal comparison of match and mismatch trials, RT scores for non-self shapes were submitted to a 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Trial Type: match, mismatch) repeated-measures ANOVA. Consistent with previous studies (Sui et al., 2012, 2013), a robust effect of trial type emerged, $F(1,45) = 146$, $MSE = 1664$, $p < .001$, $\eta_p^2 = .764$, showing that participants responded more quickly for match than mismatch trials. The main effects for relevance and valence were both non-significant, $F(1,45) = 1.64$, $p = .21$, and $F(1,45) = 0.220$, $p = .64$, respectively. Nonetheless, trial type interacted with valence, $F(1,45) = 5.44$, $MSE = 1329$, $p = .024$, $\eta_p^2 = .108$, but the interaction was not reliable for relevance, $F(1,45) = 2.52$, $MSE = 1660$, $p = .12$, $\eta_p^2 = .053$. All other interactions were non-significant.

Accuracy. The same analysis of mismatch trials in the accuracy data revealed only a marginally significant main effect of valence, $F(1,45) = 3.69$, $MSE = .007$, $p = .061$, $\eta_p^2 = .076$, with a trend for greater accuracy for negative compared to positive identities. Surprisingly, this result is an inversion of the main effect observed for match trials. All other effects were non-significant, all $p > .42$. See Figure 4.2b for accuracy performance for mismatch trials.

To provide a formal comparison of match and mismatch trials, accuracy data were submitted to a three-way (Relevance × Valence × Trial Type) repeated-measures ANOVA to examine the effects of relevance and valence for non-self identities. Results revealed a significant main effect for relevance, $F(1,45) = 5.40$, $MSE = .007$, $p = .025$, $\eta_p^2 = .107$, with participants responding more accurately for high-relevance compared to low-relevance identities. A marginal main effect for valence was also observed, $F(1,45) = 3.55$, $MSE = .009$, $p = .066$, $\eta_p^2 = .073$, with numerically higher accuracy for positive than for negative identities. Unlike for the RT results, the main effect of trial type (i.e., match vs. mismatch) was non-significant, $F(1,45) = 0.614$, $p = .44$. However, trial type interacted with identity valence, $F(1,45) = 14.5$, $MSE = .012$, $p < .001$, $\eta_p^2 = .244$, and relevance, $F(1,45) = 4.29$, $MSE = .010$, $p = .044$, $\eta_p^2 = .087$.

4.1.2. Performance for the Self Shape

Response time. In mismatch trials, performance for the self shape did not reliably differ from any of the four non-self shapes; all *t*-tests were non-significant, $p > .36$.

A 5 (Shape Identity: self, friend, enemy, admired, detested) × 2 (Trial Type: match, mismatch) repeated-measures ANOVA was used to conduct a formal comparison between self-biases on match and mismatch trials. Results reveal a robust effect of trial type, $F(1,45) = 231$, $MSE = 1986$, $p < .001$, $\eta_p^2 = .837$, with participants responding faster for match than mismatch trials. A main effect was also found for shape identity, $F(1,45) = 12.8$, $MSE = 1583$, $p < .001$, $\eta_p^2 = .221$. Consistent with the observed self-biases in match trials (but not mismatch trials), the effect of shape identity was qualified by a Shape Identity × Trial Type interaction, $F(1,45) = 14.3$, $MSE = 1311$, $p < .001$, $\eta_p^2 = .242$.

Accuracy. In mismatch trials, accuracy for the self shape was significantly greater than for the friend shape, $t(45) = 2.42$, $p = .020$, $d = 0.36$, and the admired-figure shape, $t(45) = 3.14$, $p = .003$, $d = 0.46$. All other shape contrasts with the self shape were non-significant, $p > .16$.

A 5 (Shape Identity: self, friend, enemy, admired, detested) × 2 (Trial Type: match, mismatch) repeated-measures ANOVA was used to conduct a formal comparison between self-biases on match and mismatch trials in the accuracy data. Like the RT results, the accuracy analysis revealed a significant main effect of trial type, $F(1,45) = 5.13$, $MSE = .014$, $p = .028$, $\eta_p^2 = .102$, with greater accuracy for match than mismatch trials. A main effect was also found for shape identity, $F(1,45) = 15.0$, $MSE = .007$, $p < .001$, $\eta_p^2 = .250$. Consistent with the differences in self-bias observed between match and mismatch trials (see also RT analysis), shape identity interacted with trial type, $F(1,45) = 8.22$, $MSE = .010$, $p < .001$, $\eta_p^2 = .154$.

4.2. Sensitivity Analysis for Experiment 6: Predicting the Self-Tagging Advantage

4.2.1. Sensitivity Index Computation

Collectively, the RT and accuracy data replicate findings from Sui and colleagues (Sui et al., 2012; Sui, Rotshtein, & Humphreys, 2013) on the self-tagging effect. Namely, self-advantages are most reliably observed for match trials. The subsequent analyses focus on match trials only, to examine the utility of relevance and valence sensitivity in predicting performance for the self shape. It is assumed that mismatch trials require additional decision-making steps (e.g., re-checking; Farell, 1985; Krueger, 1978) that likely obscure not only self-tagging effects (see Sui et al., 2012) but also relevance and valence effects (see results for non-self shapes reported above).

To examine the roles of relevance and valence sensitivity in predicting individual differences in prioritisation of the self shape, it is important to equate for overall differences in performance (see Faust et al., 1999). Therefore, we standardised relevance-sensitivity and valence-sensitivity effect scores (i.e., the extent to which participants' responses differed as a function of non-self-identity relevance and valence, respectively) were computed at the subject level and used to predict self-advantage magnitude. We first Z-transformed all RT and accuracy[17] data for each participant to control for between-participants differences in mean performance and variance, thus giving each participant equal weight in subsequent regression analyses.

[17] Note that the same analysis was also performed on unstandardised accuracy data, as it is not conventional to Z-transform such data. The results were overall very similar (albeit slightly less reliable) compared to the Z-transformed results.

Relevance sensitivity and valence sensitivity were computed by first averaging Z-transformed RTs/accuracy for non-self identities at each level of relevance and valence, respectively, and then calculating difference scores, with larger positive values signifying a larger relevance-/valence-sensitivity effect. For example,

$$RT_{Relevance\ Sensitivity} = zRT_{low\text{-}relevance} – zRT_{high\text{-}relevance}$$

$$Acc_{Relevance\ Sensitivity} = zAcc_{high\text{-}relevance} – zAcc_{low\text{-}relevance}$$

where low-relevance scores represent the average of admired and detested figures and high-relevance scores represent the average of friend and enemy.

4.2.2. Primary Analysis

In separate analyses for RT and accuracy, the two sensitivity scores and their interaction (i.e., Relevance Sensitivity × Valence Sensitivity) were entered as regressors in a general linear model to predict self-advantages relative to each identity (e.g., $RT_{Self–Friend\ Advantage} = zRT_{friend} – zRT_{self}$; $Acc_{Self–Friend\ Advantage} = zAcc_{self} – zAcc_{friend}$). Importantly, the computed relevance-sensitivity and valence-sensitivity effects did not reliably correlate with each other in the RT or accuracy data, p = .14 and .98, respectively.

Self versus friend shape. The friend shape was chosen as a key comparison because friends, like the self, are both valued and relevant to day-to-day life. If the self-advantage is a function of its high relevance and positive valence, then greater sensitivity to relevance and valence should predict smaller self–friend advantages (i.e., a negative correlation between sensitivity and advantage magnitude). To test this hypothesis, the self–friend advantage was regressed on the relevance-sensitivity score, the valence-sensitivity score, and the Relevance × Valence interaction.

Response time. Response latency results show that the three-term model accounts for a significant proportion of the variance in the self-versus-friend advantage, R^2_{adj} = .228, *F*(3,42) = 5.438, $p = .003$. Relevance- and valence-sensitivity effects significantly and negatively predicted the self-versus-friend advantage. (See Table S12 for all regression statistics.) In other words, greater relevance and valence sensitivity predicted smaller self-advantage magnitudes. The Relevance × Valence interaction did not significantly predict the self-versus-friend advantage, $p > .59$.

Accuracy. Accuracy results also show that the three-term model accounts for a significant proportion of the variance in the self-versus-friend advantage, $R^2_{adj} = .144$, $F(3,42) = 3.533$, $p = .023$. As in the RT results, relevance- and valence-sensitivity effects significantly and negatively predicted the self-versus-friend advantage (i.e., with more relevance and valence sensitivity predicting smaller self-advantage magnitude). Importantly, this effect does not appear to be due to ceiling effects as the mean accuracy for matched self trials was 91% (*SD* = 8.2%).

Unlike for the RT results, the Relevance × Valence interaction was also a significant predictor of the self-versus-friend advantage. Simple slopes analysis (Aiken & West, 1991) showed that valence sensitivity was a significant predictor only for participants with low (-1 SD), but not high (+1 SD), relevance-sensitivity scores, $t(45) = 3.113$, $p = .003$, versus $t(45) = 0.983$, $p = .33$, respectively. Given low relevance sensitivity, greater valence sensitivity was associated with a decrease in the accuracy advantage between the self and friend shapes (see Figure 4.5A in 4.2.3.3.). Similarly, relevance sensitivity was a significant predictor only for participants with low (-1 SD), but not high (+1 SD), valence sensitivity scores, $t(45) = 2.451$, $p = .018$, versus $t(45) = 1.444$, $p = .16$, respectively. Given low valence sensitivity, greater relevance sensitivity was associated with a decrease in the accuracy advantage between the self and friend shapes (see Figure 4.5B in 4.2.3.3.). Thus, heightened sensitivity to relevance or valence only diminished the self-advantage if the other sensitivity effect was comparatively small.

Self versus other shapes. Following up on the self-versus-friend analysis, similar regressions were performed for each of the other three shapes relative to the self. The purpose of these analyses was to validate the specificity of relevance and valence effects in predicting the self-tagging effect. If the self-advantage is a Relevance × Valence function, then individual differences in sensitivity to relevance and valence should have different impacts on each identity. Particularly, increased sensitivity on both dimensions should predict an increase in self-prioritisation over the detested figure (i.e., a negative, low-relevance identity). This would result from the detested figure being pushed in a negative direction from the self on each dimension. Additionally, relevance and valence effects should have opposing influences on self-prioritisation over mixed identities such as the enemy (i.e., a negative, high-relevance identity) and the admired figure (i.e., a positive, low-relevance identity).

Response time. The three-term models for all three non-self identities were highly significant, $R^2_{adj} = .409$, $F(3,42) = 11.387$, $p < .001$, $R^2_{adj} = .504$, $F(3,42) = 16.268$, $p < .001$, and $R^2_{adj} = .288$, $F(3,42) = 7.061$, $p = .001$, respectively, for the enemy, the admired figure, and the detested figure. (See Table S12 for all regression statistics.)

As with the self-versus-friend analysis, regression results show that relevance and valence sensitivity each negatively predicted the self-tagging effect—but only where the non-self identity was close to the self (i.e., on the basis of relevance for the enemy and valence for the admired figure). That is, greater relevance sensitivity predicted a smaller RT self-advantage over the high-relevance enemy, and greater valence sensitivity predicted a smaller RT self-advantage over the positive admired figure.

In contrast, where the non-self identity was distant from the self (i.e., on the basis of valence for the enemy, relevance for the admired figure, and both valence and relevance for the detested figure), relevance and valence sensitivity positively predicted the self-tagging effect. That is, greater relevance sensitivity predicated a larger RT self-advantage over the low-relevance admired and detested figures, and greater valence sensitivity predicted a larger RT self-advantage over the negative enemy and detested figure.

Accuracy. The three-term models for the enemy, $R^2_{adj} = .399$, $F(3,42) = 10.972$, $p < .001$, admired figure, $R^2_{adj} = .341$, $F(3,42) = 8.759$, $p < .001$, and detested figure, $R^2_{adj} = .626$, $F(3,42) = 26.156$, $p < .001$, were highly predictive of the self-tagging advantages. (See Table S12 for full regression statistics.) Overall, the results were largely consistent with the RT results reported above. Relevance sensitivity predicted a decreased self-advantage for identities close to the self on that dimension (e.g., enemy) and an increased self-advantage for identities distant from the self on that dimension (e.g., admired and detested figures). Similarly, valence sensitivity predicted smaller self-advantages for identities close to the self on that dimension (e.g., admired figure) and an increased self-advantage for identities distant from the self on that dimension (e.g., enemy and detested figure). Thus, for the detested figure (i.e., low in both valence and relevance), increased sensitivity on either dimension increased the self-advantage magnitude. However, for the enemy (i.e., a negative, high-relevance identity) and the admired figure (i.e., a positive, low-relevance identity), relevance and valence sensitivity had significant and opposing effects on the self-advantage magnitude.

Although the Relevance × Valence interaction was non-significant for the self-versus-enemy and self-versus-admired analyses, it was significant for the self-versus-detested analysis. Simple slopes analysis (Aiken & West, 1991) revealed that the effect of valence sensitivity was a significant predictor of the self-versus-detested advantage for participants with low (-1 SD) and high (+1 SD) relevance-sensitivity scores, $t(45) = 2.030$, $p = .049$, versus $t(45) = 5.325$, $p < .001$, respectively. In other words, the positive effect of valence sensitivity on self-advantage magnitude increased as a function of participants' relevance-sensitivity scores (see Figure 4.6A in 4.2.3.3.). Similarly, relevance sensitivity was a significant predictor of the self-versus-detested advantage only for participants with high (+1 SD), but not low (-1 SD), valence sensitivity scores, $t(45) = 6.241$, $p < .001$, versus $t(45) = 1.552$, $p = .13$, respectively. Given high valence sensitivity, greater relevance sensitivity was associated with a further increase in the accuracy advantage between the self and detested-figure shapes (see Figure 4.6B in 4.2.3.3.). In sum, the positive association of relevance and valence effects on the self-versus-detested accuracy advantage is disproportionately enhanced if both effects are large. Notably, the Relevance × Valence interaction observed for the self-versus-friend analysis did not show this additive pattern. In that analysis, heightened sensitivity to relevance or valence only diminished the self-advantage if the other sensitivity effect was comparatively small. This suggests that these two dimensions may have a more complicated subtractive dynamic for identities that are proximal to the self. This question will be addressed in greater detail in the discussion.

Table S12

Self-Tagging-Effect Regression Summaries, Experiment 6

Contrast	Index	Factor	*B*	*SE(B)*	β	*t*	*p*
Friend vs. Self	Response Time	Constant	0.471	0.055		8.65	.000
		Relevance Sensitivity	**-0.433**	**0.137**	**-0.442**	**-3.17**	**.003**
		Valence Sensitivity	**-0.492**	**0.182**	**-0.363**	**-2.70**	**.010**
		Relevance × Valence	-0.272	0.496	-0.075	-0.55	.586
	Accuracy	Constant	0.235	0.045		5.19	.000
		Relevance Sensitivity	**-0.406**	**0.191**	**-0.386**	**-2.13**	**.039**
		Valence Sensitivity	**-0.363**	**0.139**	**-0.379**	**-2.61**	**.012**
		Relevance × Valence	**1.634**	**0.636**	**0.481**	**2.57**	**.014**
Enemy vs. Self	Response Time	Constant	0.485	0.046		10.45	.000
		Relevance Sensitivity	**-0.400**	**0.116**	**-0.420**	**-3.45**	**.001**
		Valence Sensitivity	**0.473**	**0.155**	**0.359**	**3.05**	**.004**
		Relevance × Valence	-0.678	0.422	-0.191	-1.61	.116
	Accuracy	Constant	0.227	0.044		5.15	.000
		Relevance Sensitivity	**-0.498**	**0.186**	**-0.407**	**-2.68**	**.011**
		Valence Sensitivity	**0.600**	**0.135**	**0.539**	**4.43**	**.000**
		Relevance × Valence	0.456	0.619	0.116	0.74	.465
Admired Figure vs. Self	Response Time	Constant	0.485	0.046		10.45	.000
		Relevance Sensitivity	**0.600**	**0.116**	**0.576**	**5.16**	**.000**
		Valence Sensitivity	**-0.527**	**0.155**	**-0.366**	**-3.40**	**.001**
		Relevance × Valence	-0.678	0.422	-0.175	-1.61	.116
	Accuracy	Constant	0.227	0.044		5.15	.000
		Relevance Sensitivity	**0.502**	**0.186**	**0.431**	**2.70**	**.010**
		Valence Sensitivity	**-0.400**	**0.135**	**-0.377**	**-2.96**	**.005**
		Relevance × Valence	0.456	0.619	0.121	0.74	.465
Detested Figure vs. Self	Response Time	Constant	0.471	0.055		8.65	.000
		Relevance Sensitivity	**0.567**	**0.137**	**0.556**	**4.15**	**.000**
		Valence Sensitivity	**0.508**	**0.182**	**0.360**	**2.79**	**.008**
		Relevance × Valence	-0.272	0.496	-0.072	-0.55	.586
	Accuracy	Constant	0.235	0.045		5.19	.000
		Relevance Sensitivity	**0.594**	**0.191**	**0.373**	**3.11**	**.003**
		Valence Sensitivity	**0.637**	**0.139**	**0.439**	**4.58**	**.000**
		Relevance × Valence	**1.634**	**0.636**	**0.318**	**2.57**	**.014**

Note. Models for all contrasts were significant for both accuracy and response time, $p < .05$. Positive betas indicate a positive relationship with the normalised self-tagging effect magnitude (e.g., relative to the friend). Significant predictors of interest are highlighted in bold.

4.2.3. Supplementary Analysis

If the self is anchoring the effects of relevance and valence for non-self identities, then individual differences in sensitivity to these two dimensions should be associated with mean performance for all non-self identities, but not for the self, which serves as the anchoring point. We therefore tested the same regression models as above, changing the dependent variable from a self-advantage difference score (e.g., $zRT_{friend} – zRT_{self}$) to a simple mean performance score (e.g., zRT_{self}). In separate analyses for RT and accuracy, the two sensitivity scores and their interaction were entered as regressors in a general linear model to predict mean performance for each of the five identities.

Regression models for non-self identities were all significant (all $R^2_{adj} > .51$, $F(3,42) > 16.9$, $p < .001$). Results were identical to analyses using the corresponding self-advantage score as the dependent variable (see Table S13; cf. Table S12): Greater relevance sensitivity predicted faster and more accurate responses to high-relevance targets (friend, enemy), and slower and less accurate responses to low-relevance targets (admired, detested); greater valence sensitivity predicted faster and more accurate responses to positive targets (friend, admired), and slower and less accurate responses to negative targets (enemy, detested).

More importantly, the regression model for the self shape RT scores was non-significant, $F(3,42) = 0.533$, $p = .66$. The same model for accuracy scores significantly predicted mean performance for the self, $R^2_{adj} = .143$, $F(3,42) = 3.495$, $p = .024$. However, none of the three predictors in the model were significant. These results confirm that mean performance for the self is not reliably affected by relevance- or valence-sensitivity. Taken together with the finding that self-advantages are related to relevance and valence sensitivity, these findings are consistent with the self's hypothesised role as an anchor on the dimensions of relevance and valence.

Table S13

Mean-Performance Regression Summaries, Experiment 6

DV	Index	Factor	*B*	*SE(B)*	β	*t*	*p*
Friend	Response Time	Constant	0.110	0.029		3.75	.001
		Relevance Sensitivity	**-0.486**	**0.073**	**-0.709**	**-6.65**	**.000**
		Valence Sensitivity	**-0.465**	**0.098**	**-0.490**	**-4.76**	**.000**
		Relevance × Valence	0.085	0.266	0.033	0.32	.750
	Accuracy	Constant	-0.051	0.024		-2.08	.044
		Relevance Sensitivity	**0.445**	**0.103**	**0.592**	**4.33**	**.000**
		Valence Sensitivity	**0.456**	**0.075**	**0.666**	**6.09**	**.000**
		Relevance × Valence	**-0.823**	**0.342**	**-0.339**	**-2.41**	**.021**
Enemy	Response Time	Constant	0.123	0.026		4.76	.000
		Relevance Sensitivity	**-0.454**	**0.065**	**-0.591**	**-7.02**	**.000**
		Valence Sensitivity	**0.500**	**0.086**	**0.470**	**5.79**	**.000**
		Relevance × Valence	-0.321	0.235	-0.112	-1.37	.179
	Accuracy	Constant	-0.043	0.025		-1.72	.092
		Relevance Sensitivity	**0.537**	**0.104**	**0.561**	**5.16**	**.000**
		Valence Sensitivity	**-0.507**	**0.076**	**-0.583**	**-6.71**	**.000**
		Relevance × Valence	0.354	0.346	0.115	1.02	.312
Admired Figure	Response Time	Constant	0.123	0.026		4.76	.000
		Relevance Sensitivity	**0.546**	**0.065**	**0.675**	**8.44**	**.000**
		Valence Sensitivity	**-0.500**	**0.086**	**-0.447**	**-5.80**	**.000**
		Relevance × Valence	-0.321	0.235	-0.107	-1.37	.179
	Accuracy	Constant	-0.043	0.025		-1.72	.092
		Relevance Sensitivity	**-0.463**	**0.104**	**-0.537**	**-4.46**	**.000**
		Valence Sensitivity	**0.493**	**0.076**	**0.627**	**6.51**	**.000**
		Relevance × Valence	0.354	0.346	0.127	1.02	.312
Detested Figure	Response Time	Constant	0.110	0.029		3.75	.001
		Relevance Sensitivity	**0.514**	**0.073**	**0.704**	**7.02**	**.000**
		Valence Sensitivity	**0.535**	**0.098**	**0.531**	**5.48**	**.000**
		Relevance × Valence	0.085	0.266	0.031	0.32	.750
	Accuracy	Constant	-0.051	0.024		-2.08	.044
		Relevance Sensitivity	**-0.555**	**0.103**	**-0.498**	**-5.40**	**.000**
		Valence Sensitivity	**-0.544**	**0.075**	**-0.537**	**-7.28**	**.000**
		Relevance × Valence	**-0.823**	**0.342**	**-0.229**	**-2.41**	**.021**
Self	Response Time	Constant	-0.362	0.034		-10.64	.000
		Relevance Sensitivity	-0.054	0.085	-0.101	-0.63	.533
		Valence Sensitivity	0.027	0.114	0.037	0.24	.814
		Relevance × Valence	0.357	0.310	0.181	1.15	.255
	Accuracy	Constant	0.185	0.030		6.06	.000
		Relevance Sensitivity	0.039	0.128	0.055	0.30	.763
		Valence Sensitivity	0.092	0.093	0.143	0.99	.329
		Relevance × Valence	0.811	0.427	0.356	1.90	.065

Note. Models for all non-self dependent variables (DVs) were significant for both accuracy and response time, $p < .001$. The model for the self DV was significant only for accuracy, $p < .05$. Positive betas indicate a positive relationship with normalised mean performance for a given identity (e.g., friend). Significant predictors of interest are highlighted in bold.

4.3. Analysis of Chinese Participants Only for Experiment 7

4.3.1. Performance for Non-Self Shapes

Response time. As in Experiment 6, RT data for non-self shapes were submitted to a 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Trial Type: match, mismatch) repeated-measures ANOVA. Consistent with Experiment 6, a robust effect of trial type emerged, $F(1,41) = 111$, $MSE = 2025$, $p < .001$, $\eta_p^2 = .731$, showing that participants responded more quickly for match trials ($M = 708$, $SE = 11.3$) than for mismatch trials ($M = 760$, $SE = 13.2$). Unlike in Experiment 6, a significant main effect of valence was observed, $F(1,41) = 16.5$, $MSE = 2005$, $p < .001$, $\eta_p^2 = .288$, with faster responses for liked ($M = 724$, $SE = 11.1$) compared to disliked ($M = 744$, $SE = 13.3$) identities. The main effect of relevance was non-significant, $F(1,41) = 0.139$, $p = .71$. As in Experiment 6, trial type interacted with valence, $F(1,41) = 25.2$, $MSE = 1432$, $p < .001$, $\eta_p^2 = .380$, and not with relevance, $F(1,41) = 0.517$, $p = .48$. All other interactions were non-significant.

As in previous experiments (see also Sui et al., 2012, 2013), we now analyse match and mismatch trials separately.

Match trials. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) repeated-measures ANOVA for match trial RTs revealed a significant main effect of valence, $F(1,41) = 25.8$, $MSE = 2687$, $p < .001$, $\eta_p^2 = .386$. Participants showed numerically faster RTs for positive ($M = 688$, $SE = 9.90$) compared to negative ($M = 728$, $SE = 13.7$) identities. All other effects were non-significant, $p > .87$.

Mismatch trials. The same analysis for match trial RTs was applied to mismatch trial RTs, revealing no significant effects, all $p > .23$. All means and standard errors for RT data are found in Table S14.

Table S14

Descriptive Statistics for the Perceptual-Matching Task, Experiment 7

Trial Type	Identity	Relevance	Valence	Mean	SEM
Match	Detested	Low	Neg	729	13.1
	Admired	Low	Pos	688	10.5
	Enemy	High	Neg	727	16.9
	Friend	High	Pos	687	12.4
	Self	-	-	625	13.0
Mismatch	Detested	Low	Neg	753	13.4
	Admired	Low	Pos	761	13.3
	Enemy	High	Neg	765	14.7
	Friend	High	Pos	760	14.1
	Self	-	-	755	14.5

Accuracy. As with RT, accuracy scores were submitted to a three-way (Relevance × Valence × Trial Type) repeated-measures ANOVA to examine the effects of relevance and valence for non-self identities. Results revealed a significant main effect for valence, $F(1,41) = 6.42$, $MSE = .010$, $p = .015$, $\eta_p^2 = .135$, with numerically higher accuracy for positive ($M = .803$, $SE = .013$) than for negative ($M = .774$, $SE = .014$) identities. Unlike for the RT results, the main effect of trial type (i.e., match vs. mismatch) was non-significant, $F(1,41) = 0.020$, $p = .89$. However, trial type interacted with identity valence, $F(1,41) = 31.4$, $MSE = .011$, $p < .001$, $\eta_p^2 = .434$. Separate analyses of match and mismatch trials are reported below.

Match trials. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) repeated-measures ANOVA for match trial accuracy scores revealed a significant main effect for valence only, $F(1,41) = 24.1$, $MSE = .015$, $p < .001$, $\eta_p^2 = .370$. As in the RT analysis of match trials, participants for positive ($M = .834$, $SE = .020$) compared to negative ($M = .740$, $SE = .020$) identities. All other effects were non-significant, $p > .79$.

Mismatch trials. The same analysis for match trial accuracy revealed a significant main effect of valence, $F(1,41) = 8.76$, $MSE = .007$, $p = .005$, $\eta_p^2 = .176$, with greater accuracy for negative ($M = .808$, $SE = .014$) compared to positive ($M = .771$, $SE = .015$) identities. This result is an inversion of the main effect observed for match trials. Notably, this same crossover interaction was found in Experiment 6 (UK sample). All other effects were non-significant, all $p > .48$. Complete means and standard errors for accuracy data are found in Figure S6.

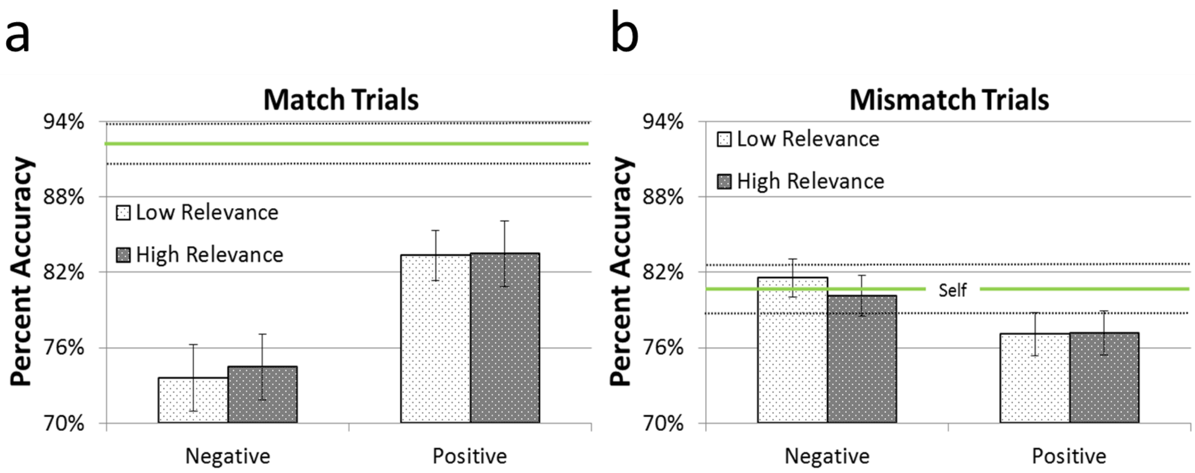

Figure S6. Accuracy data from the perceptual matching task for match trials (a) and mismatch trials (b). Match trials (a) show reliable prioritisation of positive (vs. negative) identities. A significant reversed valence effect is visible in the mismatch trials (b). Performance for the self (mean = green line, standard error = dotted lines)) is provided for a comparison.

4.3.2. Performance for the Self Shape

Response time. RT data were submitted to a 2 (Trial Type: match, mismatch) × 2 (Shape Identity: friend, enemy, admired, detested, self) repeated measures ANOVA. Results reveal a robust effect of trial type, $F(1,41) = 192$, $MSE = 2502$, $p < .001$, $\eta_p^2 = .824$, with participants responding faster for match (*M* = 691, *SE* = 11.2) than for mismatch (*M* = 759, *SE* = 13.3). A main effect was also found for shape identity, *F*(1,41) = 19.2, *MSE* = 2106, $p < .001$, $\eta_p^2 = .319$. However, the effect of shape identity was qualified by a Shape Identity × Trial Type interaction, *F*(1,41) = 21.3, *MSE* = 1675, $p < .001$, $\eta_p^2 = .341$. In match trials, latencies for self-shape trials were significantly shorter compared to the friend, *t*(41) = 5.73, *d* = 0.885, $p < .001$, the enemy, *t*(41) = 9.03, *d* = 1.39, $p < .001$, the admired figure, *t*(41) = 5.71, *d* = 0.992, $p < .001$, and the detested figure, *t*(41) = 10.6, *d* = 1.63, $p < .001$, shapes. In mismatch trials, performance for the self shape did not reliably differ from any of the four non-self shapes, all $p > .17$.

Accuracy. Accuracy data were submitted to a 2 (Trial Type: match, mismatch) × 2 (Shape Identity: friend, enemy, admired, detested, self) repeated measures ANOVA. Unlike the RT results, the accuracy analysis failed to show a reliable main effect of trial type, *F*(1,41) = 1.50, $p = .23$. A main effect was found for shape identity, *F*(1,41) = 11.4, *MSE* = .010, $p < .001$, $\eta_p^2 = .217$. As with the RT data, shape identity interacted with trial type, *F*(1,41) = 11.6, *MSE* = .013, $p < .001$, $\eta_p^2 = .221$. In match trials, accuracy for self-shape trials was greater compared to the friend, *t*(41) = 3.22, *d* = 0.497, $p = .003$, the enemy, *t*(41) = 5.77, *d* = 0.890, $p < .001$, the admired figure, *t*(41) = 3.75, *d* = 0.579, $p < .001$, and the detested figure, *t*(41) = 7.06, *d* = 1.09, $p < .001$, shapes. In mismatch trials, accuracy for the self shape was marginally greater than for the friend shape, *t*(41) = 1.95, *d* = 0.301, $p = .058$, and significantly greater than for the admired figure shape, *t*(41) = 2.52, *d* = 0.388, $p = .016$. All other shape contrasts with the self shape were non-significant, $p > .58$.

4.3.3. Relevance and Valence Sensitivity Analyses

To examine the impact of relevance and valence sensitivity in predicting prioritisation of the self shape in the China-based sample, standardised relevance-sensitivity and valence-sensitivity effect scores (i.e., the extent to which participants' responses differed as a function of non-self-identity relevance and valence, respectively) were computed at the subject level and used to predict standardised self-advantage magnitude. We used the same procedure used to analyse data from UK-based participants in Experiment 6 (see Appendix 4.2.1., for more information). As a reminder, cell means for match trials were Z-transformed according each participant's mean and standard deviation. Relevance sensitivity and valence sensitivity were computed by first averaging Z-transformed RTs/accuracy for non-self identities at each level of relevance and valence, respectively, and then calculating difference scores, with larger positive values signifying a larger relevance-/valence-sensitivity effect. For example,

$$RT_{\text{Relevance Sensitivity}} = zRT_{\text{low-relevance}} - zRT_{\text{high-relevance}}$$

$$Acc_{\text{Relevance Sensitivity}} = zAcc_{\text{high-relevance}} - zAcc_{\text{low-relevance}}$$

where low-relevance scores represent the average of admired and detested figures and high-relevance scores represent the average of friend and enemy.

In separate analyses for RT and accuracy, the two sensitivity scores and their interaction (i.e., Relevance Sensitivity × Valence Sensitivity) were entered as regressors in a general linear model to predict self-advantages relative to each identity (e.g., $RT_{\text{Self–Friend Advantage}} = zRT_{\text{friend}} - zRT_{\text{self}}$; $Acc_{\text{Self–Friend Advantage}} = zAcc_{\text{self}} - zAcc_{\text{friend}}$). As in the UK sample (see Appendix 4.2.2.), the computed relevance-sensitivity and valence-sensitivity effects did not reliably correlate with each other in the RT or accuracy data, p = .61 and .37, respectively.

Self versus friend shape. The friend shape was chosen as a key comparison because friends, like the self, are both valued and relevant to day-to-day life. If the self anchors the dimensions of relevance and positive valence, then greater sensitivity to relevance and valence should predict smaller self–friend advantages (i.e., a negative correlation between sensitivity and advantage magnitude). Alternatively, if relevance/valence sensitivity facilitates performance for all relevant/positive entities, then performance for the self should benefit as much as (if not more than) for the friend in participants with high sensitivity to either dimension. To test between these hypotheses, the self–friend advantage was regressed on the relevance-sensitivity score, the valence-sensitivity score, and the Relevance × Valence interaction.

Response time. Response latency results show that the three-term model accounts for a significant proportion of the variance in the self-versus-friend advantage, $R^2_{adj} = .457$, $F(3,38) = 12.5$, $p < .001$. Only valence-sensitivity significantly and negatively predicted the self-versus-friend advantage. The predictor for relevance-sensitivity was non-significant, $p > .37$. (See Table S15 for all regression statistics.) In other words, greater valence sensitivity predicted smaller self-advantage magnitudes. The Relevance × Valence interaction did not significantly predict the self-versus-friend advantage, $p > .71$.

Accuracy. Accuracy results also show that the three-term model accounts for a significant proportion of the variance in the self-versus-friend advantage, $R^2_{adj} = .380$, $F(3,38) = 9.37$, $p < .001$. Unlike in the RT results (but similar to UK participants), both relevance- and valence-sensitivity effects significantly and negatively predicted the self-versus-friend advantage (i.e., with more relevance and valence sensitivity predicting smaller self-advantage magnitude). Importantly, this effect does not appear to be due to ceiling effects as the mean accuracy for matched self trials was 92% ($SD = 9.6\%$).

Unlike for the RT results (but similar to UK participants), the Relevance × Valence interaction was also a significant predictor of the self-versus-friend advantage. Simple slopes analysis (Aiken & West, 1991) showed that valence sensitivity was a significant predictor only for participants with low (-1 SD), but not high (+1 SD), relevance-sensitivity scores, $t(41) = 2.86$, $p = .007$, versus $t(41) = 0.980$, $p = .33$, respectively. Given low relevance sensitivity, greater valence sensitivity was associated with a decrease in the accuracy advantage between the self and friend shapes (see Figure S7A). Similarly, relevance sensitivity was a significant predictor only for participants with low (-1 SD), but not high (+1 SD), valence sensitivity scores, $t(41) = 3.87$, $p < .001$, versus $t(41) = 0.520$, $p = .61$, respectively. Given low valence sensitivity, greater relevance sensitivity was associated with a decrease in the accuracy advantage between the self and friend shapes (see Figure S7B). Thus, heightened sensitivity to relevance or valence only diminished the self-advantage if the other sensitivity effect was comparatively small.

Self versus other shapes. Following up on the self-versus-friend analysis, similar regressions were performed for each of the other three shapes relative to the self. The purpose of these analyses was to validate the specificity of relevance and valence effects in predicting the self-tagging effect. If the self-advantage is a Relevance × Valence function, then individual differences in sensitivity to relevance and valence should have different impacts on each identity. Particularly, increased sensitivity on both dimensions should predict an increase in self-prioritisation over the detested figure (i.e., a negative, low-relevance identity). This would result from the detested figure being pushed in a negative direction from the self on each dimension. Additionally, relevance and valence effects should have opposing influences on self-prioritisation over mixed identities such as the enemy (i.e., a negative, high-relevance identity) and the admired figure (i.e., a positive, low-relevance identity).

Response time. The three-term models for all three non-self identities were highly significant, $R^2_{adj} = .271$, $F(3,38) = 6.10$, $p = .002$, $R^2_{adj} = .272$, $F(3,38) = 6.11$, $p = .002$, and $R^2_{adj} = .325$, $F(3,38) = 7.58$, $p < .001$, respectively, for the enemy, the admired figure, and the detested figure. (See Table S15 for all regression statistics.)

Table S15

Self-Tagging-Effect Regression Summaries, Experiment 7

Contrast	Index	Factor	*B*	*SE(B)*	β	*t*	*p*
Friend vs. Self	Response Time	Constant	0.686	0.078		8.67	.000
		Relevance Sensitivity	0.201	0.215	0.188	0.93	.357
		Valence Sensitivity	**-1.413**	**0.322**	**-0.867**	**-4.39**	**.000**
		Relevance × Valence	0.091	0.248	0.049	0.367	.716
	Accuracy	Constant	0.303	0.068		4.47	.000
		Relevance Sensitivity	**-0.953**	**0.237**	**-0.784**	**-4.02**	**.000**
		Valence Sensitivity	**-0.405**	**0.174**	**-0.292**	**-2.34**	**.025**
		Relevance × Valence	**1.508**	**0.682**	**0.428**	**2.21**	**.033**
Enemy vs. Self	Response Time	Constant	0.656	0.091		7.22	.000
		Relevance Sensitivity	**-0.999**	**0.250**	**-0.933**	**-4.00**	**.000**
		Valence Sensitivity	**0.891**	**0.373**	**0.546**	**2.39**	**.022**
		Relevance × Valence	0.100	0.288	0.053	0.35	.730
	Accuracy	Constant	0.335	0.074		4.52	.000
		Relevance Sensitivity	**-0.778**	**0.260**	**-0.568**	**-3.00**	**.005**
		Valence Sensitivity	**0.569**	**0.190**	**0.364**	**3.00**	**.005**
		Relevance × Valence	-0.276	0.745	-0.069	-0.37	.713
Admired Figure vs. Self	Response Time	Constant	0.656	0.091		7.22	.000
		Relevance Sensitivity	**1.001**	**0.250**	**0.935**	**4.01**	**.000**
		Valence Sensitivity	**-1.109**	**0.373**	**-0.679**	**-2.97**	**.005**
		Relevance × Valence	0.100	0.288	0.053	0.35	.730
	Accuracy	Constant	0.335	0.074		4.52	.000
		Relevance Sensitivity	0.222	0.260	0.205	0.85	.399
		Valence Sensitivity	**-0.431**	**0.190**	**-0.351**	**-2.27**	**.029**
		Relevance × Valence	-0.276	0.745	-0.088	-0.37	.713
Detested Figure vs. Self	Response Time	Constant	0.686	0.078		8.76	.000
		Relevance Sensitivity	0.201	0.215	0.209	0.93	.357
		Valence Sensitivity	0.587	0.322	0.402	1.82	.076
		Relevance × Valence	0.091	0.248	0.054	0.37	.716
	Accuracy	Constant	0.303	0.068		4.47	.000
		Relevance Sensitivity	0.047	0.237	0.039	0.20	.846
		Valence Sensitivity	**0.595**	**0.174**	**0.432**	**3.43**	**.001**
		Relevance × Valence	**1.508**	**0.682**	**0.431**	**2.21**	**.033**

Note. All regression models were significant for both accuracy and response time, $p < .05$, except the admired figure vs. self model for the accuracy data ($p = .16$). Positive betas indicate a positive relationship with the normalised self-tagging effect magnitude (e.g., relative to the friend). Significant predictors of interest are highlighted in bold.

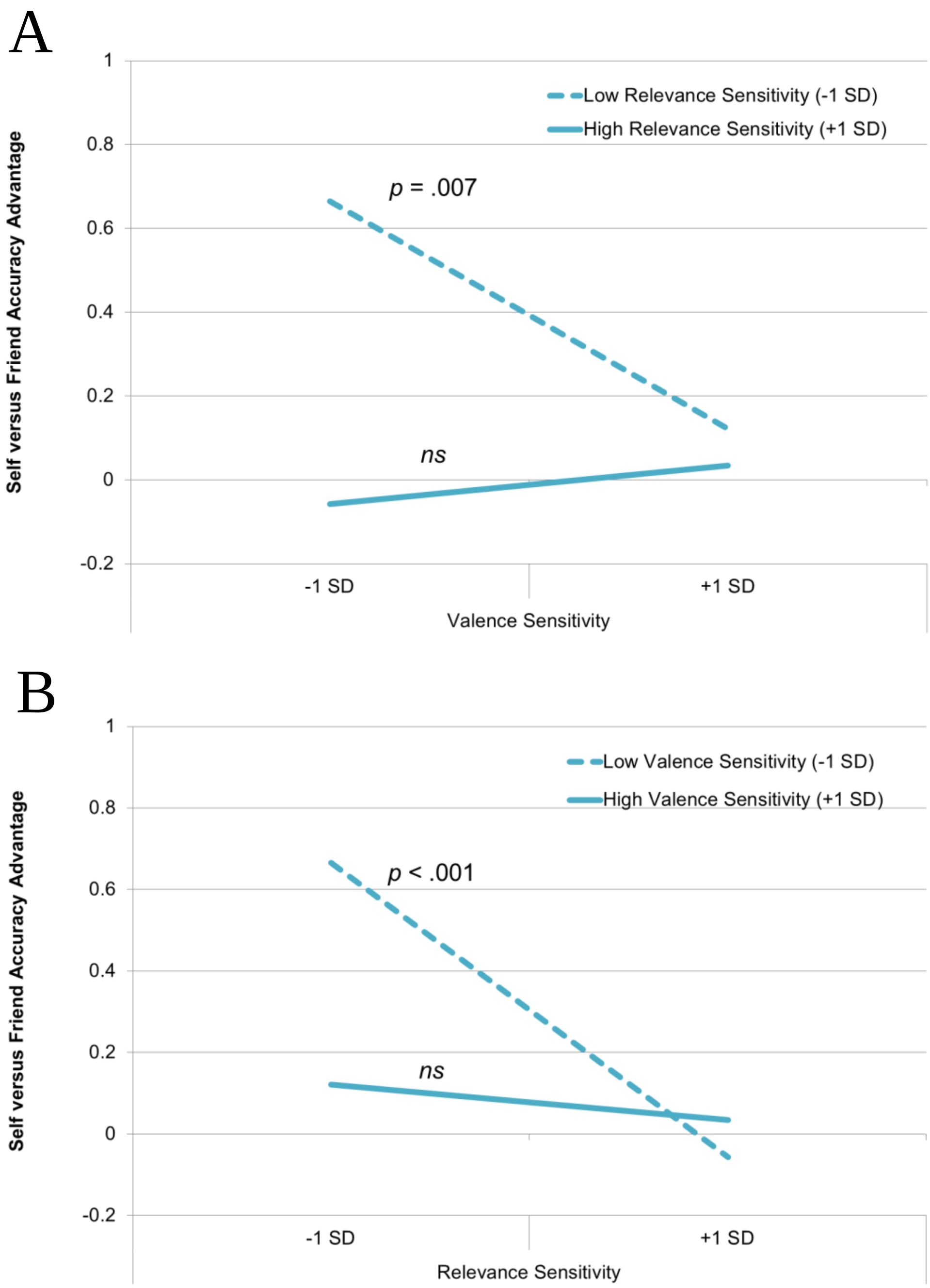

Figure S7. Simple slopes analysis for the Relevance × Valence interaction in the prediction of the self-versus-friend accuracy advantage. Panel A shows the interaction with relevance sensitivity as the moderator. Panel B shows the interaction with valence sensitivity as the moderator. Projected accuracy advantages are presented at -1 SD (Low) and +1 SD (High) from the group mean for each factor.

As with the self-versus-friend analysis, regression results showed that relevance and valence sensitivity each negatively predicted the self-tagging effect—but only where the non-self identity was close to the self (e.g., on the basis of relevance for the enemy and valence for the admired figure). That is, greater relevance sensitivity predicted a smaller RT self-advantage over the high-relevance enemy, and greater valence sensitivity predicted a smaller RT self-advantage over the positive admired figure.

In contrast, where the non-self identity was distant from the self (i.e., on the basis of valence for the enemy, relevance for the admired figure, and both valence and relevance for the detested figure), relevance and valence sensitivity positively predicted the self-tagging effect. That is, greater relevance sensitivity predicated a larger RT self-advantage over the low-relevance admired and detested figures, and greater valence sensitivity predicted a larger RT self-advantage over the negative enemy and detested figure[18].

Accuracy. The three-term models for the enemy, $R^2_{adj} = .417$, $F(3,38) = 10.8$, $p < .001$, and detested figure, $R^2_{adj} = .370$, $F(3,38) = 9.03$, $p < .001$, were highly predictive of the self-tagging advantages. The model for the admired figure did not reach statistical significance, $R^2_{adj} = .058$, $F(3,38) = 1.84$, $p = .16$. (See Table S15 for full regression statistics.) Overall, the results were largely consistent with the RT results reported above and with the analysis of UK participants in Appendix 4.2.2. Relevance sensitivity predicted a decreased self-advantage for identities close to the self on that dimension (e.g., enemy) and an increased self-advantage for identities distant from the self on that dimension (e.g., detested figure[19]). Similarly, valence sensitivity predicted smaller self-advantages for identities close to the self on that dimension (e.g., admired figure) and an increased self-advantage for

[18] Unlike for the enemy and admired figure, the sensitivity predictors for the detested figure did not reach statistical significance. Nonetheless, the overall model was significant, and both predictors correlated in the expected (positive) direction.

[19] This effect for the detested figure was only observed in participants with high valence sensitivity (see Relevance × Valence predictor). For the admired figure, relevance sensitivity was a null predictor. Nonetheless, we note that relevance sensitivity was a significant positive predictor for the admired figure in the RT analysis.

identities distant from the self on that dimension (e.g., enemy and detested figure). Thus, for the enemy (i.e., a negative, high-relevance identity) and the admired figure (i.e., a positive, low-relevance identity), relevance and valence sensitivity had significant and opposing effects on the self-advantage magnitude.

Although the Relevance × Valence interaction was non-significant for the self-versus-enemy and self-versus-admired analyses, it was significant for the self-versus-detested analysis. Simple slopes analysis (Aiken & West, 1991) revealed that the effect of valence sensitivity was a significant predictor of the self-versus-detested advantage for participants with low (-1 SD) and high (+1 SD) relevance-sensitivity scores, $t(41) = 2.92$, $p = .006$, and $t(41) = 3.30$, $p = .002$, respectively. In other words, the positive effect of valence sensitivity on self-advantage magnitude increased as a function of participants' relevance-sensitivity scores (see Figure S8A). Similarly, relevance sensitivity was a significant predictor of the self-versus-detested advantage only for participants with high (+1 SD), but not low (-1 SD), valence sensitivity scores, $t(41) = 3.61$, $p < .001$, versus $t(41) = 0.157$, $p = .88$, respectively. Given high valence sensitivity, greater relevance sensitivity was associated with a further increase in the accuracy advantage between the self and detested-figure shapes (see Figure S8B).

In sum, the positive association of relevance and valence effects on the self-versus-detested accuracy advantage is disproportionately enhanced if both effects are large. Notably, the Relevance × Valence interaction observed for the self-versus-friend analysis did not show this additive pattern. In that analysis, heightened sensitivity to relevance or valence only diminished the self-advantage if the other sensitivity effect was comparatively small. This suggests that these two dimensions may have a more complicated subtractive dynamic for identities that are proximal to the self. The interaction patterns for both the friend and detested figure mirror those found in the UK sample (see Appendix 4.2.2.).

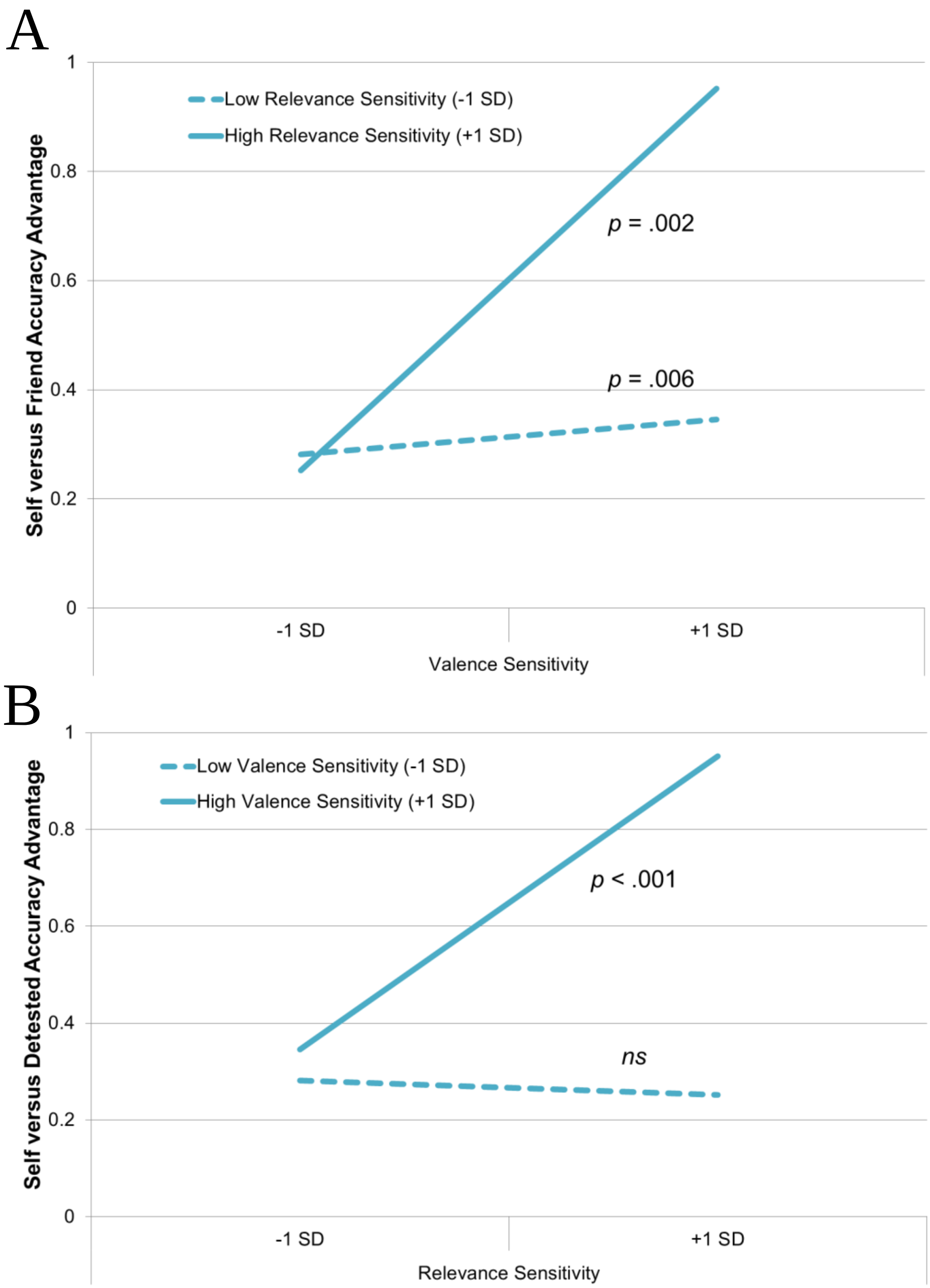

Figure S8. Simple slopes analysis for the Relevance × Valence interaction in the prediction of the self-versus-detested accuracy advantage. Panel A shows the interaction with relevance sensitivity as the moderator. Panel B shows the interaction with valence sensitivity as the moderator. Projected accuracy advantages are presented at -1 SD (Low) and +1 SD (High) from the group mean for each factor.

Supplementary analysis. If the self is indeed anchoring the effects of relevance and valence for non-self identities, then individual differences in sensitivity to these two dimensions should be associated with mean performance for all non-self identities, but not for the self, which serves as the anchoring point. To test this possibility, we tested the same three-term regression model as above, changing the dependent variable from a self-advantage difference score (e.g., $zRT_{friend} – zRT_{self}$) to a simple mean performance score (e.g., zRT_{friend}). In separate analyses for RT and accuracy, the two sensitivity scores and their interaction (i.e., Relevance Sensitivity × Valence Sensitivity) were thus entered as regressors in a general linear model to predict mean performance for each of the five identities.

For each non-self identity, regression models for both RT and accuracy were highly significant (all $R^2_{adj} > .45$, $F(3,38) > 12.4$, $p < .001$), and results were consistent with those obtained using the corresponding self-advantage score as the dependent variable (see Table S16 for regression statistics; cf. Table S15): Greater relevance sensitivity predicted faster and more accurate responding to high-relevance targets (friend, enemy), and slower and less accurate responding to low-relevance targets (admired, detested); greater valence sensitivity predicted faster and more accurate responding to positive targets (friend, admired), and slower and less accurate responding to negative targets (enemy, detested).

More importantly, the regression models for the self shape RT and accuracy data were non-significant, $F(3,38) = 0.545$, $p = .66$, and $F(3,38) = 1.04$, $p = .39$, respectively. These results confirm that mean performance for the self is not reliably affected by sensitivity to relevance and valence. Taken together with the finding that self-advantages are related to relevance and valence sensitivity, these findings are consistent with the self’s hypothesised role as an anchor on the dimensions of relevance and valence, consistent with previous findings from the UK sample reported in Appendix 4.2.3.

Table S16

Mean-Performance Regression Summaries, Experiment 7

DV	Index	Factor	*B*	*SE(B)*	β	*t*	*p*
Friend	Response Time	Constant	0.190	0.042		4.49	.000
		Relevance Sensitivity	**-0.453**	**0.100**	**-0.555**	**-4.51**	**.000**
		Valence Sensitivity	**-0.564**	**0.090**	**-0.534**	**-6.27**	**.000**
		Relevance × Valence	-0.132	0.175	-0.092	-0.75	.457
	Accuracy	Constant	-0.048	0.035		-1.36	.184
		Relevance Sensitivity	**0.661**	**0.124**	**0.806**	**5.35**	**.000**
		Valence Sensitivity	**0.471**	**0.090**	**0.503**	**5.21**	**.000**
		Relevance × Valence	**-1.015**	**0.355**	**-0.427**	**-2.86**	**.007**
Enemy	Response Time	Constant	0.159	0.042		3.74	.001
		Relevance Sensitivity	**-0.548**	**0.101**	**-0.677**	**-5.44**	**.000**
		Valence Sensitivity	**0.592**	**0.090**	**0.565**	**6.57**	**.000**
		Relevance × Valence	-0.010	0.176	-0.007	-0.054	.957
	Accuracy	Constant	-0.080	0.038		-2.12	.041
		Relevance Sensitivity	**0.486**	**0.132**	**0.514**	**3.67**	**.001**
		Valence Sensitivity	**-0.503**	**0.097**	**-0.467**	**-5.21**	**.000**
		Relevance × Valence	**0.769**	**0.380**	**0.280**	**2.03**	**.050**
Admired Figure	Response Time	Constant	0.159	0.042		3.74	.001
		Relevance Sensitivity	**0.452**	**0.101**	**0.667**	**4.49**	**.000**
		Valence Sensitivity	**-0.408**	**0.090**	**-0.465**	**-4.53**	**.000**
		Relevance × Valence	-0.010	0.176	-0.008	-0.05	.957
	Accuracy	Constant	-0.080	0.038		-2.12	.041
		Relevance Sensitivity	**-0.514**	**0.132**	**-0.712**	**-3.89**	**.000**
		Valence Sensitivity	**0.497**	**0.097**	**0.603**	**5.14**	**.000**
		Relevance × Valence	**0.769**	**0.380**	**0.367**	**2.03**	**.050**
Detested Figure	Response Time	Constant	0.190	0.042		4.49	.000
		Relevance Sensitivity	**0.547**	**0.100**	**0.725**	**5.45**	**.000**
		Valence Sensitivity	**0.436**	**0.090**	**0.447**	**4.86**	**.000**
		Relevance × Valence	-0.132	0.175	-0.100	-0.75	.457
	Accuracy	Constant	-0.048	0.035		-1.36	.184
		Relevance Sensitivity	**-0.339**	**0.124**	**-0.354**	**-2.75**	**.009**
		Valence Sensitivity	**-0.529**	**0.090**	**-0.484**	**-5.86**	**.000**
		Relevance × Valence	**-1.015**	**0.355**	**-0.365**	**-2.86**	**.007**
Self	Response Time	Constant	-0.505	0.056		-9.10	.000
		Relevance Sensitivity	0.017	0.132	0.029	0.13	.901
		Valence Sensitivity	0.137	0.118	0.185	1.16	.254
		Relevance × Valence	-0.102	0.230	-0.103	-0.45	.659
	Accuracy	Constant	0.255	0.050		5.14	.000
		Relevance Sensitivity	-0.293	0.174	-0.416	-1.68	.101
		Valence Sensitivity	0.065	0.127	0.082	0.51	.610
		Relevance × Valence	0.493	0.500	0.242	0.99	.331

Note. Models for all non-self DVs were significant for both accuracy and RTs, $p < .001$. The models for the self DV were both non-significant. Positive betas indicate a positive relationship with normalised mean performance for a given identity (e.g., friend). Significant predictors of interest are highlighted in bold.

4.4. Mismatch Trial Analyses for Group-Level Analyses, Experiment 7

4.4.1. Performance for Non-Self Shapes

Standardised response time. Unlike in the analysis of match trials only (see 4.3.3.1), a 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Country: UK, China) split-plot ANOVA on mismatch-trial RT data revealed no reliable effects, all $p > .20$.

A formal comparison of match and mismatch trials was conducted in the form of a 2 (Trial Type: match, mismatch) × 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor. Results revealed significant main effects of trial type, $F(1,86) = 317$, $MSE = .085$, $p < .001$, $\eta_p^2 = .786$, and valence, $F(1,86) = 13.0$, $MSE = .081$, $p < .001$, $\eta_p^2 = .131$, with smaller Z_{RT}s (i.e., faster responses) for shape–label matches versus mismatches and for positive (i.e., liked) versus negative (i.e., disliked) target shapes. Unexpectedly, a main effect of country persisted even in the Z_{RT} analysis, $F(1,86) = 6.30$, $MSE = .024$, $p = .014$, $\eta_p^2 = .068$, with smaller Z_{RT}s for the UK-based versus China-based participants[20].

Consistent with findings from Experiment 6 (UK sample only), valence significantly interacted with trial type, $F(1,86) = 28.9$, $MSE = .071$, $p < .001$, $\eta_p^2 = .251$, consistent with the observation of faster latencies for positive identities on match versus mismatch trials. Relevant to our analysis of group differences, a Valence × Country interaction was also observed, $F(1,86) = 8.55$, $MSE = .081$, $p = .004$, $\eta_p^2 = .090$, consistent with the observation of a larger valence effect in the China-based sample. Both significant two-way interactions were

[20] Although Z-transformed RTs should neutralise group differences in overall performance, such a finding is nonetheless possible if the two groups differed in their respective biases toward the self shape, which was Z-transformed together with non-self shapes but was not included in this analysis. This possibility is explored in the following section (Appendix 4.4.2).

subsumed by a reliable three-way Valence × Trial Type × Country interaction, $F(1,86) = 4.99$, $MSE = .071$, $p = .028$, $\eta_p^2 = .055$, consistent with the observation of a significant Valence × Country interaction only for match trials. All other main effects and interactions were non-significant, $p > .10$.

Accuracy. In contrast to the analysis of match trials only (see 4.3.3.1), a 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Country: UK, China) split-plot ANOVA on mismatch-trial accuracy data revealed that both groups showed a main effect of valence, $F(1,86) = 12.7$, $MSE = .007$, $p = .001$, $\eta_p^2 = .129$. Greater accuracy was observed for *negative* compared to positive shape targets. All other main effects and interactions were non-significant, $p > .29$.

As with Z_{RT} data, a formal comparison of match and mismatch trials was conducted in the form of a 2 (Trial Type: match, mismatch) × 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor. Results revealed a reliable main effect of valence, $F(1,86) = 9.55$, $MSE = .010$, $p = .003$, $\eta_p^2 = .100$, with overall greater accuracy for positive compared to negative identities. This effect was modulated by trial type, $F(1,86) = 44.6$, $MSE = .012$, $p < .001$, $\eta_p^2 = .342$, consistent with the same cross-over interaction pattern suggested by separate analyses of match and mismatch trials (i.e., bias for positive shapes on match trials, bias for negative shapes on mismatch trials). Apart from this Valence × Trial Type interaction, no other interactions were observed in the analysis of accuracy data, all $p > .10$.

4.4.2. Performance for the Self Shape

Five-identity ANOVA. To determine whether any group differences existed for any of the five identities (including the self), we computed separate 5 (Shape Identity: self, friend, enemy, admired, detested) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVAs, with country as the between-subjects factor for RT and accuracy data.

Standardised response time. Results revealed significant main effects for trial type, $F(1,86) = 539$, $MSE = .100$, $p < .001$, $\eta_p^2 = .862$, and shape identity, $F(1,86) = 33.4$, $MSE = .098$, $p < .001$, $\eta_p^2 = .279$. Consistent with previous analyses, both groups were faster for match versus mismatch trials and for the self versus all other shapes. As expected based on previous analyses, this self-advantage was qualified by a significant Shape Identity × Trial Type interaction, $F(1,86) = 39.3$, $MSE = .075$, $p < .001$, $\eta_p^2 = .314$. For match trials, participants from both samples were faster for the self relative to the friend, $t(87) = 9.09$, $d = 0.969$, $p < .001$, the enemy, $t(87) = 12.6$, $d = 1.35$, $p < .001$, the admired figure, $t(87) = 10.5$, $d = 1.12$, $p < .001$, and the detested figure, $t(87) = 14.4$, $d = 1.53$. For mismatch trials, performance for the self did not differ reliably from the four non-self shapes, all $p > .20$.

Relevant to the present examination of cross-cultural differences, a significant effect of country was observed, $F(1,86) = 6.25$, $MSE = .006$, $p = .014$, $\eta_p^2 = .068$. As in the analysis of non-self shapes, the UK group showed a slightly smaller overall Z_{RT} value compared to the China group[21]. However, this was qualified by a significant Shape Identity × Country interaction, $F(1,86) = 2.52$, $MSE = .098$, $p = .041$, $\eta_p^2 = .028$. UK participants showed smaller Z_{RT} values relative to China participants only for the enemy shape, $t(86) = 2.56$, $d = 0.273$, $p = .012$. A similar, albeit non-significant, trend was observed for the detested-figure shape,

[21] Surprisingly, the main effect of country remained reliable even after including all Z-transformed condition means in the ANOVA. As expected with Z_{RT} data, both groups had grand mean values approaching zero. However, the UK sample mean ($M_{ZRT} = .0224$) was less than one seventh of a standard deviation smaller than the China sample's mean ($M_{ZRT} = .0357$). Although reliable, we consider this small effect ($\eta_p^2 = .068$) to be negligible. We speculate that this apparent group difference resulted from noise introduced when trial-specific Z_{RT}s were averaged across each condition and/or when these condition means were subsequently averaged across participants.

$t(86) = 1.70$, $d = 0.181$, $p = .094$. Standardised RTs were similar for both groups for all other shapes, all $p > .23$.

Accuracy. Accuracy data were also submitted to a 5 (Shape Identity: self, friend, enemy, admired, detested) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor. Results revealed main effects of trial type, $F(1,86) = 5.83$, $MSE = .021$, $p = .018$, $\eta_p^2 = .063$, and shape identity, $F(1,86) = 25.0$, $MSE = .008$, $p < .001$, $\eta_p^2 = .226$. Consistent with the RT analysis, these two effects significantly interacted, $F(1,86) = 19.7$, $MSE = .011$, $p < .001$, $\eta_p^2 = .187$. For match trials, participants from both samples were more accurate for the self relative to the friend, $t(87) = 4.89$, $d = 0.521$, $p < .001$, the enemy, $t(87) = 8.04$, $d = 0.857$, $p < .001$, the admired figure, $t(87) = 6.12$, $d = 0.653$, $p < .001$, and the detested figure, $t(87) = 9.68$, $d = 1.03$, $p < .001$. For mismatch trials, this was only the case for the friend, $t(87) = 3.09$, $d = 0.329$, $p = .003$, and admired figure, $t(87) = 4.13$, $d = 0.440$, $p < .001$ (all other $p > .24$). For all shape identities, self-advantage effect sizes were smaller for mismatch trials than for match trials. No effects of country were observed.

Self versus non-self ANOVA. A second analysis specifically tested for country differences in performance for the self versus non-self shapes (average Z_{RT} for non-self shapes for each trial type). To this end, we computed separate 2 (Shape Identity: self, non-self) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor for RT and accuracy data.

Standardised response time. Consistent with previous analyses, results revealed significant main effects of trial type, $F(1,86) = 703$, $MSE = .053$, $p < .001$, $\eta_p^2 = .891$, and shape identity, $F(1,86) = 126$, $MSE = .059$, $p < .001$, $\eta_p^2 = .594$, with smaller Z_{RT}s for match versus mismatch and self versus non-self shapes. Notably, the main effect of country was non-significant in this analysis, $F(1,86) = 0.412$, $p = .52$. Consistent with previous analyses, the Shape Identity × Trial Type interaction was significant, $F(1,86) = 214$, $MSE = .028$, $p < .001$, $\eta_p^2 = .714$. Participants were reliably faster for the self shape (vs. non-self shape average) on match trials, $t(87) = 16.5$, $d = 1.75$, $p < .001$, but not on mismatch trials, $t(87) = 0.982$, $p = .33$.

Critically, Shape Identity × Trial Type interaction was further modulated in a three-way interaction with country, $F(1,86) = 4.20$, $MSE = .028$, $p = .044$, $\eta_p^2 = .047$. Follow-up ANOVAs were computed at each level of trial type. For match trials, the effect of shape identity was significant, $F(1,86) = 288$, $MSE = .046$, $p < .001$, $\eta_p^2 = .770$, consistent with all previous analyses of match trials. More importantly, this effect interacted with country, $F(1,86) = 5.50$, $MSE = .046$, $p = .021$, $\eta_p^2 = .060$. As anticipated, China-based participants showed smaller Z_{RT}s for the self shape ($Z_{RT} = -0.722$) relative to UK-based participants ($Z_{RT} = -0.597$), $t(86) = 2.33$, $d = 0.248$, $p = .022$. The two groups did not differ reliably in their average performance for non-self shapes on match trials, $t(86) = 1.07$, $p = .29$. For mismatch trials, ANOVA revealed no significant effects, all $p > .32$.

Accuracy. As in the RT data, accuracy scores were also submitted to a 2 (Shape Identity: self, non-self) × 2 (Trial Type: match, mismatch) × 2 (Country: UK, China) split-plot ANOVA, with country as the between-subjects factor. Consistent with previous analyses, main effects were observed for shape identity, $F(1,86) = 94.5$, $MSE = .005$, $p < .001$, $\eta_p^2 = .524$, and trial type, $F(1,86) = 28.0$, $MSE = .009$, $p < .001$, $\eta_p^2 = .246$. Shape identity was modulated by trial type, $F(1,86) = 43.9$, $MSE = .005$, $p < .001$, $\eta_p^2 = .338$, as in all preceding analyses. Contrasts revealed that participants across both samples were more accurate for the self relative to the average for the four non-self shapes in both match, $t(87) = 9.93$, $d = 1.06$, p

< .001, and mismatch trials, $t(87) = 2.83$, $d = 0.302$, $p = .006$, but this effect was three times larger for match trials. No effects of country were observed.

4.5. Optimisation of the Social-Tagging Task for fMRI

The five-identity perceptual matching task used in this study was adapted from the version used in the first two experiments of Chapter 4 (see 4.2.2.). Shape stimuli were the same as in these behavioural experiments. However, the background grey colour was slightly darkened to provide a good contrast for the use of white text and fixation crosses (changed from black text). A number of changes were made to the trial procedure. First, the minimum stimulus display was set at 400 ms for all participants. This was slightly longer than previous fMRI research on self-tagging (e.g., 100 ms: Sui et al., 2013). However, this increase was implemented to ensure sufficient processing time for the shape–label pairings, especially given that the number of identities is greater in this paradigm compared to previous studies. Following Sui and colleagues (2013), we fixed the post-stimulus blank screen to display time of 1100 ms independent of response. (In Experiments 6–7, this screen was terminated upon response or else jittered between 801 and 1200 ms.) Participants responded with their index finger for match trials and with their middle finger for mismatch trials.

In line with Sui and colleagues (2013), we also introduced temporal jittering using 2100-ms null trials that were presented on 33% of trials. Null trials presented only a fixation cross for the full duration of the trial and required no response. Additionally, to increase the number of relatively more reliable match trials, we altered the frequency of these trials, such that match trials were twice as likely as mismatch trials. Participants were not informed of the frequency distributions for match and mismatch trials. In each of three matching task runs, participants completed 180 trials, including null trials. For each run, participants responded to 80 match trials, resulting in 16 trials per condition. Mean accuracy feedback was changed to appear after every 60 trials (rather than every 10 trials) and for a total of 5 seconds (rather than unlimited). At the conclusion of the task, participants viewed a blank screen for 15 seconds to sample signal during a period of no task engagement.

4.6. Behavioural Data Analysis for Experiment 8

For each scanning sequence, RT data were trimmed at the participant level, excluding all trials exceeding 3 standard deviations from the participant's overall mean. Trimmed RTs for correct responses were subsequently averaged within each condition. Finally, these condition means were averaged across scan sequence. This last step was done both for RT and accuracy data[22]. Mean RT and accuracy for each participant fell within 3 standard deviations of the group mean RT (M = 681, SD = 60.4) and accuracy (M = .951, SD = .036), respectively. Thus, data from all 24 participants with useable fMRI data were included in the analysis. RT and accuracy data are provided in Table S17.

4.6.1. Performance for Non-Self Shapes

Response time. RT data were submitted to a 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Trial Type: match, mismatch) repeated-measures ANOVA. Results revealed a significant main effect of trial type, $F(1,23) = 179$, $MSE = 2675$, $p < .001$, $\eta_p^2 = .886$, and valence, $F(1,23) = 7.03$, $MSE = 856$, $p = .014$, $\eta_p^2 = .234$, as well as a marginal effect of relevance, $F(1,23) = 4.17$, $MSE = 1853$, $p = .053$, $\eta_p^2 = .153$. Consistent with previous findings (see Experiments 6–7), participants were faster for match (vs. mismatch) trials, positive (vs. negative) shapes, and high- (vs. low-) relevance shapes. Trial type interacted with both relevance, $F(1,23) = 5.39$, $MSE = 502$, $p = .029$, $\eta_p^2 = .190$, and valence, $F(1,23) = 21.9$, $MSE = 1098$, $p < .001$, $\eta_p^2 = .487$. All other effects from this omnibus

[22] By collapsing our data across scan sequence, we parallel the analysis of fMRI data. Nonetheless, we also conducted analyses conserving scan sequence as a factor. These analyses revealed that participants reliably improved as they progressed through the three scan sequences. Along with this general improvement, participants also showed smaller relevance and valence effect sizes. Interestingly, the self-versus-friend advantage did not change across sessions. Although we did not have any predictions for performance over time, these results suggest that social-tagging effects are critically linked to learning, with participants learning more quickly for positive and relevant others, as well as the self.

analysis were nonsignificant, $p > .25$. Consistent with previous analyses, we now conduct separate follow-up ANOVAs for match and mismatch trials.

Table S17

Descriptive Statistics for the Perceptual-Matching Task, Experiment 8

Response Index	Trial Type	Identity	Relevance	Valence	Mean	SEM
Response Time	Match	Detested	Low	Neg	663	14.1
		Admired	Low	Pos	635	13.6
		Enemy	High	Neg	648	12.8
		Friend	High	Pos	610	12.8
		Self	-	-	575	11.3
	Mismatch	Detested	Low	Neg	734	13.6
		Admired	Low	Pos	749	16.7
		Enemy	High	Neg	733	15.4
		Friend	High	Pos	740	15.2
		Self	-	-	723	14.6
Accuracy	Match	Detested	Low	Neg	.966	.006
		Admired	Low	Pos	.990	.004
		Enemy	High	Neg	.975	.004
		Friend	High	Pos	.990	.003
		Self	-	-	.993	.003
	Mismatch	Detested	Low	Neg	.932	.017
		Admired	Low	Pos	.896	.018
		Enemy	High	Neg	.922	.017
		Friend	High	Pos	.903	.015
		Self	-	-	.950	.012

Match trials. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) repeated-measures ANOVA was conducted on match trial RTs. Results revealed significant main effects of relevance, $F(1,23) = 8.11$, $MSE = 1206$, $p = .009$, $\eta_p^2 = .261$, and valence, $F(1,23) = 24.4$, $MSE = 1107$, $p < .001$, $\eta_p^2 = .515$. Consistent with the omnibus analysis, participants were faster for high- (vs. low-) relevance identities and for liked (vs. disliked) identities. The Relevance × Valence interaction was non-significant, $p > .28$.

Mismatch trials. The same analysis of mismatch trial RTs revealed only a marginal main effect of valence, $F(1,23) = 3.55$, $MSE = 844$, $p = .072$, $\eta_p^2 = .134$, with a trend for slower performance for positive (vs. negative) identities. This pattern is the inverse of the reliable pattern found for match trials (cf. UK participants: 4.2.3.1., Chinese participants: 4.3.3.1.). All other effects were unreliable, $p > .46$. See Table S17 for RT condition means.

Accuracy. Accuracy data were submitted to a 2 (Relevance: low, high) × 2 (Valence: positive, negative) × 2 (Trial Type: match, mismatch) repeated-measures ANOVA. Results revealed a significant main effect of trial type, $F(1,23) = 31.6$, $MSE = .007$, $p < .001$, $\eta_p^2 = .578$. Consistent with the RT analysis and previous findings (see Experiments 6–7), participants were more accurate for match (vs. mismatch) trials. Main effects for relevance and valence were non-significant. Although trial type failed to interact with relevance, it did interact with valence, $F(1,23) = 14.9$, $MSE = .002$, $p < .001$, $\eta_p^2 = .394$. All other effects from this omnibus analysis were non-significant, $p > .15$. Consistent with previous analyses, we now conduct separate follow-up ANOVAs for match and mismatch trials.

Match trials. A 2 (Relevance: low, high) × 2 (Valence: positive, negative) repeated-measures ANOVA was conducted on match trial accuracy scores. Results revealed a significant main effect of valence, $F(1,23) = 30.3$, $MSE < 0.001$, $p < .001$, $\eta_p^2 = .568$.

Consistent with the omnibus analysis, participants were more accurate for liked (vs. disliked) identities. All other effects were non-significant, $p > .26$.

Mismatch trials. The same analysis of mismatch trial accuracy scores also revealed a significant main effect of valence, $F(1,23) = 7.15$, $MSE = .003$, $p = .014$, $\eta_p^2 = .237$, with more accurate performance for disliked (vs. liked) identities. As in the RT analysis above, this pattern is the inverse of the pattern found for match trials (cf. UK participants: 4.2.3.1, Chinese participants: 4.3.3.1). All other effects were unreliable, $p > .35$. See Table S17 for accuracy condition means.

4.6.2. Performance for the Self Shape

Response time. RT data were submitted to a 2 (Trial Type: match, mismatch) × 2 (Shape Identity: friend, enemy, admired, detested, self) repeated measures ANOVA. Results reveal a robust effect of trial type, $F(1,23) = 226$, $MSE = 3181$, $p < .001$, $\eta_p^2 = .907$, with participants responding faster for match than mismatch trials. A main effect was also found for shape identity, $F(1,23) = 15.5$, $MSE = 1238$, $p < .001$, $\eta_p^2 = .402$. However, the effect of shape identity was qualified by a Shape Identity × Trial Type interaction, $F(1,23) = 16.0$, $MSE = 764$, $p < .001$, $\eta_p^2 = .410$. In match trials, latencies for self-shape trials were significantly shorter compared to the friend, $t(23) = 4.20$, $d = 0.856$, $p < .001$, the enemy, $t(23) = 7.73$, $d = 1.58$, $p < .001$, the admired figure, $t(23) = 5.98$, $d = 1.22$, $p < .001$, and the detested figure, $t(23) = 9.28$, $d = 1.89$, $p < .001$, shapes. In mismatch trials, participants were faster for the self than for the admired figure, $t(23) = 2.72$, $d = 0.555$, $p = .012$. The self did not reliably differ from any of the other non-self shapes, all $p > .11$.

Accuracy. Accuracy data were submitted to a 2 (Trial Type: match, mismatch) × 2 (Shape Identity: friend, enemy, admired, detested, self) repeated measures ANOVA. As in the RT analysis, the accuracy analysis showed a reliable main effect of trial type, $F(1,23) =$

29.8, *MSE* = .008, $p < .001$, $\eta_p^2 = .564$, with more accurate performance for match compared to mismatch trials. A main effect was found for shape identity, $F(1,23) = 4.11$, *MSE* = .002, $p = .004$, $\eta_p^2 = .152$. As with the RT data, this effect was modulated by trial type, $F(1,23) = 5.23$, *MSE* = .002, $p < .001$, $\eta_p^2 = .185$. In match trials, accuracy for self-shape trials was greater compared to the enemy, $t(23) = 4.14$, $d = 0.846$, $p < .001$, and the detested figure, $t(23) = 4.43$, $d = 0.904$, $p < .001$, shapes. Performance for the self did not differ reliably from for the friend and admired figure, $p > .35$. These null differences are likely due to a ceiling effect, as mean accuracy for the self, friend, and admired figures on match trials exceeded 98.9%. In mismatch trials, accuracy for the self shape was significantly greater than for the friend shape, $t(23) = 4.49$, $d = 0.917$, $p < .001$, the enemy shape, $t(23) = 2.07$, $d = 0.422$, $p = .050$, and the admired figure shape, $t(23) = 4.09$, $d = 0.836$, $p < .001$, but not for the detested figure shape, $p > .19$.