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Is It Always Me First? Effects of Self-Tagging on Third-Person Perspective-Taking

Bradley Mattan
University of Birmingham

Kimberly A. Quinn
University of Birmingham and DePaul University

Ian A. Apperly
University of Birmingham

Jie Sui
University of Oxford and Tsinghua University

Pia Rotshtein
University of Birmingham

Self-relevant information is associated with facilitation of perceptual and memory processes. In 2 experiments, participants verified the number of dots within a virtual room that were visible to a given perspective, corresponding to participants' own first-person perspectives or the third-person perspectives for self- and other-associated avatars. Perspectives were either congruent or incongruent with respect to the number of dots visible to each. In Experiment 1, we examined perspective taking for self- and other-associated avatars relative to one another; both avatars appeared simultaneously in the virtual room, and participants made judgments based on the prompted avatar's perspective. In Experiment 2, we examined perspective taking for each avatar relative to the first-person perspective; only 1 avatar was visible in the virtual room (Self or Other, varying by trial), and participants made judgments based on their first-person view or the avatar's perspective. Experiment 2 also included a replication of the third-person paradigm used in Experiment 1. Results from Experiment 1 (replicated in Experiment 2) demonstrated an advantage for judgments of the Self (vs. Other) avatar's perspective; both avatars elicited reliable interference effects of similar magnitude. Results from Experiment 2 further demonstrated that participants prioritized the first-person (vs. third-person) perspective, and that the presence of the Self (vs. Other) avatar improved performance for the first- and third-person perspectives when those perspectives were congruent. Taken together, these findings suggest that self-relevant perspectives are prioritized when they are actively engaged and when they can be subsumed within the first-person view. Such prioritization appears to occur by strategic means.

Keywords: perspective taking, self-other distinction, third person, first person, self-tagging

For most, the social world is characterized 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 may frequently differ. Successful social interaction (e.g., teamwork) thus requires the tracking and management of these perspectives. Indeed, whether and how these perspectives are prioritized is implicated in research ranging from stereotyping (e.g., Taylor, Fiske, Etcoff, & Ruderman, 1978) to visual attention (e.g., Keysar, Barr, Balin, & Brauner, 2000; Samson, Apperly, Braithwaite, Andrews, & Bodley Scott, 2010). One means of prioritizing among perspectives is by their degree of self-relevance (e.g., lifelong partner vs. stranger). To what extent do perceivers prioritize perspectives that are closely tied to one's own sense of self? If such perspectives are prioritized, does this occur automatically or is it contingent on some level of effort or intention?

Although most perspective-taking research characterizes 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., massively multiplayer online 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

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Bradley Mattan, School of Psychology, University of Birmingham; Kimberly A. Quinn, School of Psychology, University of Birmingham and Department of Psychology, DePaul University; Ian A. Apperly, School of Psychology, University of Birmingham; Jie Sui, Department of Experimental Psychology, University of Oxford and Department of Psychology, Tsinghua University; Pia Rotshtein, School of Psychology, University of Birmingham.

Correspondence concerning this article should be addressed to Bradley Mattan, School of Psychology, University of Birmingham, Edgbaston, Birmingham, United Kingdom, B15 2TT. E-mail: brad.mattan@gmail.com

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 yield robust effects, such as reducing hemispatial 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 behavior (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).

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 color (see Sui, He, & Humphreys, 2012). We use the term *social-tagging* to describe novel associations of stimuli with any person, not just the self. In previous work (Sui et al., 2012), social tagging was induced by a simple 60-s 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 by key press whether the shape and label were correctly paired. Self-tagging reflects facilitated performance on self-shape trials relative to other trials (Sui et al., 2012; Sui, Rotshtein, & Humphreys, 2013), and subsequent research suggests that self-tagged shapes are more perceptually salient compared to nonself shapes (Sui, Liu, Mevorach, & Humphreys, 2013). These self-tagging phenomena are consistent with previous research on the self's facilitative role in memory (e.g., Cloutier & Macrae, 2008; Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997) and attention (e.g., Bargh, 1982; Moray, 1959; Sui, Zhu, & Han, 2006). Nonetheless, the role of self-associations in more complex processes such as perspective taking remains to be systematically explored. Through the use of self-tagging, the current study extends previous research by investigating whether self-relevance facilitates perspective taking from a third-person reference frame. Particular attention is given to the effect of self-tagging on explicit versus implicit perspective taking. For the purpose of this paper, 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.

Self-Priority Effects in Memory and Attention

The self has long been conceptualized as having at least two components, one that perceives and the other that is displayed and seen by others (see Damasio, 1999; James, 1890; Gallagher, 2000). Although the self-as-perceiver is notoriously difficult to study (Klein, 2012), the perceived self has been the subject of much research. Numerous studies on the self-reference effect (Rogers et al., 1977) have shown that arbitrary self-associations with stimuli can lead to superior memory performance (see Symons & Johnson, 1997, for a meta-analysis). Furthermore, these memory improvements are observed for both explicitly (Rogers et al., 1977) and minimally (Cloutier & Macrae, 2008) self-relevant stimuli. Self-relevance is also a key component in person perception, often determining the extent to which a perceived individual is processed (Brewer & Feinstein, 1999; Fiske, Lin, & Neuberg, 1999; Quinn & Rosenthal, 2012) and subsequently remembered (Bernstein, Young, & Hugenberg, 2007; Hehman, Mania, & Gaertner, 2010; Hugenberg, Young, Bernstein, & Sacco, 2010; Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008).

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; 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). Attentional benefits and costs of the self are not limited to words or auditory stimuli, but also extend to visual stimuli such as one's own face (Sui et al., 2006).

As noted above, research has shown that even novel self-associations facilitate responses to visual stimuli in various contexts, such as perceptual matching (Sui et al., 2012; Sui, Rotshtein et al., 2013), global-local (Sui, Liu et al., 2013), and action-label matching (Frings & Wentura, 2014) paradigms. In each paradigm, participants responded faster and more accurately to geometric shapes or actions associated with the self than to stimuli associated with others. 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. The self-tagging effect for geometric shapes appears to be mediated by the temporal-parietal junction (Sui, Rotshtein et al., 2013), suggesting that self-tagged stimuli capture attention as they become salient in the environment (Downar, Crawley, Mikulis, & Davis, 2000). Similarly, self-tagged stimuli also facilitate visual selection by altering perceptual salience, with a corresponding increase in left intraparietal sulcus activity (Sui, Liu et al., 2013). In sum, self-tagged stimuli appear to capture attention and facilitate selection in a variety of contexts, independent of the stimulus's relevance to the task at hand.

Visual-Spatial Perspective Taking

In spite of ample research on the perceived self in basic attention and memory, 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), 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 when their view is in conflict with a third-person perspective (Keysar et al., 2000). This effect is especially pronounced in Western cultures (Wu & Keysar, 2007). Nonetheless, it is possible that responses in this paradigm are biased in favor 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 center facing a 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 making decisions when explicitly adopting the 1PP relative to the 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 judgments were more efficient than judgments for the 1PP, provided both perspectives were congruent. There was no reliable difference in performance between 1PP and 3PP for incongruent trials. This finding is thus construed as a computational advantage for the 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 judgment target, the total dot number is subitized 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 judgments 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.

Another important finding from this series of studies is that neither perspective can be ignored when the two perspectives are incongruent, even when the unattended perspective is made irrelevant to the task (Samson et al., 2010, Experiment 2). There is a reliable interference cost when the contents of the 1PP and 3PP differ. However, the perspective that produces the most interference is not always the self-perspective. In some studies, the 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 the 1PP versus the 3PP in these studies suggests that neither perspective automatically monopolizes attention at the implicit level (i.e., as the distractor perspective). Indeed, one fMRI study on 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 summarizing these findings from the visual perspective-taking literature, we note that there is little evidence to suggest the "self" perspective (i.e., 1PP) is intrinsically prioritized. Paradigms showing a self-advantage (e.g., Keysar et al., 2000; Wu & Keysar, 2007) tend to require additional processes for the 3PP that are not necessary for the 1PP, such as mental rotation. Relatively simpler perspective-taking paradigms (e.g., Samson et al., 2010) show a computational advantage for the 3PP rather than the 1PP. Lastly, conflicting findings from the same paradigm suggest that neither perspective consistently produces greater interference than the other. This apparent absence of self-prioritization in visual perspective taking stands in contrast to the attention and memory literature reviewed above, 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 facilitatory 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 nonhumans. Posture cues are known to guide the perspective selection behavior of gorillas (Bania & Stromberg, 2013), prosimians (Botting, Wiper, & Anderson, 2011), dogs (Gacsi, Miklosi, Varga, Topal, & Csanyi, 2004), and even 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.

Study Overview

In the current paper, we present two studies in which we examine 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 visual perspective-taking paradigms (hereafter, 1PP-3PP tasks). In Experiment 1, we used a third-person visual perspective-taking paradigm (hereafter, 3PP-3PP task) to examine the extent to which self-associations facilitate perspective taking at an explicit and implicit level. 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. In this experiment, attentional cues from head and body orientation as well as differences in computational demands were controlled across perspectives by presenting both the Self and the 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. Experiment 2 (1PP-3PP task) was conducted to test whether the Self avatar (i.e., self-as-3PP) is meaningfully related to the phenomenological self (i.e., self-as-1PP). We hypothesized that the perspective of the Self avatar would interfere more with the 1PP compared to the Other avatar. We further wanted to determine whether the self-advantages obtained in Experiment 1 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, in Experiment 2 (3PP-3PP task), we also tested whether the findings from the 3PP-3PP task reported in Experiment 1 are replicable.

Experiment 1: Self and Other Perspectives in the Third Person

The key aim of Experiment 1 was to address whether self-advantages (e.g., Sui et al., 2012) can be observed in perspective taking when controlling for the intrinsically egocentric reference frame of the 1PP (Vogeley & Fink, 2003). To examine this question, we used a two-step procedure. In an adaptation of the perceptual matching task used in studies on self-tagging (e.g., Sui et al., 2012; Sui, Rotshtein et al., 2013), participants first learned to associate color-coded avatars with three identities (self, friend, stranger/other). Second, participants completed a third-person visual perspective-taking paradigm (hereafter, 3PP-3PP task), inspired by Samson and colleagues' (2010) paradigm. Like the paradigm used by Samson and colleagues, participants determined whether a prompt statement predicted a target avatar's perspective in a subsequently presented virtual room (see Method for details). For the sake of design simplicity in the 3PP-3PP task, only the Self and Other avatars from the perceptual matching task were included. We note that the friend identity was included in the perceptual matching task to make it sufficiently complex, consistent with previous studies (e.g., Sui et al., 2012; Sui, Rotshtein et al., 2013).

The primary difference between the 3PP-3PP task 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., first-person perspective) are always incongruent with what each avatar sees, effectively making the 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. Furthermore, both perspectives similarly benefit from visual gaze cues, though the saliency of these gaze cues in the current paradigm was attenuated by turning the avatars' heads away from the perceiver (see Method). As in the original paradigm (Samson et al., 2010), target perspective (Self, Other) and perspective congruence (congruent, incongruent) were varied orthogonally in a 2 × 2 within-participants factorial design. Perspective congruence 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 not visible to the contralateral avatar (see Figure 1 for trial examples).

In line with previous research on self-tagging advantages in attention (Sui et al., 2012; Sui, Rotshtein et al., 2013; Sui et al., 2006), salience (Sui, Liu et al., 2013), and action (Frings & Wentura, 2014), we offer two testable predictions. First, the heightened relevance of the Self avatar should facilitate the explicit adoption of the Self avatar's perspective (i.e., a main effect of target perspective). Second, relating to implicit perspective taking, the Self avatar should elicit greater interference than the Other avatar. This prediction would result in a Target Perspective × Perspective Congruence interaction, with a greater congruence effect when the target perspective is the Other avatar compared to the Self avatar.

Method

Participants. Forty-seven students (39 female; $M_{\text{age}} = 19.7$ years, $sd = 2.83$) from the University of Birmingham were recruited through an online research participation scheme and re-

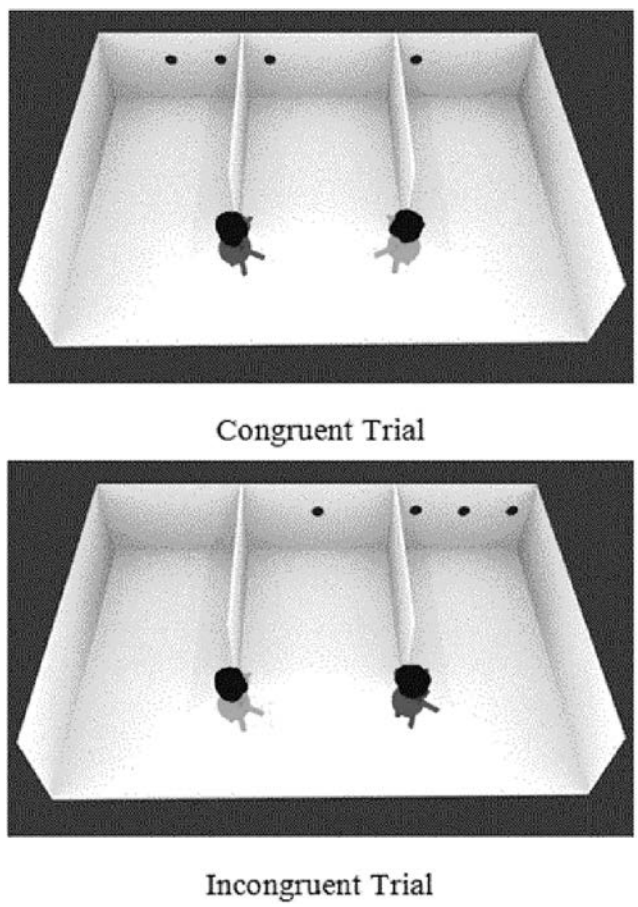

Figure 1. Trial examples for the 3PP-3PP task. In the Congruent Trial (top), both avatars are facing inward and see the same number of dots. In the Incongruent Trial (bottom), one avatar (e.g., blue) faces to the outside, such that each avatar has a different perspective. The target avatar always views more dots than the nontarget. See the online article for the color version of this figure.

ceived 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. 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 color: green, red, or blue. Given that the friend avatar was used only in the matching task to make that task sufficiently challenging, it was always red. Self and Other avatar colors were counterbalanced between green and blue across participants. 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 45° to the left or to the right, with each rendering having equal representation. Lastly, the backs of avatar heads were manually colored a dark brown (C = 0, M = 63, Y = 93, K = 89) in 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 matching task was adapted from an existing perceptual matching paradigm (Sui et al., 2012). Participants gave 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]). The labels *YOU* and *OTHER* were used instead of the participant's name to minimize differences in familiarity between Self and Other labels. This approach was also preferred as more naturalistic compared to referring to the participant in the third person (e.g., "Danny's avatar").

For all trials, participants viewed one avatar image (e.g., blue avatar) above one label (e.g., YOU) at the center of the screen with the instruction to indicate whether the label correctly matched the avatar image. All conditions were equally likely to appear. Each trial started with a fixation cross at the center of the screen for 500 ms. Then, an avatar image and label pairing was presented for a fixed duration (determined by individual performance in the practice round). A blank screen followed the stimulus and remained for 1,000 ms, or until response. Participants responded by key press: *J* for a match and *K* for a mismatch. Responses longer than 1 second were treated as incorrect.

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 minimizing 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 1,000 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 threshold was established, participants completed an additional 96 trials with the stimulus duration fixed across the trials. 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. The blue and green avatars representing Self and Other in the identity-matching task (above) were 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 1 gives an example of the virtual room display used. This room included three external walls and two internal dividing walls parallel to the side walls. The size of the 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°). The internal walls partially divided the room into three sections; the size of each section 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. Black dots (view angle = 0.5°) were placed on the wall in front of them. 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. The room was viewed from above with an angle of 45 degrees, aligned with the overall orientation of the avatars' views, such that the participants saw the avatars from behind. Thus, the participant and the avatars faced roughly the same direction but, unlike the participant's first-person perspective, the avatars' views were restricted by the dividing walls and by their head orientation. The two avatars randomly appeared on the left or the right side of the screen. 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.

Participants' task was to indicate whether a preceding prompt predicted the number of dots (e.g., two or three) seen by the target avatar (e.g., Self or Other). Participants were instructed to press the *J* key with their right index finger for matched trials and the *K* key with their right middle finger for mismatched trials; each trial type was represented with equal frequency. 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 nonshared views and not simply that the two avatars see the same number of dots.

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 comprised of 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.

Each trial began with a text prompt revealed gradually in two parts to ease comprehension. Initially, the target perspective ("Your avatar" or "Other avatar") was displayed on the screen for 750 ms followed by a number of dots the target will see ("2" or "3") for another 750 ms, after which both the identity and number disappeared. To ensure fixation at the beginning of the trial, a 900-ms fixation sequence was used. Then, the visual scene was displayed for a fixed duration (determined in the practice block), after which it was replaced by an unmasked blank screen for 2,000 ms or until the participant responded. If no response was recorded within 2,000 ms of the blank screen onset, participants immediately received the message "Please respond faster!" in centered red type for 1,500 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. (See Appendix for more details on trial design.)

After every 10 experimental trials, feedback on accuracy was provided, and participants completed four reminder trials in which they indicated the associations between the avatars and identity labels. In each reminder trial, the two avatars were presented together randomly on the left and right side of the screen. Centered 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.

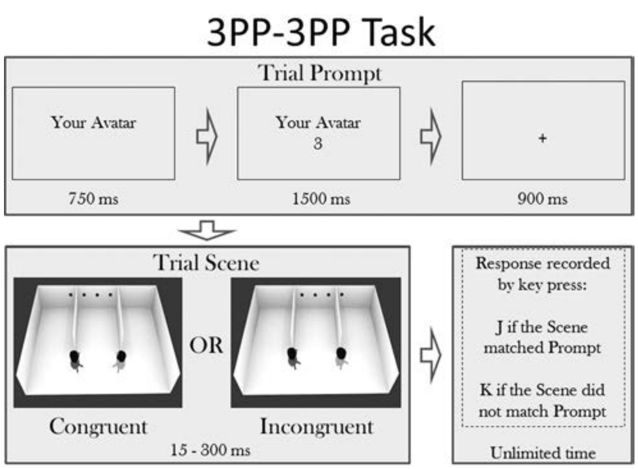

Figure 2. Trial procedure for the 3PP-3PP task. In the Trial Prompt, participants were presented with the target perspective (e.g., "Your Avatar") for 750 ms, after which the expected number of dots for the target perspective was added to the display. Participants had an additional 750 ms after the appearance of the dot number to proceed to the fixation. Participants then viewed a 900-ms centered fixation sequence that consisted of two fixation crosses initially separated by a three-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 for approximately 15–300 ms (minimum of 150 ms in Experiment 2), depending on participant's performance in the practice block. Responses were subsequently recorded by key press. See the online article for the color version of this figure.

After finishing the perspective-taking task, participants completed a brief demographic questionnaire on the PC. They were then thanked, debriefed, and compensated accordingly.

Analysis protocol. A 3-standard-deviation guideline was used to exclude reaction time (RT) outliers from analyses in both the avatar identity-matching task and the 3PP-3PP task. This was done within subjects. 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). According to the LATER model (Reddi, Asrress, & Carpenter, 2003), it is assumed that variability in accuracy and RT responses arise from the same decision mechanism. Statistical analyses are reported on these combined efficiency scores only, although similar patterns of results were obtained for the separate accuracy and RT indices (see Tables 1 and 2 for RT, accuracy, and efficiency statistics for the perceptual matching and 3PP-3PP tasks, respectively).

Consistent with the previous literature on perspective taking (e.g., Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012), analyses for the 3PP-3PP task focused on responses to prompt-scene match trials. In the context of the present paradigm, it is assumed that match versus mismatch decisions engage partly distinct processes. Furthermore, prompt-scene mismatch trials present scenes in which neither perspective matches with the prompt. In other words, both perspectives contribute to the same behavioral response, irrespective of perspective congruence. This is likely to reduce reliability in such mismatch trials. However for completeness, we also report analyses for the mismatch trials as well as formal comparisons between the match and mismatch trials.

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. For completeness, means and standard error for the RT, accuracy, and efficiency data are found in Table 1.

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, $F(1, 45) = 15.3$, $MSE = 179130$, $p < .001$, $\eta_p^2 = 0.254$, such that the Self avatar ($M = 826$) resulted in more efficient judgments than did the Other Avatar ($M = 1070$). The main effect of label match was not significant, $F(1, 45) = .992$, $p > .32$. However, a significant Avatar Identity × Label Match interaction, $F(1, 45) = 21.7$, $MSE = 142260$, $p < .001$, $\eta_p^2 = 0.326$, was observed, with a significant self-advantage on matched trials, $t(45) = 4.37$, $p < .001$, $d = 0.644$, but not on mismatched trials, $p = .57$. These results replicate previous findings on self-tagging in a perceptual matching paradigm (Sui et al., 2012; Sui, Rotshtein et al., 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

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

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] Main effect significant at $p < .05$. [b,c] Main effect significant at $p < .001$.

(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 (ps < .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.

Matched trials. A 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA on efficiency scores for matched 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, $F(1, 41) = 7.91$, $MSE = 37494$, $p = .007$, $\eta_p^2 = 0.162$, such that participants were more efficient for congruent trials ($M = 968$) than for incongruent trials ($M = 1052$). A significant effect for target perspective, $F(1, 41) = 4.68$, $MSE = 23346$, $p = .036$, $\eta_p^2 = 0.102$, showed more efficient judgments for the Self avatar ($M = 984$) relative to the Other avatar ($M = 1035$). The interaction term was nonsignificant, $F(1, 41) = 0.264$, $p > .61$.

Mismatched trials. The 2 × 2 repeated-measures ANOVA for mismatched trials resulted in a significant main effect of perspective congruence, $F(1, 41) = 4.28$, $MSE = 88235$, $p = .045$, $\eta_p^2 = 0.095$, with more efficient performance for congruent ($M = 1017$) than incongruent trials ($M = 1111$). The main effect of target perspective and the Target Perspective × Perspective Congruence interaction were both nonsignificant, $F(1, 41) = 0.398$, $p = .53$ 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: matched, mismatched) × 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, $F(1, 41) = 9.59$, $MSE = 70067$, $p = .004$, $\eta_p^2 = 0.190$, with greater efficiency for congruent ($M = 992$) compared to incongruent trials ($M = 1082$). A marginal effect of trial type was also found, $F(1, 41) = 3.16$, $MSE = 78669$, $p = .083$, $\eta_p^2 = 0.072$, with numerically greater efficiency for prompt–scene matches ($M = 1010$) than mismatches ($M = 1064$). The main effect of target perspective was nonsignificant, $F(1, 41) = 1.10$, $p > .30$. However, a marginal Trial Type × Target Perspective interaction was found, $F(1, 41) = 3.84$, $MSE = 24118$, $p = .057$, $\eta_p^2 = 0.086$. In summary, congruency effects were observed in both the matched and mismatched trials; the interaction trend suggested greater efficiency for the Self avatar only in the matched trials (see Table 2 for descriptive statistics).

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. Though 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-

Table 2
Descriptive Statistics for 3PP-3PP Task, Experiment 1

Trial type	Response index	Target	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[a]
		Other	.830 (.016)	.778 (.020)	.052	.804[a]
	Efficiency	Self	949 (53.4)	1020 (50.1)	71	984[b]
		Other	986 (44.9)	1084 (43.9)	98	1035[b]
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] Main effect significant at $p < .05$.

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 prioritize self-relevant over nonrelevant 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 hypothesized 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-prioritization is likely strategic (i.e., not automatic).

Finally, the self-advantage effect was more reliable during the prompt-scene match trials, though this trend did not reach statistical significance. The reasons for weaker and less reliable self-advantage effects in the mismatched trials for both the avatar identity-matching and the 3PP-3PP tasks are unclear and warrant further research.

One open question from Experiment 1 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 favoring 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 prioritization effect. The second experiment thus aimed to test the relationship between the two avatars and the participant's phenomenological self.

Experiment 2: Self Avatar's Relationship to the 1PP

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; Shelton & McNamara, 2001). Consequently, the visual perspective-taking literature tends to position the self at the first-person perspective (Gallagher, 2000; Vogeley & Fink, 2003) rather than the third-person perspective (e.g., Experiment 1). Although Experiment 1 was useful for demonstrating participants' prioritization 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 Experiment 1, the first-person view was always incongruent with the avatars and irrelevant to the task. A second experiment was conducted to examine whether self-relevant perspectives (e.g., the Self avatar) are prioritized when one's own first-person view is made salient.

In Experiment 2, participants completed a 1PP-3PP task in which they viewed scenes similar to the 3PP-3PP task in Experiment 1, but with only one avatar (i.e., Self or Other) appearing in any given scene. The prompted target perspective was revealed at the beginning of each trial, varying across trials between the first-person perspective (1PP) and the third-person perspective (3PP; i.e., the Self/Other avatar). As in previous perspective-taking studies (e.g., Samson et al., 2010), the 1PP was congruent with the 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 factorial design. Given the main effect of the target perspective in Experiment 1, we predicted the Self avatar advantage would emerge under conditions favoring the explicit processing of self-relevance.

We further predicted that the Self avatar's greater salience would result in greater interference on the 1PP compared to the less salient Other avatar. Concretely, we predicted a Target Perspective × Perspective Congruence × Avatar Identity interaction, with greater interference from the 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 Experiment 1 was solely due to heightened vigilance from the prompt. This is because distractor perspectives (i.e., source of interference effects on incongruent trials) are not revealed in the prompt, unlike target perspectives. 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 Experiment 1 stemmed from the prompt rather than the presence of a self-tagged avatar.

Method

Participants. Forty-one students (25 female; $M_{age} = 23.6$ years, $SD = 5.04$) 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 1.

Avatar identity-matching task. he same matching task and procedure from Experiment 1 (see Method) was used to train participants on avatar color in this experiment. As in Experiment 1, 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 1. 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 1.[1] 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.

[1] As a result of this adaptation to the 3PP-3PP task in Experiment 2, 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 ($M_{obs} = 8$, $SD_{obs} = 1.9$).

1PP-3PP task. The critical perspective-taking paradigm (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 randomized 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 the 1PP was also visible to the 3PP (i.e., Self/Other avatar). As in Experiment 1, participants indicated whether a preceding prompt predicted the number of dots (e.g., two or three) visible to the target perspective (1PP or 3PP). Participants pressed the *J* key with their right index finger for matched trials and the *K* key with their right middle finger for mismatched 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 1, 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 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 1's 3PP-3PP task. For a graphical representation of the full trial time course and details, see Figure 3.

After finishing the 1PP-3PP task, participants completed a brief demographic questionnaire on the PC. They were then thanked, debriefed, and compensated accordingly.

Analysis protocol. A 3-standard-deviation guideline was used to exclude RT outliers from analysis in all tasks. This was done within subjects. As in Experiment 1, statistical analyses were performed on efficiency scores only. See Tables 3, 4, 5, and 6 for RT, accuracy, and efficiency statistics for each of the tasks in this experiment.

As in the 3PP-3PP task from Experiment 1, analysis focused on the findings from the matched trials. However, for completeness, results from the mismatch trials as well as formal comparisons between the two conditions are reported.

Results

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 3.

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, $F(1, 40) = 20.1$, $MSE = 20222$, $p < .001$, $\eta_p^2 = 0.334$ such that the Self avatar ($M = 841$) resulted in more efficient judgments relative to the Other avatar ($M = 940$). The main effect

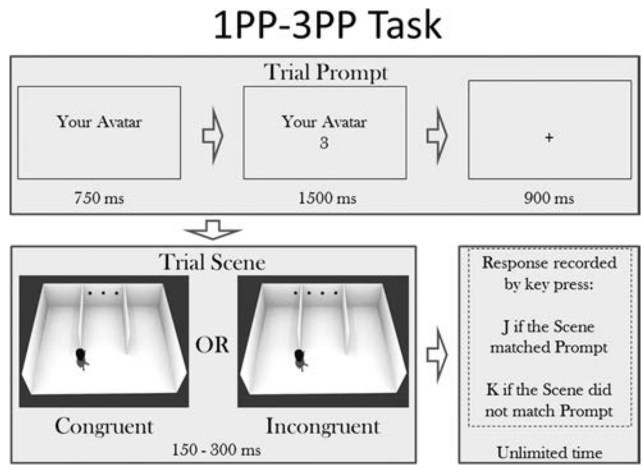

Figure 3. Trial procedure for the 1PP-3PP task. In the Trial Prompt, participants were presented with the target perspective (e.g., "Your Avatar") for 750 ms after which the expected number of dots for the target perspective was added to the display. Participants had an additional 750 ms after the appearance of the dot number to proceed to the fixation. Participants then viewed a 900 ms centered fixation sequence that consisted of two fixation crosses initially separated by a three-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 for approximately 150–300 ms, depending on participant's performance in the practice block. Responses were subsequently recorded by key press. See the online article for the color version of this figure.

of label match was not significant, $F(1, 40) = 1.32$, $p > .26$. However, a significant Avatar Identity × Label Match interaction was observed, $F(1, 40) = 45.6$, $MSE = 19617$, $p < .001$, $\eta_p^2 = 0.532$, with a significant self-advantage on matched trials, $t(40) = 6.32$, $p < .001$, $d = 0.987$, and a smaller albeit significant other-advantage on mismatched trials, $t(40) = 2.37$, $p = .023$, $d = 0.369$. These results again confirm a reliable pattern of prioritization for the Self avatar, at least for matching trials, replicating previous findings (Sui et al., 2012; Sui, Rotshtein et al., 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

Table 3
Descriptive Statistics for the Avatar Identity-Matching Task, Experiment 2

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 $p < .01$.

Table 4
Descriptive Statistics for 3PP-3PP Task, Experiment 2

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 $p < .05$.

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 (ps $< .001$). 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 1,277 ms with a median of 762 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 4.

Matched trials. A 2 (Target Perspective: Self, Other) × 2 (Perspective Congruence: congruent, incongruent) repeated-measures ANOVA on efficiency scores for matched 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 1, we found a significant main effect for target perspective, $F(1, 39) = 5.45$, $MSE = 16694$, $p = .025$, $\eta_p^2 = 0.123$, showing more efficient judgments for the Self avatar ($M = 849$) than the Other avatar ($M = 897$). 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 nonsignificant, $F(1, 39) = 0.44$, $p = .51$.

Mismatched trials. The 2 × 2 repeated-measures ANOVA for mismatched trials replicated the results of Experiment 1. We observed a significant main effect of perspective congruence, $F(1, 39) = 4.13$, $MSE = 42621$, $p = .049$, $\eta_p^2 = 0.096$, with more efficient performance for congruent ($M = 907$) than incongruent trials ($M = 973$). The main effect of target perspective and the Perspective Congruence × Target Perspective interaction were both nonsignificant, $F(1, 39) = 1.69$, $p = .20$ and $F(1, 39) = 2.99$, $p = .09$, respectively.

A formal comparison between matched and mismatched trials was computed using a 2 (Trial Type: matched, mismatched) × 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, $F(1, 39) = 3.66$, $MSE = 38851$, $p = .063$, $\eta_p^2 = 0.086$, with numerically greater efficiency for congruent ($M = 885$) compared to incongruent trials ($M = 928$). A significant effect of trial type was also found, $F(1, 39) = 6.85$, $MSE = 52546$, $p = .013$, $\eta_p^2 = 0.149$, with greater efficiency for prompt–scene matches ($M = 873$) than mismatches ($M = 940$). The main effect of target perspective was also significant, $F(1, 39) = 5.38$, $MSE = 24059$, $p = .026$, $\eta_p^2 = 0.121$, with greater efficiency for the Self avatar ($M = 886$) compared to the Other avatar ($M = 927$). 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

Table 5
Descriptive Statistics for 1PP-3PP Task, Efficiency Scores

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.

Table 6
Descriptive Statistics for 1PP-3PP Task, RT and Accuracy Scores

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.

greater interference from the Self avatar on the Other avatar compared to the reverse case (see Table 4 for descriptive statistics).

In summary, using fewer trials and longer exposure duration, we replicated the effects of the Self avatar for matching trials. Congruence effects were overall less reliable in Experiment 2 compared to Experiment 1. 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 mismatched trials was similar to that of the matched trials in spite of 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 (ps $< .001$). As in Experiment 1, 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. Thus, efficiency scores were used as the key unit of analysis (Townsend & Ashby, 1983). See Table 5 for all means and standard errors for efficiency data. For completeness, descriptive statistics are also reported for RT and accuracy data (see Table 6).

Matched trials. A 2 (Target Perspective: 1PP, 3PP) × 2 (Perspective Congruence: congruent, incongruent) × 2 (Avatar Identity: Self, Other) repeated-measures ANOVA on efficiency scores for matched trials was computed. Replicating previous studies, the data showed a significant main effect for perspective congruence, $F(1, 39) = 42.3$, $MSE = 16455$, $p < .001$, $\eta_p^2 = 0.520$, such that participants were more efficient for congruent trials ($M = 628$) than for incongruent trials ($M = 721$). A significant effect for target perspective, $F(1, 39) = 9.08$, $MSE = 15362$, $p = .005$, $\eta_p^2 = 0.189$, showed more efficient judgments for the 1PP ($M = 653$) relative to the Other avatar ($M = 695$). The Target Perspective × Perspective Congruence interaction was nonsignificant for matched trials, $F(1, 39) = 1.31$, $p = .259$. Notably, the Avatar Identity × Perspective Congruence interaction was significant, $F(1, 39) = 4.91$, $MSE = 9747$, $p = .033$, $\eta_p^2 = 0.112$. On trials where the 1PP and 3PP were congruent, participants showed significantly more efficient performance when the Self avatar was present ($M = 608$) than when the Other avatar was present ($M = 647$), $t(39) = 2.69$, $p = .011$, $d = 0.425$. On trials where the 1PP and 3PP were incongruent, there was no significant difference in performance between Self ($M = 726$) and Other ($M = 716$) trials, $t(39) = 0.563$, $p = .58$. All other main effects and interactions were nonsignificant for matched trials, all ps $> .20$.

Mismatched trials. The same three-way ANOVA for mismatched trials resulted in a significant main effect of perspective congruence, $F(1, 39) = 19.2$, $MSE = 9850$, $p < .001$, $\eta_p^2 = 0.330$, with more efficient performance for congruent ($M = 647$) than incongruent trials ($M = 696$). A significant effect for target perspective, $F(1, 39) = 106$, $MSE = 10925$, $p < .001$, $\eta_p^2 = 0.731$, showed more efficient judgments for the 1PP ($M = 611$) relative to the Other avatar ($M = 732$). The Perspective Congruence × Target Perspective interaction was significant, $F(1, 39) = 38.9$, $MSE = 10793$, $p < .001$, $\eta_p^2 = 0.499$ (cf. 1PP-3PP matching trials analysis). Contrasts revealed reliable interference from the 1PP on the 3PP ($M = 121$), $t(39) = 6.20$, $p < .001$, $d = .980$, and an inverse interference effect from the 3PP on the 1PP ($M = -24$), $t(39) = 2.05$, $p = .047$, $d = 0.325$. Consistent with the main effect of target perspective, participants were significantly more efficient for the 1PP compared to the 3PP on congruent trials, $t(39) = 3.54$, $p = .001$, $d = 0.560$, and incongruent trials, $t(39) = 10.2$, $p < .001$, $d = 1.61$, showing an especially large effect size for the latter. Finally, the Avatar Identity × Perspective Congruence interaction was nonsignificant, $F(1, 39) = 2.22$, $p = .144$ (cf. 1PP-3PP matching trials analysis). All other main effects and interactions were nonsignificant for mismatched trials, ps $> .52$.

A formal comparison of the matched and mismatched trials was computed using a 2 (Trial Type: matched, mismatched) × 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, $F(1, 39) = 81.5$, $MSE = 9883$, $p < .001$, $\eta_p^2 = 0.676$, with greater efficiency for congruent ($M = 637$) compared to incongruent trials ($M = 708$). A reliable effect of target perspective was also found, $F(1, 39) = 86.2$, $MSE = 12203$, $p < .001$, $\eta_p^2 = 0.688$, with greater efficiency for 1PP ($M = 632$) than 3PP ($M = 713$). A significant Target Perspective × Perspective Congruence interaction, $F(1, 39) = 31.8$, $MSE = 9351$, $p < .001$, $\eta_p^2 = 0.449$, revealed greater interference from the 1PP on the 3PP ($M = 114$), $t(39) = 10.2$, $p < .001$, $d = 1.61$, than from the 3PP on the 1PP ($M = 28$), $t(39) = 2.60$, $p = .013$, $d = 0.410$.

Trial type interacted statistically with target perspective, $F(1, 39) = 17.6$, $MSE = 14084$, $p < .001$, $\eta_p^2 = 0.311$. As reported above, in both matched and mismatched trials, the 1PP was more efficient than the 3PP, but this effect was larger for mismatched trials. The interaction of trial type and perspective congruence, $F(1, 39) = 4.84$, $MSE = 16422$, $p = .034$, $\eta_p^2 = 0.110$, is consistent with the larger effect of perspective congruence for matched relative to mismatched trials. The three-way interaction of Trial Type × Target Perspective × Perspective Congruence, $F(1, 39) = 10.6$, $MSE = 13003$, $p = .002$, $\eta_p^2 = 0.214$, reflected the fact that the effect of congruence was reliably modulated by target perspective but only in the mismatched trials. Finally, the Trial Type × Avatar Identity × Perspective Congruence interaction, $F(1, 39) = 9.65$, $MSE = 5413$, $p = .004$, $\eta_p^2 = 0.198$, confirmed that the presence of the Self avatar reliably modulated the congruence effect, but only for matched trials. All other terms were nonsignificant, $ps > .21$. As in the 3PP-3PP task (Experiments 1 and 2), the overall pattern of results across matched and mismatched trials was similar, with some effects being more pronounced for one condition as opposed to the other, but no crossover interactions were observed.

Discussion

Results of the avatar identity-matching task and of the matching trials in the 3PP-3PP task run in Experiment 2 replicated the findings of Experiment 1. 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 1, mismatched trials did not show a reliable self-advantage. However, in these same conditions we did observe reliable self-advantages in Experiment 2. This strengthens the argument that responses to mismatched 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 the 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 as opposed to 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 had a special relationship with the self-as-1PP, relative to the Other avatar. Namely, the presence of the Self (vs. Other) avatar in the virtual room boosted perspective-taking efficacy 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 and 2) 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.

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 visual perspective-taking studies that have found the 1PP to be prioritized over the 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 has 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 the 1PP when the two perspectives are congruent (Ramsey et al., 2013; Samson et al., 2010). Potential factors contributing to this variability in perspective prioritization patterns are considered in greater detail in the General Discussion.

General Discussion

The present set of experiments aimed to test whether self-prioritization effects reported across many different cognitive domains can also be observed in the context of perspective-taking tasks. The data provided evidence for the prioritization of self-relevant compared to low-relevance (i.e., Other avatar) perspectives. Prioritized processing of the Self over the Other avatar was observed when the perspective of the two avatars were viewed together, and when each was contrasted solely with the 1PP. Specifically, in the 3PP-3PP task (Experiments 1 and 2), participants prioritized the target perspective when the target was the Self compared to a nonrelevant Other. In this task the 1PP was kept constant and was irrelevant to the task. The 1PP-3PP task (Experiment 2) examined whether a self-relevant 3PP may similarly benefit performance when the first-person view is meaningfully varied. In this task, we observed that the 1PP received priority processing 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., the 1PP and both 3PPs). Finally, the overall pattern of results was more reliable for matched than for the mismatched 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 perspective vs. distractor perspective).

Prioritization of Self-Relevant Perspectives

In the current experiments, priority for self-relevant perspectives (i.e., Self avatar and the 1PP) was observed during explicit processing. This advantage is consistent with previous findings from the visual perspective-taking literature showing that the 1PP is often privileged over the 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 (Frings & Wentura, 2014; Sui et al., 2009, 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 visual perspective-taking 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 the 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 the Self and the Other. Relative to previous paradigms, the current study also reduced the differences in gaze direction between the 3PP and the 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 prioritization 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-color 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.

Neither experiment revealed any indication that participants were favoring 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 the Self and Other avatars (Experiments 1 & 2). The 1PP-3PP task similarly failed to show any difference between the Self avatar and the Other avatar in terms of their interference on the 1PP (Experiment 2). We also did not observe implicit prioritization of the 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 prioritization of given perspectives. In some studies, the 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 behavioral pattern across these many visual perspective-taking studies suggests that there is no reliable evidence supporting automatic prioritization of any perspective at an implicit level. The lack of implicit self-prioritization in these perspective-taking tasks contrasts with the attention literature showing that self-relevant information captures attention even when irrelevant to the task (Rogers et al., 1977; Sui et al., 2006; Symons & Johnson, 1997). 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 behaviorally.

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 though that different 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). Though, perspective taking appears to be unreliably affected by avatar realism. In two experiments, MacDorman and colleagues (MacDorman, Srinivas, & Patel, 2013) show similar performance for human avatars and eerie fantasy creatures in perspective adoption and interference. Considering these factors, it is unclear whether participants actually identified with the monocolor 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 the self-relevance of stimuli in a social context are readily learned, leading to robust prioritization effects. For example, in minimal group paradigms, arbitrary group assignments (e.g., via colored wristbands) can engender immediate prioritization 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 prioritization.

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 the 1PP was congruent with the Other avatar.

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 was 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 attentional 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, judgments 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 hold multiple 3PPs simultaneously, despite the increased computational demand and the 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 (see 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 and 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 hypothesized to involve two stages: a computation and a selection stage (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 conceptualized 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"), subsequently 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, 2010; Samson, Apperly, & Humphreys, 2007).

The current study suggests that the presence of a self-relevant 3PP can lead to a generalized enhancement in perspective taking when that perspective and the 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 perspective taking 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 medial prefrontal cortex (MPFC) 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 the 1PP and 3PP provide conflicting information (e.g., incongruent trials).

Methodological Considerations

In the current study, we report perspective-taking data for trials in which the prompt matched the virtual room (i.e., matched) and trials in which the prompt did not match the room (i.e., mismatched). These trials were analyzed separately, as it was assumed that the decision processes for matched and mismatched trials may engage partly distinct processes. Nonetheless, we note that the pattern of results was similar across both types of trials, though less reliable and consistent in the mismatched trials. It is unclear why mismatched trials produce less consistent results. We speculate that a number of factors can potentially contribute to this observation. For example, prompt–scene 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 behavioral response. Additionally, cognitive theories on comparative judgments (e.g., same vs. different) argue that "different" judgments are "noisier" and may involve additional processes such as rechecking (Krueger, 1978; see Farell, 1985, for a review). This potentially leads to increased variance, consequently obscuring differences between conditions for trials requiring a "different" judgment. In sum, these factors are thought to reduce the reliability of mismatched trials. We note that similar rationales for focusing on matched trials have been offered by previous perspective-taking studies (Qureshi et al., 2010; Ramsey et al., 2013; Samson et al., 2010; Surtees & Apperly, 2012). Nonetheless, we note that the modification of visual perspective-taking paradigms to avoid the use of match-mismatch decisions may help further improve the sensitivity of such tasks.

Conclusion

The current study 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 and 2), 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 prioritization of self-relevant 3PPs is most reliable under conditions of intentional perspective taking. When considered in contrast to the first-person view (1PP-3PP task; Experiment 2), 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 nonself perspective. Lastly, the current results suggest that gaze cues may play an important role in the relative prioritization of first- versus third-person perspectives. 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.

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Appendix

Trial Design for the 3PP-3PP Task

In the design of the matching trials (i.e., trials where the prompt matched the subsequent scene), the following guidelines were applied: (a) 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. (b) All scenes displayed a total of four dots, thus keeping the paradigm within the subitizable range (see Kaufman, Lord, Reese, & Volkmann, 1949; Trick & Pylyshyn, 1994) and holding the first-person perspective constant. (c) The target avatar was equally likely to be gazing toward the shared space or toward one of the lateral spaces. (d) 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. (e) No two trials involved the same configuration of target avatar, target position/gaze, dot display, and prompt number. (f) Lastly, an equal number of mismatched trials were derived from a corresponding match trial by eliminating exactly one dot, avoiding any novel dot configurations.

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Correction to Mattan et al. (2014)

In the article "Is It Always Me First? Effects of Self-Tagging on Third-Person Perspective-Taking," by Bradley Mattan, Kimberly A. Quinn, Ian A. Apperly, Jie Sui, and Pia Rotshtein (*Journal of Experimental Psychology: Learning, Memory, and Cognition*, Advance online publication. December 22, 2014. http://dx.doi.org/10.1037/xlm0000078), the **Experiment 1** section contained sentences that should not have been included. Please see the following changes:

In **Experiment 1: Self and Other Perspectives in the Third Person** section, under the **Method** subsection, under the **Avatar identity-matching task**, the last three sentences of the second paragraph in the *Procedure* section should read: "A blank screen followed the stimulus and remained until response. Participants responded by key press: *J* for match and *K* for mismatch."

Also, in the same **Method** subsection, under the **3PP-3PP task**, the last five sentences of the second paragraph in the *Procedure* section should read: "Then, the visual scene was displayed for a fixed duration (determined in the practice block), after which it was replaced by an unmasked blank screen until the participant responded. For a graphical representation of the full trial time course and details, see Figure 2. (See Appendix for more details on trial design.)"

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