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The role of the self in mindblindness in autism

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ABSTRACT

Since its inception the 'mindblindness' theory of autism has greatly furthered our understanding of the core social-communication impairments in autism spectrum conditions (ASC). However, one of the more subtle issues within the theory that needs to be elaborated is the role of the 'self'. In this article, we expand on mindblindness in ASC by addressing topics related to the self and its central role in the social world and then review recent research in ASC that has yielded important insights by contrasting processes relating to both self and other. We suggest that new discoveries lie ahead in understanding how self and other are interrelated and/or distinct, and how understanding atypical self-referential and social-cognitive mechanisms may lead to novel ideas as to how to facilitate social-communicative abilities in ASC.

1. Introduction

If history is any metric of importance, then the 'self' should be ranked not only among one of the most important topics in psychological inquiry, but also among one of the most important topics in autism research. Inquiry into the self dates back to as early as the ancient Greeks. The aphorism *gnōthi seauton* ("know thyself") refers to the idea that to understand human behavior, morals, and thought one must first understand oneself. Similarly, autism spectrum conditions (ASC) are named after the Ancient Greek word *autos*, which literally translates as 'self'. The first characterizations of autism by Kanner (1943) and Asperger (1944) introduced notions of 'extreme egocentrism' that lead to 'autistic aloneness'. From the start, these early notions suggested the concept of 'self' is fundamentally altered in autism and is integral to the hallmark difficulties in social and communicative domains.

If we fast forward to the mid-1980s, it was discovered that individuals with ASC are profoundly impaired in understanding minds; an normative ability we now refer to as 'theory of mind' or 'mentalizing' (Baron-Cohen, Leslie, & Frith, 1985). This theory of mind impairment in ASC is not explained simply as a deficit in *general* meta-representation (e.g., decoupling events from reality) as individuals with ASC pass tests of 'out of date' pictorial representations (e.g., false photos) even whilst failing tests about understanding 'out of date' beliefs (e.g., false beliefs) (Charman & Baron-Cohen, 1992; Leslie & Thaiss, 1992). Furthermore, the theory of mind impairment in ASC extends into an understanding of one's *own* mental states (Baron-Cohen, 1989; Perner, Frith, Leslie, & Leekam, 1989) and has been shown to be more impaired in the self-referential than the social domain (Williams & Happe, 2009). Rather than a complete lack of theory of mind, meta-analytic evidence suggests that many (though not all) individuals with ASC do develop a rudimentary *explicit* mentalizing ability, albeit at a very delayed point in development (Happe, 1995). However, even here, this explicit mentalizing ability developed at later ages may mask the true deficits in understanding and attributing mental states, as studies of automatic or *implicit* mentalizing find deficits in ASC all the way up to adulthood (Abell, Happe, & Frith, 2000; Klin, 2000; Senju, Southgate, White, & Frith, 2009; Senju et al.,

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2010). Thus, the marked impairments specifically in representing mental states was formulated as the 'mindblindness' theory of autism and still stands today as one of the primary cognitive explanations behind social-communicative difficulties in ASC (Baron-Cohen, 1995; Frith, 2001; Hamilton, 2009).

One of the main premises behind the mindblindness theory is the idea that while the general population possesses an intact mechanism for representing or attributing mental states to both *self* and *other*, this mechanism (Carruthers, 2009) or set of mechanisms (Baron-Cohen, 1995; Leslie, 1994) is profoundly impaired in ASC. Of particular note is that the proposed mechanisms for mindblindness in ASC have been very '*other*'-centric in nature (Baron-Cohen, 1995; Leslie, 1994), focusing on how individuals read social cues from others (e.g., facial expressions, eye gaze, body postures), or have been agnostic with respect to the target of mentalizing (Baron-Cohen, 1995; Carruthers, 2009) (e.g., intentionality detection, mental state representation). While informative in their own right, '*other*'-centric or 'target-agnostic' mechanisms have left a gap in terms of mechanisms that may be responsible for atypical self-referential processes in ASC and their integration into the bigger picture of how individuals navigate and interact with the social world.

Thus, rather than adopting the a priori stance that the mechanisms for mindreading are '*other*-centric' or 'target-agnostic', we pose the question of whether there is anything to be gained by exploring similarities and differences in self-referential vs. other-referential processes in ASC. Approximately 15 years ago when the 'mindblindness' account was expanded to a consideration of underlying mechanisms, we alluded to the idea that there is much to be gained by taking into account mechanisms for both understanding our own and other minds (see p. 130 in Baron-Cohen (1995)). Along with work by many others, the self has begun to garner more attention in accounts of mindblindness in ASC (Carruthers, 2009; Frith, 2003; Frith & de Vignemont, 2005; Frith & Happe, 1999; Goldman, 2006; Happe, 2003; Hobson, 1990; Hobson, Chidambi, Lee, & Meyer, 2006; Hobson & Meyer, 2005; Hurlburt, Happe, & Frith, 1994; Nichols & Stich, 2003; Williams, 2010).

With the growing momentum of research on the self in social cognition (not just in autism) over the past 2–3 decades, we take this opportunity to update the mindblindness account by examining some additional factors that take into account the importance of self-referential processing. In this article we begin by highlighting ideas from social psychology. These include ideas such as the relationship between self and other, egocentrism, simulation, asymmetry of informational sources about self and other, perceived similarity, and distinguishing self from other – just a few ways in which knowledge about the self in social cognition can start to provide new insights into the topic of mindblindness and social difficulties in ASC. Our hope is to steer future work in the direction of taking a more balanced approach, looking at how both atypical self-referential and social-cognitive mechanisms contribute to the social difficulties in ASC.

2. Relational multidimensional selves

People do not exist in a vacuum. We are 'selves' embedded in a rich social world full of other 'selves'. As social psychological and personality research demonstrates, 'selves' are not unidimensional; we are multidimensional constructs (Goldberg, 1990; Greenwald & Pratkanis, 1984). Our self-concept is represented as an array of traits in multidimensional space and this multidimensionality allows us to share some variance with others, yet at the same time still be unique – a property which we refer to as the 'duality of self' (Lombardo & Baron-Cohen, 2010; Lombardo et al., 2010a). This duality of self (being both similar to and yet different from others at the same time) is something we believe is important in social-cognitive processes such as mentalizing and we later discuss how the push and pull of similarities and differences between self and other can be used to overcome gaps we have in perceiving self and other.

As multidimensional 'selves' embedded within a rich social world replete with other multidimensional 'selves', it is also well known that the relations we have with others subsequently affect our multidimensional percept of both self and other (Andersen & Chen, 2002; Aron, Aron, & Smollan, 1992; Aron, Aron, Tudor, & Nelson, 1991; Brewer, 1991; Kenny, 1994). For example, the unique relationship you develop with a close other differentially affects how you perceive that (now individuated) person independently of general trends you might exhibit when you generally perceive others. In social psychological models such as the influential 'social relations model' (SRM; Kenny & La Voie, 1984), this is a type of 'relationship-effect' that is an emergent property of the interaction between the target (e.g., another person) and the perceiver (e.g., oneself). This type of interaction is independent of the more general 'main effects' due to characteristics that just the 'perceiver' or 'target' bring to the equation. In another example, imagine two strangers engaged in repeat social interactions. Both individuals build perceptions of the other person that are *emergent properties* of the history of interactions with that person. Thus, part of the interactive process of mentalizing can be conceptualized in a computational framework modeling both 'relationship-effects' as well as what the 'target' or 'perceiver' generally add to the equation. Computational approaches applied to mentalizing processes have recently emerged, with studies showing that specific parameters modeling the emergent properties of social interactions (e.g., relationship effects[1]) map onto variability in neural systems involved in mentalizing (Behrens, Hunt, & Rushworth, 2009; Behrens, Hunt, Woolrich, & Rushworth, 2008; Hampton, Bossaerts, & O'Doherty, 2008). It is also worth noting that this type of effect is more characteristic of naturalistic social interactions in the real world and thus gets us closer to the external validity we strive to attain.

[1] The usage of the phrase 'relationship effects' should not be interpreted in the traditional way a 'relationship effect' is interpreted under the social relations model as the modeling strategies from these studies differ from those put forth by Kenny and La Voie (1984). However, the phrase is useful here since these modeling studies are assessing parameters that reflect the relations between people that emerge as a property of the growing interaction between them.

Adding to the complexity of emergent 'relationship-effects' in how we perceive ourselves and others, there are also general factors to account for. James (1890) was the first to suggest that how we see ourselves is in part based on how we think we look in the eyes of others. This idea was developed into the concept of the 'Looking Glass Self' (Cooley, 1902; Mead, 1934) and refers to the fact that the perceptions of others have a substantial impact on how we perceive ourselves (Brewer, 1991; Srivastava & Beer, 2005). Outside the context of being embedded in a real-world social interaction, if you know that others generally see you as being 'trustworthy', you may then perceive yourself to be a trustworthy person, even though you have enough privileged information to know whether this is actually an accurate reflection of yourself. Conversely, the general perception we have of ourselves affects how we then perceive others (Srivastava, Guglielmo, & Beer, 2010). A person who is generally upbeat and positive is likely to judge others as positive and upbeat in a biased manner congruent with their own self-perception. Thus, how we construe both our own *intra*personal as well the *inter*personal social world depends in part on a variety of these more general factors as well as factors built upon relationships we have with others.

As noted earlier, much of the research on social difficulties in autism is inherently one-sided, focusing mainly on reading social cues from others (e.g., face-processing, eye gaze, biological motion, emotion recognition, action understanding, pragmatic aspects of language). What is needed is a more *relational* approach in order to reveal the deeper complexities involved in interpersonal relations. It is increasingly apparent that these basic mechanisms for related to reading social cues of others, are unlikely to account for all the variability in the real-world social difficulties in ASC. This is especially true for emergent properties of social interactions such as 'relationship-effects' that are a given outside the laboratory setting.

To illustrate this point consider a recent study by Chiu et al. (2008) where participants with ASC were scanned with fMRI while playing the 'trust game' with another person. The 'trust game' is a social interaction where emergent properties of the interaction play a major role in shaping the neural mechanisms elicited in both the investor and trustee's brain (King-Casas et al., 2006), but do not shape the same neural mechanisms when the interaction is non-social, such as when playing against a computer (Tomlin et al., 2006). Chiu and colleagues found that an area outside the traditional mentalizing system (the middle cingulate cortex; MCC) was specifically underactive when participants with ASC had to decide how much to invest in the other person. This result is important because the psychological processes involved in making this type of decision are relevant to what we do when we mentalize. In this particular scenario, participants likely think about what *they* want to do, but also need to take into account the consequences that their decision will have on the *other* person's perception of them (what Frith and Frith (2008) dub as 'reputation management'). Given that 'reputation management' must involve mentalizing, it is striking that Chiu and colleagues did not find typical mentalizing system regions underactive in ASC. Instead, a region not typically involved in traditional mentalizing studies emerged: the MCC. This type of interaction in the trust game is a clear example of a 'relationship-effect' since it is an emergent property of being in a social interaction. Thus, one could say that the MCC result from the Chiu et al., study highlights a new neural mechanism for mindblindness in ASC that arises specifically from the emergent properties of being embedded in a social interaction.

The approach demonstrated by Chiu and colleagues demonstrates a very different approach from the traditional way in which mentalizing or theory of mind is assessed in autism research. Past studies have typically assessed the participant making judgments about the mental states of another individual outside of the context where they are interacting with them. This traditional approach may have highlighted more *general* effects that are part of the mentalizing process, such as the capacity to represent mental states, but they are most likely independent of some of the 'relationship-effects' that are likely to emerge as a property of the social interaction itself. Thus, we take this opportunity to point out that both investigating mentalizing within and outside of social interactions are important and provide complimentary information about the mechanisms involved in mindblindness in ASC. However, this case represents an example where the mechanism for general representation of mental states in ASC may not be able to account for the deeper complexity embedded in the emergent properties that come out of interpersonal interactions. In this case, the basic idea of 'mindblindness' still holds, but the mechanism behind it is likely to be one that integrates the information gained from the interaction of the relationship between self and other, rather than just a mechanism that attributes a propositional attitude to an agent.

A second piece of evidence that highlights the role of the MCC region highlighted by Chiu et al. (2008) involves comparing the response of this region while participants with ASC mentalize independently about themselves or another person. Despite the general premise that mindblindness extends to impairments in understanding one's own and another's mind, this premise has not been extensively tested within the brain and within the same paradigm in ASC. According to this premise, there should be no neural mechanisms *asymmetrically* involved in mentalizing more for self compared to others (or vice versa) (Carruthers, 2009). However, if self-referential processing is important for explaining some of the mechanisms involved in mindblindness in ASC, we should expect that there will be specific areas of the brain that respond atypically for mentalizing specifically about self or other. We showed that the MCC is one of these special regions. In the general population, MCC responds more when information is self-relevant (Lombardo et al., 2010a; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006) but also responds more in self-relevant decisions embedded in the context of a social interaction (King-Casas et al., 2006; Tomlin et al., 2006). When asked to mentalize separately about self and other, typical participants activate MCC more when mentalizing about self than when mentalizing about other. However, individuals with ASC display the opposite pattern; MCC responded more when mentalizing about others compared to mentalizing about themselves (Lombardo et al., 2010a). Therefore, target-agnostic mechanisms involved in mindblindness irrespective of whether the target is self or other (Carruthers, 2009), cannot account for the specificity of this result. Along with the evidence from Chiu et al. (2008) this highlights that there is more complexity involved in mindblindness in ASC than just one general-purpose mechanism accounting for all deficits in mentalizing about self and other.

3. Asymmetry in informational sources about self and other

Beyond this idea that the relations we have with the social world considerably affects our perception of it, there are also fundamental considerations regarding differences in the *kind* of information we use to make inferences about self and other. The information we use for ourselves is largely *introspective* and *interoceptive* while the information available for making sense of others is largely *extrospective* and *exteroceptive*. That is, we have direct and privileged access to every sensation, emotion, and thought we have. However, when it comes to others, there is a dearth of direct information that we can collect about another's embodied experience. Instead, our experience of others' phenomenology is largely dominated by observing their external behaviors (Pronin, 2008). This *asymmetry in informational sources* plays a major role in shaping the kinds of mechanisms that are involved in how we understand our own and others' phenomenology.

To demonstrate how different kinds of inputs necessitate the need for different mechanisms, take the example of a car engine. A car that runs on diesel has one particular type of mechanism (an internal combustion engine) to deal with this input. This mechanism cannot easily handle different types of input (e.g., electric power). However, a hybrid car has two integrated mechanisms that can deal with both types of input: these being the electrical motor and an internal combustion engine as well as the computer that regulates the integration of both. In this scenario, the fuel or electrical power is the input to the system and these inputs are fundamentally different. Because they are different, they require different mechanisms to get the same output. Thus, the difference in the quality/type of input makes a difference to how efficiently (if at all) the operations can run (as you would sadly discover if accidentally you put unleaded petrol into your diesel car) as well determining the kinds of mechanisms needed to operate on such fundamentally different kinds of input.

This example is not to say that for mentalizing information to be processed it must be handled by one special kind of mechanism for each type of input. However, given the complexity involved in performing operations on multiple types of input, one unitary mentalizing mechanism (Carruthers, 2009) or a set of *other*-centric or target-agnostic mentalizing mechanisms (Baron-Cohen, 1995; Leslie, 1994) are necessarily ill-equipped for handling qualitatively different types of information available for self-referential processing, such as introspective or interoceptive information. From what we know about the specific neural mechanisms involved in dealing with introspective/interoceptive compared to extroceptive/exteroceptive input (e.g., Olsson & Ochsner, 2008) it is more likely that the mentalizing system needs mechanisms that handle the *different* types of inputs as well as mechanisms where convergence and integration occurs across the different types of input.

Because of this asymmetry in informational sources for self and other, it is necessary to pay close attention to the differences between mindblindness for self and mindblindness for other in ASC. Difficulty in understanding one's own mental states might be due to differences in the unique types of information available for self-referential processing and thus the distinct mechanisms that handle such input. On the other hand, mindblindness for others may be due to mechanisms aligned with dealing with input available when perceiving others. However, a third alternative not mutually exclusive to the others, is that of a mechanism responsible for mentalizing operations on both self and other. One way to begin to understand whether the mechanisms behind mindblindness for self and other are similar or different is to examine them both within the same study. Because of this consideration about the differences in informational sources, we should not necessarily assume a priori that the mechanisms at work for understanding our own minds are the same as those working to understand other's minds. It is likely there will be some common ground, but it is also likely there will be some important differences.

Interoception is a good example to demonstrate the importance of casting a spotlight on the *kind* of information used to make inferences about self and other. Interoceptive information is only directly accessible to the agent experiencing it. This type of embodied information (e.g., somatosensory, visceral) is processed by a mechanism that allows the agent to become conscious or aware of its own bodily or physiological state. While important for the agent to gauge their own bodily or physiological state, the same neural mechanisms that handle this interoceptive function for ourselves also come online when we simply observe others in situations where their experience (e.g., pain or disgust) might evoke extreme somatosensory or visceral states (Craig, 2002; Singer et al., 2004; Wicker et al., 2003). Thus, accurately interpreting and using interoceptive information seems to be a basis for not only understanding our own experience, but also for empathically jumping into the experiences of others.

Given these arguments, it is surprising that we do not yet know if interoceptive processing is specifically impaired in ASC or whether this mechanism is influencing the difficulties in empathizing with others. Although we know *introspection* is difficult in ASC (Hill, Berthoz, & Frith, 2004; Hurlburt et al., 1994; Lombardo, Barnes, Wheelwright, & Baron-Cohen, 2007; Toichi et al., 2002) there is as yet no test of *interoceptive* accuracy in ASC. Individuals with ASC have alexithymic tendencies that hint at difficulty in interoception (Hill et al., 2004; Lombardo et al., 2007) but may simply reflect difficulties due to introspection. Supporting the idea that introspective processes may be involved is the observation that appraisal of negative emotion is different in ASC compared to controls, despite the two groups showing equivalent physiological arousal to the emotion eliciting stimuli (Ben Shalom et al., 2006). On the other hand, corticospinal excitability to viewing other's in pain is reduced in ASC (Minio-Paluello, Baron-Cohen, Avenanti, Walsh, & Aglioti, 2009). This neurophysiological difference may be the first step in demonstrating a disconnect between physiological or bodily state information and interoceptive manipulation of such information in an empathic way. The ambiguous nature of existing data suggests that this is an important area for future research in ASC as it may clarify the extent of difficulties in access to self-referential information as well as possibly highlighting critical mechanisms that may underlie difficulties in empathy (Bird et al., 2010; Minio-Paluello, Lombardo, Chakrabarti, Wheelwright, & Baron-Cohen, 2009; Silani et al., 2008).

4. Egocentrism

We also need to pay more attention to the idea of egocentrism in ASC. While autism may seem like 'egocentrism in the extreme' (Asperger, 1944; Frith & de Vignemont, 2005), we must keep in mind that some degree of egocentrism itself is in fact the norm within the typical population. Social psychological research has repeatedly demonstrated the egocentric ways in which we make sense of and interpret the world (Greenwald, 1980; Krueger, 2003; Nickerson, 1999). Nowhere is egocentrism more obvious than in how it manifests when we try to predict what others think and know. When asked to estimate the general consensus on a topic, most people tend to overestimate that the consensus will conform in a congruent way with what they believe; an effect known the 'false consensus effect' (Krueger & Clement, 1994; Ross, Greene, & House, 1977). We also tend to overestimate how much attention is being paid to us (e.g. the 'spotlight' effect) (Gilovich, Medvec, & Savitsky, 2000) and how transparent we think we are in the eyes of others (the 'illusion of transparency') (Gilovich, Savitsky, & Medvec, 1998). Both children and adults show signs of egocentrism in social prediction. In the 'curse of knowledge' paradigm, people tend to overestimate the probability that naïve others will look for an object in a location that they themselves know the object to be in. Although in this paradigm it is easy to step back and consider what the naïve other person knows independently of what 'I' know (Birch & Bloom, 2003, 2007), even adults make egocentric errors on this paradigm or variants of it (Dumontheil, Apperly, & Blakemore, 2010; Epley, Morewedge, & Keysar, 2004b; Keysar, Lin, & Barr, 2003). These are just a few examples of egocentrism applied in the social domain.

Given that some degree of egocentrism is the norm in the general population, how do we know that egocentrism in autism is an extreme version of this? While there are hints of egocentrism scattered throughout the autism literature (Lombardo and Baron-Cohen (2010), there is little work on this topic in autism with relation to standard social psychology paradigms that elicit marked egocentrism in social prediction in the general population. A more systematic examination of egocentrism in autism, especially in relation to egocentrism in social prediction, will be an important avenue for future research.

5. Simulation: the upshot of egocentrism and privileged access

Although we possess privileged, yet asymmetrical informational access to embodied information and are highly prone to egocentric biases, there are clear benefits for having both. Both enable us to readily use ourselves as proxies for predicting the social world. Since we have ready and direct access to our own experiences and mental life, we exploit this information to our advantage when given an impoverished environment with a lack of direct access to what others think and feel. Philosophers have coined this process *simulation* (Goldman, 2006; Gordon, 1992) and many accounts of 'simulation' (sometimes under another guise or label) can be found from philosophy (Gallese, 2001; Goldman, 2006; Gordon, 1992; Heal, 1986; Humphrey, 1984; Hurley, 2008), social cognition (Ames, 2004a, 2004b; Epley, Keysar, Van Boven, & Gilovich, 2004a; Nickerson, 1999), embodied cognition (Aziz-Zadeh & Damasio, 2008; Niedenthal, 2007; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005), to neuroscience (Buckner & Carroll, 2006; Decety & Grezes, 2006; Iacoboni & Dapretto, 2006; Keysers & Gazzola, 2007; Mitchell, Banaji, & Macrae, 2005; Mitchell, Macrae, & Banaji, 2006; Rizzolatti & Craighero, 2004). Despite all the different varieties of simulation accounts, they all share one common quality: we use privileged access to our own phenomenology to gain a window of insight into the phenomenology of others. Thus, we can bypass being behaviorists (e.g., using 'behavior rules') or disembodied 'theorists' in interpreting the extrospective and exteroceptive information we get from others, by looking inward and projecting or simulating that other person as if we were them. This is not the only way we come to know the minds of others (Gopnik & Wellman, 1992), but it is one important path towards the difficult problem of getting into another's mind and experiences, especially in instances where others are perceived to be similar to oneself and/or when not much individuating information is known about the target person (Ames, 2004a, 2004b; Epley, 2008).

6. Simulation as anchoring and adjustment

As the multiple varieties of simulation out there might suggest, the basic idea of using oneself as a proxy for understanding others has not been very consistent in how it is specified. Thus, an idea that may be useful here is to frame the process of simulation as both automatic, and yet effortful and controlled. An integral idea here is the general process in the judgment and decision making literature that Tversky and Kahneman dubbed the 'anchoring and adjustment' heuristic (Tversky & Kahneman, 1974). That is, when people make judgments under uncertainty, they start from an initial anchor value automatically set based on information that is most readily available and then go through an effortful and controlled process of serial adjustment away from that anchor in order to come up with an answer that in the end will be sufficient to them. However, this process of serial adjustment away from the anchor point is usually insufficient for honing in on the correct answer and is usually biased towards the initial starting values (Slovic & Lichtenstein, 1971).

So what are the starting values for social judgments? In the general formulation of the anchoring and adjustment heuristic, Tversky and Kahneman (1974) noted that the anchor is usually spontaneously self-defined, based on the most available information present at the time (known as the 'availability heuristic') (Tversky & Kahneman, 1973). Thus, as noted in the section on egocentrism as well as Meltzoff's developmental 'like me' framework (Meltzoff, 2007a, 2007b), information about the self is usually the most available information and tends to be the automatic default starting value or anchor point

for social judgments. A caveat here is that self is usually the default anchor for social judgments in instances of uncertainty about the other person. The more information is known about a particular target the more it may be the case that other types of information may be more readily available than just what we know of ourselves (Epley, 2008).

Using self as a habitual reference point in the social domain can be exemplified in studies that find asymmetries in similarity judgments depending on how the similarity statement is linguistically specified. When the self is specified as the referent and another person as the subject (e.g., 'How similar are you to X?'), similarity ratings are much higher than when the other person is the referent and the self is the subject (e.g., 'How similar is X to you?') (Srull & Gaelick, 1983). The explanation behind this is that the 'self' is a supraordinate object of knowledge, whilst others are a subordinate object of knowledge. Comparing a supraordinate object to a subordinate object of knowledge will render more matches than making the comparison in the other direction (see Fig. 1). However, rather than this simply occurring because of linguistic convention, further manipulations can be performed to show that the self is indeed a habitual reference point in the social domain. Catrambone, Beike, and Niedenthal (1996) replicated the asymmetry in similarity judgments mentioned above. However, they also included a manipulation where the referent and subject were not forced upon the participant based on linguistic conventions. By simply asking people 'How similar are these two people in general?' and then offering self and the other person under this statement in a vertical arrangement, they found that these non-forced similarity judgments rendered similarity ratings identical to those where the self is placed as the referent. Thus, this simple set of studies illustrates the frequent observation throughout the egocentrism literature, that people automatically use themselves as the habitual reference point in social judgments (Alicke, 1993; Clement & Krueger, 2000; Dunning & Cohen, 1992; Dunning, Meyerowitz, & Holzberg, 1989; Meltzoff & Brooks, 2008; Nickerson, 1999). Furthermore, as the 'spotlight' effect and the 'illusion of transparency' demonstrate, people use their own phenomenology when estimating how they will be evaluated by others (Chambers, Epley, Savitsky, & Windschitl, 2008; Epley, Savitsky, & Gilovich, 2002; Gilovich et al., 1998, 2000). This is not particularly surprising given that information for self typically rests on a wealth of access to one's own phenomenology, but observing others rests predominantly on externally observable (e.g., behavioral) information (Pronin, 2008).

Although we automatically use ourselves as a plausible anchor or reference point to facilitate social inference, the second hurdle of adjustment from our anchor point is essential for accurate social inference. This adjustment process, unlike the automatic nature of anchoring on oneself, is effortful and controlled. Because adjustment requires effort and control, it is highly susceptible to disruption and thus, becomes insufficient. In the context of social judgment, when adjustments are insufficient they are biased toward the starting value; ourselves. Epley and Gilovich (2006) suggest that adjustments are usually insufficient because this process terminates when we settle on a plausible (though not always correct) value, and because in most contexts individuals are not motivated enough to go through the extra search for more information that will provide evidence for further adjustment towards an accurate estimate. However, give an individual a financial incentive

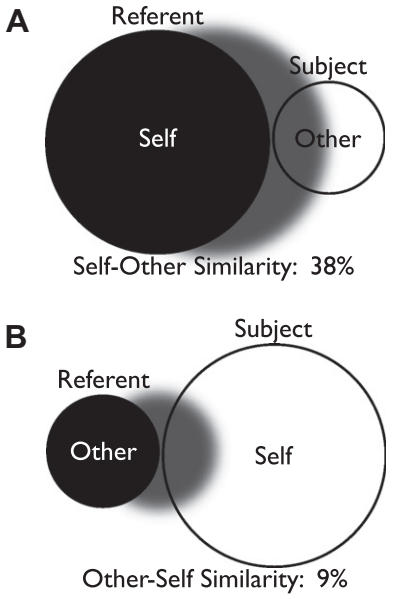

Fig. 1. Self-as-a-supraordinate and Other-as-a-subordinate object of knowledge. This figure illustrates Self and Other as circles. The size of the circle depicts the amount of knowledge one has about each. When Self is compared to Other, the overlap (represented by the area of the shadow on the subject) is larger than when Other is compared to Self. This is used as an explanation for the phenomenon that similarity between self and other is rated as higher when Self is the 'referent' and Other is the 'subject' (e.g., 'How similar are you to ⟨Other⟩?') compared to when Other is the 'referent' and Self is the 'subject' (e.g., 'How similar is ⟨Other⟩ to you?') (Srull & Gaelick, 1983). When people are not forced to make the similarity ratings in a manner where referent and subject are pre-specified linguistically (e.g., 'How similar are these two people?'), people tend to default by placing the Self as the 'referent' because similarity ratings in this case are identical to when Self is designated as the 'referent' (Catrambone et al., 1996).

to be accurate and adjustments tend to become more accurate. Given these ideas that adjustment is effortful and controlled and that insufficient adjustment will lead to judgments closer to self-referential anchors, one way to determine if people use anchoring and adjustment is to intervene at the adjustment stage. The prediction here is that manipulations that disrupt serial adjustment away from self-referential anchor points will lead to increasingly egocentric biases in social prediction. However, manipulations that motivate the participant to continue the adjustment process (e.g., financial incentives) should lead to less egocentric bias.

Through a series of studies Epley et al. (2004a) were able to show that systematic manipulations to intervene in the adjustment stage can systematically alter how much of an egocentric bias in social judgment is expressed. Across four studies, Epley and colleagues were able to first demonstrate egocentric biases in social prediction and that individuals serially adjust from their self-referential starting point. Furthermore, manipulations that disrupted the effortful and controlled adjustment process led to more pronounced egocentric biases, while financial incentive manipulations led participants to adjust towards more accurate social predictions. The most dramatic result in this set of studies was that people who reported hearing backward masked messages in music (e.g., hearing "Its fun to smoke marijuana" while listening to the Queen song *Another One Bites the Dust* played backwards) would egocentrically predict that naïve others would also hear the backward masked message, and that adjustment processes away from this egocentric anchor could be disrupted simply by answering questions about what other's would hear while nodding their head (an implicit act of acceptance). The idea here is that people start from the egocentric anchor that others will be like me and hear the backward masked message, and head nodding leads people to accept values earlier in the adjustment process (Wells & Petty, 1980), thus leading to more pronounced egocentrism in predicting whether others could also hear the message.

Given the idea that simulation is a key process for how individuals gain insight into the social world, it is striking that there is such a dearth of work on simulation[2] in the context of mentalizing research in autism. This is perhaps the case since the trend has typically been to study other-referential or self-referential processing separately, rather than within the same study. However, recent studies consistently show that individuals with autism are impaired in both self-referential and social-cognitive processing (Lombardo et al., 2007; Williams & Happe, 2009, 2010), suggesting at the very least, that some of the same mechanisms are involved in both self-referential and social cognition, and perhaps implicating that simulation approaches may be worthwhile in testing for common mechanisms underlying self-referential and social deficits in autism.

Our recent work tied together a variety of self-referential and social-cognitive measures and found that individuals with ASC have concurrent and related impairments in both domains (Lombardo et al., 2007). We followed this behavioral study with an fMRI study to investigate whether there were any common neural mechanisms involved in mindblindness for self and other. In the general population, a distributed network of brain regions is recruited for both mentalizing about self and other (Lombardo et al., 2010b). One of these shared mentalizing regions known to be specifically involved in the general representation of mental states, the right temporo-parietal junction (RTPJ) (Saxe & Kanwisher, 2003; Saxe & Powell, 2006), was hypoactive in ASC across both mentalizing about self and other. Furthermore, the magnitude of early childhood social impairments was related to decreased activation of this region across both mentalizing about self and other (Lombardo, Chakrabarti, Bullmore, MRC AIMS Consortium, & Baron-Cohen, in preparation). Thus, the premise that mind-blindness in ASC may stem from similar mechanisms deployed for self and other seems to be confirmed. This study clarifies that this mechanism may be involved specifically with the representation of mental states itself. However, as we argue in this paper, there are likely to be considerably more mechanisms that contribute to mindblindness for self and other, and some may affect self, other, or the unique interaction of the two within a social interaction.

7. Perceived similarity and distinguishing between self and other

The final notion we will underscore as important for considering the role of the self in mindblindness in ASC is the idea of whether others are perceived as similar to or different from self. Perceived similarity between self and other is one of the primary factors in determining how much adjustment away from self-referential anchors will be required in order to successfully simulate the experience of others. While one may want to anchor on self for others who are similar to oneself, they will not want to engage in much adjustment away from the self-referential anchor point. Alternatively, those who are perceived to be dissimilar to self will likely be those where adjustment processes may become more important.

Ames highlighted this notion in a series of two papers where he describes his 'similarity contingency model' of social inference (Ames, 2004a, 2004b). In this model he describes two forms of social inference: projection (i.e. 'simulation') and stereotyping. His prediction was that the deployment of such forms of social inference would depend on the perceived similarity of the target to oneself. In cases where one is similar to self, projection would be deployed, while stereotyping would be deployed for dissimilar others. Across a range of different manipulations, Ames showed that indeed, the more similar perceivers are to target others, the more the perceiver's own attitudes and opinions are projected onto the target other. However, when the target is dissimilar, perceivers engage more in stereotyping processes. Ames' results are largely congruent with other findings in the false consensus literature which highlight that social categorization significantly

[2] We do not discuss areas of research on 'simulation' such as mirror neurons as this extends discussion into topics such as action understanding and while relevant to discussing its relation to the social deficits in autism, is a bit beyond the scope of discussing 'simulation' specifically within the context of mindblindness in autism.

mediates the degree to which the false consensus effect occurs (Clement & Krueger, 2000). The take home message of Ames' studies is that while egocentrism creates many biases in social perception, it also has the upshot of facilitating an understanding of others, depending on how well one serves as a proxy for others. In the scope of the anchoring and adjustment perspective, Ames' work demonstrates that when one is similar to oneself, the adjustment process is much easier than when adjusting far from the anchor point for dissimilar others. The deployment of other heuristics for dissimilar others, such as more rule-based stereotyping, is important to highlight since this may be a shortcut around the effortful process of serial adjustment away from self-referential anchors and highlights that anchoring and adjustment may be part of a larger toolkit people use when making sense of the social world.

Perceiving similarities and differences between self and others relies on specific neural mechanisms. fMRI studies have consistently demonstrated that one area of the brain crucial for making such a distinction is the ventromedial prefrontal cortex (vMPFC). Activity in vMPFC increases in linear fashion when information is perceived to be increasingly self-relevant (Moran, Heatherton, & Kelley, 2009; Moran et al., 2006) and thus responds on average more when thinking about oneself compared to others (Kelley et al., 2002). When individuals with autism reflect on themselves or others, vMPFC responds atypically, in an egocentrically equivalent fashion for both self and other (Kennedy & Courchesne, 2008; Lombardo et al., 2010a). This lack of a neural self-other distinction mirrors behavioral evidence that individuals with ASC show markers of atypical self-other distinctions (Lee & Hobson, 2006; Lee, Hobson, & Chiat, 1994; Mitchell & O'Keefe, 2008). Furthermore, underscoring the idea that mechanisms for distinguishing self from other are important in the social domain, we found that the degree to which vMPFC responds selectively for self compared to other was predicted by the degree of early childhood social impairment, such that individuals whose vMPFC responded most egocentrically to the mental characteristics of self and other were the most socially impaired in early childhood (see Fig. 2) (Lombardo et al., 2010a). Because perceiving similarities and differences between self and other are integral in simulation aspects of mindreading, this insight further illustrates the importance of taking the self into account when addressing mindblindness and the hallmark social difficulties in ASC.

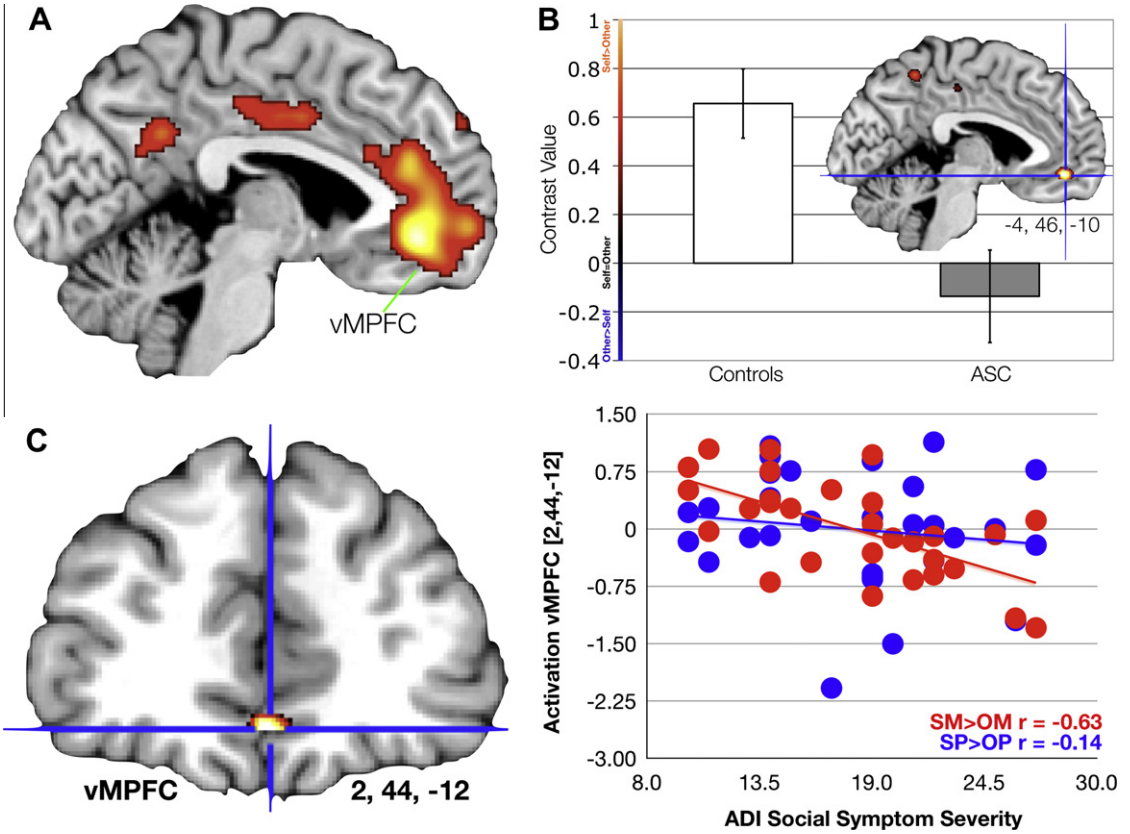

Fig. 2. Atypical neural self-other distinction in ASC and its relationship to social impairment (Taken from Lombardo et al. (2010a)). (A) Results from a quantitative meta-analysis highlighting regions of the brain consistently recruited more self-referential cognition compared to thinking about others. Ventromedial prefrontal cortex (vMPFC) is the maximal peak from this meta-analysis. (B) While vMPFC responds more to thinking about self compared to others in healthy Controls, it responds equivalently to self and other in ASC. (C) Magnitude of self-other distinction expressed by vMPFC in the mentalizing domain (red) but not the physical domain (blue) correlates with social impairment in ASC. Those individuals whose vMPFC made the largest self-other distinction were least socially impaired, while those whose vMPFC made little to no distinction between self and other were most socially impaired. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

In conclusion, we have provided several arguments that illustrate why it is important to consider the role of the self in mindblindness. Integrating knowledge from social psychology is an important first step in this topic, as many considerations about the self discussed here may play an important role in mentalizing in ASC. However, new ideas raise many new questions. We have highlighted some of these new directions as well as some recent research that begins to take this new approach of integrating the self into social cognition in ASC. Further work along these lines will yield not only new insights into mindblindness and social-communication difficulties in ASC, but also inform us as to how critical this topic is in typical social development. In the clinical domain, paying further attention to mechanisms involved in mindblindness and how they are related to self-referential processing may provide new ways of facilitating both self-referential and social-communicative deficits in ASC.

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