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Review

Visual Perspective-Taking and Embodied Self in Autistic Spectrum Disorders

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Abstract

A key characteristic associated with Autistic Spectrum Disorders (ASD) is impairment in communication and sociability. Such impairments have been attributed exclusively to a deficit in theory of mind; however, this thesis has been widely challenged. People with ASD do not necessarily struggle with all forms of perspective-taking. Although people with ASD perform poorly in explicit visual perspective-taking tasks, they perform no worse than typically developing people do in implicit visual perspective-taking tasks. This study attempted to explain this discrepancy by focusing on the embodied self and self-awareness. This study offered the following supposition for ASD-related weakness in visual perspective-taking: Explicit visual perspective-taking is enabled by the person detaching their embodied representational self from their somatic sensations; people with ASD struggle to accomplish such detachment because their representational self is too strongly anchored to their somatic sensations owing to their excessively acute self-awareness. As for implicit visual perspective-taking, such perspective-taking is an intersubjective phenomenon that occurs when the self–other distinction is loosened. Therefore, the observation that people with ASD can accomplish implicit visual perspective-taking must be attributable to the persistence of this loosening mechanism. From these suppositions, this study proposed the following developmental model for people with ASD: Unable to control their unstable somesthesis, people with ASD develop somesthetic disorder, creating an atypical embodied self, which ultimately manifests in social impairment. This approach implies that ASD-related researchers and educators should devote greater attention to somesthesis typical to ASD and the atypical embodied self it generates.

Keywords: Visual perspective-taking • Autistic spectrum disorders • Representational self • Physical self • Embodiment • Theory of mind

Introduction

Autistic Spectrum Disorders (ASD) encompasses several related subgroups [1], including Asperger syndrome, pervasive developmental disorder, and high-functioning autism. According to the literature, no single explanation exists for the diverse conditions represented by these subgroups each subgroup is associated with a different set of social and communication challenges [2,3], and people with ASD may exhibit no social and communication deficits compared with typically developing peers [4,5]. However, this study is not concerned with the variation between the subgroups; it aims to address common traits that apply across the ASD spectrum by reevaluating the findings of Visual Perspective-Taking (VPT) in people with ASD.

Literature Review

The necessity of reconsidering ASD research

In 1985, Baron-Cohen, Leslie, and Frith reported that children and adults with ASD lack a basic metarepresentational capacity known as "Theory of Mind" (ToM) [6]. Their study was followed by a series of similar reports, including one suggesting that ToM is also impaired in people with ASD whose intelligence is equal to neurologically typical people [7]. This ToM thesis can explain the potential struggle of people with ASD in surmising what another person believes or wants [8], or in determining whether another person is lying [9]. The ToM paradigm deserves credit for revealing that the social impairments seen in people with ASD cannot simply be explained as intellectual disability [10]. Even today, empirical research [11], continues to assume that ASD is characterized by limited impairment of ToM [12].

However, the problem with the ToM thesis is that it suggests that people with ASD struggle with perspective-taking per se, without accounting for variation between different forms of perspective-taking. In light of recent research in which non-linguistic techniques are used to show that young children can surmise mental states in others [13,14], whereas adults commit errors when engaging in implicit perspective-taking [15]. Apperly and Butterfill suggested that humans have two perspective-taking systems: the implicit system, which works in a fast, automatic, and inflexible fashion, and the explicit system, which works in a slower, controlled, and flexible fashion [16]. A series of reports suggest that people with ASD experience difficulty in one, not both, of the systems, but the reports are inconsistent as to which of the two it is. Problems occur in the explicit system according to a study that found that the performance of people with ASD is impaired in explicit, but not in implicit, social perspective-taking tasks [17]. Another study attributed this finding to poor metarepresentational capacity [18]. Yet other studies point to difficulties in the implicit system: One such report suggests that people with ASD struggle to understand implicit false beliefs [19]. Another found that children with ASD perform worse in an implicit false-belief test compared with their neurotypical peers [20]. This inconsistency on the question of which system is impaired in people with ASD—implicit or explicit—has been attributed to the lack of clear distinction between implicit and explicit false beliefs as well as to reproducibility issues in certain implicit false-belief tasks [21]. In any case, the present study is unconcerned with the validity of each study that used false-belief tasks.The ToM thesis is also challenged by other fields of research. Two studies reported that people with ASD, when compared with neurotypical peers, exhibit impairments in cognitive empathy as the ToM thesis suggests, but show no significant impairments in emotional empathy [22,23]. Another study suggested that when emotional cognitive impairments are present, these may in fact be attributable to alexithymia, which often co-occurs with ASD [24]. Moreover, adults with ASD have been found to perform well in an ecologically valid false-belief task (the empathic accuracy paradigm) [25]. Another study reported that adults with ASD perform no worse than their neurotypical peers in a communication game in which they distinguish between their beliefs and the beliefs of others [26]. Alongside such research, one study noted that people with ASD, while continuing to experience core cognitive deficits, can nonetheless minimize the behavioral symptoms they exhibit in daily life by compensating for their difficulties; the study also noted that the mechanisms behind such compensation remain largely unexplored [27]. The above studies illustrate that ToM is insufficiently compelling as a single explanation for ASD.

An effective measure for understanding ASD may be obtained by reexamining another core symptom: "restricted, repetitive patterns of behavior, interests, or activities" [28]. Children with ASD, in their

visual perceptual experiences, exhibit a bias toward local perception (focusing on details in the image) rather than gestalt perception (seeing the bigger picture), which explains their struggle with central processing of context-dependent information [29]. The problem of central coherence can generate both positive and negative effects in a single task; for example, a person might exhibit an unusual talent for remembering a series of unrelated items (such as word strings) but also exhibit an unusual weakness for understanding the relation among items (such as sentences) [30]. In light of this local bias, Happé and Frith proposed the weak central coherence model—the idea that people with ASD tend toward a detail-focused processing style and that this tendency explains their weakness in central processing [31]. Other studies have focused on executive function, in light of a report that people with ASD struggle with pattern recognition: after a pattern is altered, they often erroneously adhere to the pre-altered pattern [32]. Indeed, ASD has been attributed to deficiency in executive function, a term that encompasses functions such as impulse control and monitoring of action [33-35]. However, neither central coherence nor executive function impairments are fully satisfactory. It has even been suggested that ASD may be shaped by deficits in early domain-general skills [36]. In some respects, previous researchers explain ASD in terms of clinical phenomena, and in other respects, the explanation is inadequate. Thus, the complex symptoms of ASD cannot be explained by a single theoretical framework [37]. A breakthrough in ASD studies may be achieved by exploring avenues that have been under-explored. Particularly promising is Visual Perspective-Taking (VPT), which has yet to garner the same scholarly attention as the ToM thesis despite both involving the capacity to envisage an alternative perspective. Reevaluating the findings of VPT research should unlock new insights into the characteristics of ASD. VPT is the ability to visualize objects from another point in space. "Another point" does not necessarily mean the perspective of another person; it simply means a point in space other than one's own. Thus, unlike ToM, which is concerned with the capacity to envisage a social perspective, VPT requires no other person to be present. As such, it can allow researchers to study the inflexible, detail-focused response patterns associated with ASD without being excessively influenced by social relations, as they might if they relied on the ToM thesis.

Visual perspective-taking in people with ASD

VPT consists of two processes: placing oneself in a different position (the perspective operation) and the cognitive processing required for task situations (the information processing) [38]. Flavell defined two levels in VPT: level 1 is the ability to understand that other people have a different line of sight to one's own, whereas level 2 is the understanding that the same item may be seen differently for others in different points [39]. Level 1 thus involves understanding about others' perspectives, and level 2 involves the ability to process the information about others. Children with typical development master level 1 by age 3 years and master level 2 by later childhood. Warreyn and colleagues set a level 1 VPT task among children with ASD aged 3 to 7 and a control-group with corresponding ages, the age range at which children's ability lies between levels 1 and 2 [40]. They found that the children with ASD performed less well. Other studies, however, suggest that problems occur at level 2, not level 1. Hamilton, Brindley, and Frith set a level 2 VPT task and a closely matched mental rotation task on children with ASD who were aged around 8 but had a verbal mental age of around 4 and on neurotypical children aged 4 years to 8 years [41]. Relative to the neurotypical children, the children with ASD exhibited greater difficulties in the level 2 VPT task than they did in the mental rotation task. Similarly, Brunyé and colleagues reported that university students with strong ASD-characteristic traits exhibited impaired performance in level 2 VPT, but not level 1 VPT [42]. Another study found no impairment in VPT level 1 among people with high-functioning autism who were diagnosed with Asperger syndrome [43].

Although these results seem to imply that, of the two VPT levels, people with ASD exhibit impairment in level 2, such a conclusion would be too hastily drawn. That is, the VPT tasks set in the above studies differed not only in the VPT level but also in whether the perspective operation required in the task (regardless of level) was explicit or implicit. Given that level 2 tasks mostly require explicit procedures; the task results may imply that people with ASD struggle with explicit VPT. This inference is supported by evidence from a study that set both implicit and explicit level 1 VPT tasks for people with high-functioning autism and a control group [44]. While no inter-group differences were observed in implicit VPT, the ASD group struggled with the explicit task. This finding would explain the observed impairment at level 1[40], or level 2: children with ASD struggled in the VPT task, not because of its level but because it happened to require explicit procedures (the children were instructed to state what the experimenter was looking at), like most of the level 2 tasks did.

As such, the reason that people with ASD struggle with explicit VPT remains unclear. A clue can be found in the idea that people with ASD, when engaging in VPT, employ a mental rotation strategy (mentally rotating the object toward themselves) rather than employing an embodied-self transformation strategy (imagining themselves in another person's location) as neurotypical people do. Pearson and colleagues set three tasks for children with and without ASD: a VPT task, a mental rotation task, and a body-posture matching task, the last of which required the children to match images of a body seen from different viewpoints [45]. Among the children with ASD, performance in the mental rotation task predicted performance in the VPT task. Among the neurotypical children, VPT performance predicted performance in body-posture matching. These results imply that children with ASD, when engaging in VPT, use something akin to a mental rotation strategy rather than the embodied self-transformation used by neurotypical children. Similarly, in an intervention that provided training in both strategies to children with and without ASD, the neurotypical children gained more from the embodied-self transformation strategy than they did the other, whereas the children with ASD benefitted similarly from both strategies[46]. Thus, people with ASD experience difficulties in maintaining or in appropriately employing the embodied self.

Embodied self in people with ASD

People with ASD may experience their own physical body in an atypical way. Hobson and Meyer conducted a sticker test on children, requiring the children to communicate to another person where on the other person's body a sticker badge should be placed[47]. The children with ASD failed to point to the location on their own bodies. The authors attributed this communication issue to a deficiency in forming an embodied (bodily-anchored) understanding of minds. Kessler and Wang examined differences in embodied processing between people with low social skills (likely to have ASD), labeled "systemisers," and those with high social skills (unlikely to have ASD), labeled "embodiers"[48]. Compared with embodiers, systemisers were less likely to assume a body posture congruent with the direction of the indicated perspective, suggesting that they were weaker at embodied processing. Gessaroli and colleagues reported that implicit access to self-body representation is inaccurate in children with ASD [49]. This report was corroborated by Fiene and Brownlow who used the Body Awareness Questionnaire [50]. Asada and colleagues also reported that people with ASD estimate their bodily dimensions less accurately than neurotypical people do [51]. These studies imply that weakness in self-body recognition is a common characteristic of people with ASD. Such impairment explains the key behavioral symptoms of ASD [52].

Regarding the manner of self-body representation associated with ASD, the literature points to another symptom of ASD: "hyper- or hypo-reactivity to sensory input or unusual interest in sensory aspects of environment" [28]. Gallagher and Varga [53], claimed that people with ASD experience motor disruption and sensory problems because of disruptive patterns in afferent and proprioceptive sensory feedback. Commenting on ASD-characteristic affections and behaviors regarded as inappropriate or abnormal (such as delusion and autistic withdrawals), Jespersen and He [54], suggested that these affections and behaviors may be the only possible means by which people with ASD "strive to make sense of some basic disturbances and re-establish some form of coherence with the world". These assertions have an empirical basis. A study conducted two tests among children with and without ASD aged 8 years to 17 years [55]. One test involved a heartbeat perception paradigm as a measure of somesthetic ability, and the other involved a rubber-hand illusion task (in which the experimenter strokes a lifelike rubber hand and the participant's real hand to see whether the participant experiences the rubber hand as their own) as a measure of embodied self. The results indicated that the children with ASD allocated their attentional resources disproportionately to internal, rather than to exter-

-nal sensory cues. Given that the self-body representation exhibited by people with ASD is a product of their unstable, volatile interception, then it can be expected to differ from that exhibited by neurotypical people. Taking an inactive approach, in which they attributed all first-person experience of the environment to the body and argued that embodied action generates interdependent interactions between an organism and its environment [56], Romero and colleagues attributed the social impairments to the poor bodily coordination exhibited by children with ASD during interpersonal encounters [57]. The above insights imply that ASD characteristics neither arise from deficits in cognitive modules, as suggested by the ToM, nor are attributable to under-developed executive function; rather, they are a natural, even necessary, product of an atypical embodied self.

Self-awareness in people with ASD

Regarding the mechanism through which the atypical embodied self in people with ASD shape their self-awareness, some insights can be found in Gallagher's interaction theory [30]. This theory distinguishes between primary and secondary intersubjectivity; the former describes an embodied, emotion-informed intersubjective awareness that develops as early as five weeks to six weeks from birth, and the latter, an ability to understand others' intentions in contextualized situations, which develops from six months of age onward. Gallagher suggested that children with ASD experience unstable somesthesis from birth and that this disrupts primary intersubjectivity. The disrupted primary intersubjectivity, in turn, disrupts secondary intersubjectivity, resulting in disrupted patterns of interpersonal emotions and difficulties in forming mutual points of external focus with others. Thus, people with ASD have an impaired concept of themselves and other persons as subjects of experience [58]. Children with ASD have been found to struggle to accurately recognize self-conscious emotions, such as embarrassment and guilt [59,60]. Other reports suggest that children with ASD overestimate their competencies [61], and empathy [62]. Thus, the social-communication impairments people with ASD experience may arise from this atypical self-awareness [63].

To obtain a clearer understanding of ASD-characteristic self-awareness, we may compare people with ASD with people with schizophrenia, a condition that involves similar socio-cognitive impairments [64,65]. People with schizophrenia exhibit weak self–other differentiation, whereas people with ASD have a sharper self–other boundary by comparison [66]. Similarly, a study that used a rubber-hand illusion test found that [67], relative to typical individuals, susceptibility to the illusion is decreased in people with ASD and increased in those with schizophrenia. According to Crespi and Badcock [68], such reports imply that people with ASD have a sharp self–other boundary and underdeveloped social cognition, whereas people with schizophrenia have a blurred self–other boundary and hyper-developed social cognition. Another study argued that ASD and schizophrenia are etiologically and phenotypically diametrical: co-occurring ASD and schizophrenia produce a normalizing effect by exerting opposing influences on socio-cognitive abilities [69].

In summary, when people with ASD attempt to process their idiosyncratic somatic sensations, their subjective self becomes anchored in their somesthesis owing to an overly sharp self–other distinction. Consequently, they struggle to introspectively perceive their objective self. If so, then the weakness people with ASD exhibit in perspective-taking can be attributed to their idiosyncratic self-awareness and embodied self. Further, the research outcomes on VPT, in which the embodied self plays a critical role, should be reevaluated in light of such self-awareness and embodied self.

Embodied self and visual perspective-taking

As described above, VPT consists of the perspective operation and information processing, with the former including the two processes of detachment of the representational self from somatic sensations and movement operation to the target perspective [70]. Detachment means the departure of the representational self from the physical self, followed by the mental movement of the detached representational self to another point in space. Using this framework, the difficulties people with ASD experience in explicit VPT can be explained as follows: It is not true that people with ASD fail to form a representational self; rather, they experience difficulties in operating the representational self (detaching it from the physical body and mentally moving it). Unable to control their unstable some thesis, they fixate upon somatic sensations—this fixation hampers the detachment of the representational self from somatic sensations and disrupts the operation of the representational self. These problems cause difficulties in explicit VPT, which requires the perspective operation. As widely reported, children with ASD tend to use mental rotation as a strategy when engaging in VPT tasks, but they may be opting for this strategy as a substitute for embodied-self transformation, the latter being inaccessible because the representational self, being embodied excessively, is difficult to detach or operate, once detached. Meanwhile, few studies have demonstrated the difficulties people with ASD experience in implicit VPT. The reason is that the mechanism underlying implicit VPT differs from that underlying explicit VPT. In infants Watanabe [71], described implicit mindreading as a form of perspective-taking that appears to arise before a self–other distinction develops, and argued that it can also occur later in life when the self–other distinction loosens. The idea is that explicit perspective-taking is mutually exclusive with implicit perspective-taking in that the former is enabled by detaching the representational self that is generated from the self–other distinction from the physical self. In other words, whereas explicit perspective-taking is enabled by self–other boundaries, implicit perspective-taking is only possible when the self–other boundaries blur. Evidence suggests that this loosening can also occur in people with ASD: One report suggests that people with ASD are indistinguishable from neurotypical people in their emotional alter centric bias (the tendency to ascribe other-related emotions to oneself) [72]. Another study reported that people with ASD perform worse than neurotypical people in a task that requires them to control the interference of another's perspective when instructed to maintain their own perspective [73]. If self–other boundaries indeed blur in people with ASD at least as much as they do in neurotypical people, then it should be unsurprising to find that people with ASD exhibit no notable weakness in implicit perspective-taking tasks. Recent psychological research supports the idea that ASD is caused by the idiosyncratic self-body schema described above, and that ASD-characteristic social impairments, which constitute the most conspicuous symptom of ASD and pervade across the person's life, in fact constitute only a secondary phenomenon (Figure 1).

Recent neuropsychol ogical findings have provided compelling evidence for the ToM thesis; these include a report suggesting that the Right Temporal Parietal Junction (rTPJ) provides a core neural basis for ToM and another suggesting that the rTPJ is deeply involved in ASD [74]. However, Wang and colleagues have postulated that the rTPJ is causally associated with embodied cognitive processes related to social functioning, and their theory has been supported empirically [75, 76]. The reason the rTPJ has been thought to play a cardinal role in ASD is likely that it governs the operation of the embodied self, which is indispensable in surmising others' mental states [77,78].

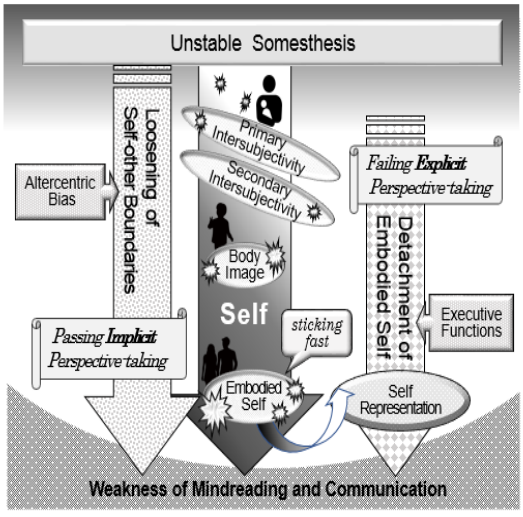

Figure 1. Mechanisms of difficulties of social interaction caused by somethesis and embodied self in ASD.

Conclusion

Our thesis underlines the need for ASD researchers and educators to devote greater attention to ASD-typical somesthesis and the atypical embodied self it generates. We believe it could potentially create a paradigm shift in both ASD studies and ASD-related education. Researchers should consider the following questions: What intersubjective interpersonal relationships do infants with ASD experience and how do these experiences shape the embodied self? What role does the atypical embodied self-play in the social and communication difficulties experienced by people with ASD from early age onward? Do these developmental findings have a neural basis that can be empirically demonstrated in neuropsychology research? Addressing these questions should yield further breakthroughs in ASD studies. A number of treatments and interventions for ASD have proven effective. These include accumulating positive communication experiences through roleplaying and social skills training. They also include the Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH), which focuses on restructuring the environment to accommodate the needs of people with ASD, such as by using visual schedules and avoiding excessive stimuli. Nonetheless, the need for psychotherapeutic support remains under-recognized despite evidence showing that children with ASD have an increased risk for motor impairment and developmental coordination disorder. If future research does indeed yield findings that highlight the importance of the embodied self, then it would create an impetus to measure the physical and motor abilities of people with ASD and to provide treatments and interventions based on the results.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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