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Pluralism, social cognition, and interaction in autism

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ABSTRACT
In this paper, I investigate social cognition and its relation to interaction in autism from the perspective of a pluralist account of social understanding by considering behavioral as well as neuroscientific findings. Traditionally, researchers have focused on mental state reasoning in autism, which is uncontroversially impaired. A pluralist account of social cognition aims to explore the varieties of social understanding that are acquired throughout ontogeny and may play a role in everyday life. The analysis shows that children with autism are well able to understand other people's behavior by considering social rules and norms, scripts, and stereotypes. Moreover, some individuals with autism succeed in understanding other people's behavior in terms of mental states by employing explicit behavioral rules as a compensatory strategy. The paper ends with a discussion of the social cognitive (dys)functions in autism and their relation to the motivation of individuals with autism to engage in social interaction.

1. Introduction

What are the social cognitive processes and procedures that underlie our understanding of other people's behavior? What dedicated role does (the motivation for) social interaction play? What about social cognition in people with mental disorders? The present article deals with questions like these and explores social cognition and interaction in autism from a pluralist perspective.

Various accounts of social cognition have been proposed in the literature, but there are two main schools in the debate that will be the focus here: Theory Theory (TT) and Simulation Theory (ST). According to TT, we understand other people's behavior in terms of mental states by means of folk psychological theories. Whereas proponents of the empiricist version of TT (e.g. Wellman & Gopnik, 1992) state that we are born with theories that we modify and revise in the course of development and interaction with the environment, proponents of the nativist version of TT (e.g. Baron-Cohen, 1995) propose that distinct mindreading modules are innate but emerge in the course of their own developmental timetable. ST, in contrast, claims that we put ourselves imaginatively “into the shoes” of another person and simulate the thoughts and feelings we would experience in his or her situation (e.g. Goldman, 2006).

Despite accounting for different social cognitive procedures, TT and ST share a number of assumptions. For example, proponents of both camps share the assumption that social understanding is in the first place a matter of predicting or explaining other people's behavior on the basis of mental state.
reasoning; theory theorists and simulation theorists propose either that there is a default procedure that individuals typically apply whenever attempts are being made to understand other people's behavior in terms of mental states (i.e., theory according to TT or simulation according to ST)—call these “default accounts”—or that there is one dominant procedure that is always involved in mental state reasoning, but is at times supplemented by others—call these “hybrids”. Moreover, neither TT nor ST accounts for social cognitive processes and procedures that consider the person-specific features of the individual whose behavior needs to be understood, such as character traits or habits. Finally, TT and ST tend to describe social understanding as an observational enterprise that relies essentially on mental state attribution without taking into account the knowledge an individual may have about the agent's person-specific characteristics. Accordingly, developmental research has focused primarily on the ontogenetic development of children's understanding of other people's mental states, in particular the development of false belief understanding that has been tested by so-called “false belief tasks” (see Wellman, Cross, & Watson, 2001 for a review). Notably, most of the tasks that have been conducted in the framework of the theory of mind debate are observational rather than interactive paradigms. As I will discuss in section 3.2., some individuals with autism are able to employ compensatory strategies to pass verbal versions of the false belief tasks—but such strategies do not enable them to meet the challenges of social interactions.

A well-established method is to draw inferences from dysfunctions of (social) cognition in people with mental disorders to theoretical models about how (social) cognition functions typically in human beings. Hence, proponents of traditional accounts such as TT (e.g. Baron-Cohen, 1995) or ST (e.g. Goldman, 2006) have taken insights from psychopathology to support the theoretical claims of their accounts of social cognition, primarily benefiting from research in autism. Autism is a developmental disorder that is diagnosed early in ontogeny on the basis of various symptoms such as persistent deficits in social communication and social interaction, including deficits in social-emotional reciprocity or failure to develop and maintain relationships, as well as restricted and repetitive patterns of behaviors and insistences on routines. Since there are multifarious manifestations of the disorder, autism needs to be understood as lying on a spectrum, that is, autism spectrum disorder (ASD) (see Frith, 2004 for a discussion). Until recently, Asperger syndrome has been regarded as an autism spectrum disorder considered to be on the “high-functioning” end of the spectrum; whereas individuals with Asperger syndrome display symptoms such as deficits in social interaction or engagement in stereotypical behaviors, they are typically not delayed in language acquisition.

In general, a number of studies show that individuals with autism have severe difficulties in predicting or explaining another person’s behavior as being guided by mental states. For example, whereas typically developing children are capable of passing verbal versions of the false belief task that require predicting an agent’s behavior on the basis of his or her false belief (e.g. about an object’s location) by age 5, children diagnosed with autism may struggle with passing these tasks and either fail to pass them or are considerably delayed in their successful performance (Frith, 2003). Theory theorists such as Baron-Cohen (1995), for example, have explained these findings by arguing that subjects with autism have a significantly impaired cognitive mechanism (“theory of mind mechanism”) that is required for a folk psychological understanding of other people’s behavior in terms of mental states; hence people with autism are “mind-blind.” Simulation theorists, in turn, have argued that people with autism fail tasks that require mental state attribution because they are impaired in executive functions (such as inhibitory control) that play a central role in running simulation routines. Goldman, for example, states that:

Given a false belief scenario, a simulator must simulate the target with a pretend belief that contravenes what he knows to be true. He must use this feigned belief rather than his genuine one to predict (or retrodict) the target’s belief … He must quarantine or inhibit his genuine belief to keep it from infecting his simulation. (2006, p. 197)

Recently, a number of pluralist theories of social cognition have been proposed (Andrews, 2012; Fiebich & Coltheart, 2015; Fiebich, Gallagher, & Hutto, 2017; Gallagher, 2015). As illustrated by Gallagher, contrary to hybrid theories or default theories,
a pluralistic theory is one that suggests that the full story of social cognition involves a combination of capabilities or procedures, one of which may be appropriate or practical for one kind of situation, and another for a different kind of situation. Moreover, there need not be a default procedure. There may be a menu of such procedures or processes that involve, for example, theoretical inference, or simulation, or interaction, or direct perception, or a reliance on narrative or situational knowledge, or knowledge about particular persons, or knowledge about social roles, and so forth. The particular situation may specify what procedure or process is appropriate, or there may be a default procedural principle that determines which strategy to use. (2015, p. 18)

A pluralist theory (PT) differs from hybrid and default versions of TT and ST with respect to its account of:

(i) **The cognitive mechanisms of mental state reasoning.** Rather than proposing a default or dominant social cognitive procedure of mental state reasoning (e.g. theory or simulation), PT argues that it depends on various factors for which (social) cognitive processes and procedures come into play, including the cognitive competencies of the individual, the given socio-situational context, the personal or social relationship between the agents, and so on.

(ii) **The frequency of mental state reasoning.** Proponents of pluralism share the assumption that in everyday social understanding, belief-desire attribution via theory and simulation comes into play less frequently than other (less effortful) social cognitive processes and procedures. Fiebich and Coltheart (2015), for example, argue that cognitive effort and fluency, that is, "the subjective experience of ease or difficulty associated with completing a mental task” (Oppenheim, 2008, p. 237), play a central role in determining which social cognitive processes and procedures an individual uses to understand another person's intentions and feelings. Andrews (2012), in turn, highlights the impact of norms and conventions that shape an individual's expectations of another person's behavior in socio-situational contexts, arguing that “we think about beliefs in particular kinds of situations, such as when a person deviates from expected behavior or violates the norms of society, but we don't need to appeal to beliefs to predict quotidian behavior” (p. 10).

(iii) **The scope of social cognition.** Proponents of pluralism do not focus on the cognitive mechanisms underlying mental state reasoning but highlight the fact that, aside from social cognitive procedures that rely essentially on mental state attribution, a variety of other factors play a central role in everyday social understanding, including knowledge about the agent-specific character traits and habits, stereotypes, understanding of the meaning of other people’s embodied intentions and emotions, their history, (shared) experiences, as well as social rules, norms, and roles that may guide those people's behavior in certain contexts.

This article aims at exploring the (dys)functioning of social cognition in autism and its relation to (the motivation for) interaction from the perspective of a pluralist theory by considering behavioral as well as neuroscientific findings. Investigating the social cognitive (dys)functions in autism from a pluralist perspective is not to focus only on the deficits of individuals with autism in understanding other people's behavior in terms of mental states. Rather, a variety of social cognitive processes and procedures needs to be considered. This is particularly important since throughout ontogeny typically developing preverbal infants are engaged in social cognitive activities long before they acquire an explicit understanding of other people's behavior in terms of mental states.

As a first step, I point to a variety of social cognitive skills and competencies that typically developing infants acquire early in ontogeny and analyze whether there are divergences in infants with autism, and if so, in what manner. Early in ontogeny, infants are typically engaged in social cognitive activities in interactive settings. Hence, it is of vital importance to discuss infants' general motivation to engage in social interactions as a first step. As a second step, I discuss a variety of social cognitive (dys)functions in autism. As a third step, I point to the compensatory strategies that individuals with autism use to overcome their difficulties in understanding other people's behavior in terms of mental states. In section 3, I summarize the results of my analysis with respect to whether and to what extent the pluralist assumptions are supported. Here, I will also point to gaps in the literature and make
suggestions for future research. Finally, I will discuss the results of the analysis with respect to the significance and cognitive mechanisms of mental state reasoning and the scope of social cognition in autism. Moreover, I will give an outlook on how the social cognitive (dys)functions in autism are related to the capacity to meet the challenges of social interactions in everyday life.

2. Dipping into ontogeny: (Dys)functions of motivation and social cognition in autism

2.1. General motivations to engage in social interactions

According to Tomasello and colleagues (Tomasello, Carpenter, Call, Behne, & Moll, 2005), the motivation to share emotions and mental states with others is typically human. In the so-called "still face paradigm", newborns younger than 4 days display signs of distress if their interaction partner disrupts the emotional connection in an ongoing interaction by displaying a neutral instead of an emotional and responsive facial expression (Nagy, 2008). Nadel and colleagues (Nadel et al., 2000) investigated the behavioral responses of children diagnosed with autism in this paradigm. The mean chronological age (CA) of these children was 9 years, whereas their mental age (MA) ranged from 18 to 48 months. Nadel and colleagues found that the children with autism did not initially show any concern about the experimenter's odd behavior (i.e. when the experimenter suddenly disrupts the interaction by displaying a still face) after having been engaged with the experimenter in an imitative interaction. Intriguingly, however, all of them did respond with patterns of distress in a second trial of the experiment, resembling the still face effect found in neuro-typical infants. Nadel and colleagues concluded that these findings suggest that low-functioning children with autism are able to integrate their previous experience with a partner and detect social contingency, but that they are not able to form a generalized expectancy for social contingency in human beings with whom they have not yet had contact. (p. 133)

Few-month-old infants typically show differential behavioral responses while observing objects moving in an intentional (imperfect) contingent versus a causal (perfect) contingent relationship from an observational viewpoint. Interestingly, Watson (1979) and Bahrick and Watson (1985) found that five-month-old infants showed a clear preference for looking at highly but imperfectly contingent images. Thus, infants' preference alters after the fifth month of life from perfectly contingent to highly but imperfectly contingent images. In contrast, as pointed out by Gergely (2001), three-month-old infants with autism continue to spend significantly more time looking at the perfectly contingent computer-generated feedback than at the imitative, human-generated feedback display. Gergeley speculates that children with Asperger syndrome are less subject to the consequences of failing to process social information that are highly but imperfectly contingent than children with infantile autism.

Rutherford, Pennington, and Rogers (2006) found that, contrary to typically developing children (mean CA: 46.4 months, MA: 40.6 months), children with autism (mean CA: 70.74 months; MA: 6.8 months) showed initial deficits in categorizing objects as animate. But children with autism showed no deficit in this ability after reaching criterion in a training process. When viewing point-light displays of biological motion, typically developing children (mean CA: 1.99 years, MA: 2.1 years) showed a significant preference for biological motion that was not observable in two-year-olds with autism. In this study, four animations were accompanied by human voices as co-occurring sounds, whereas in one animation the sound of clapping occurred at the same time that two point lights (i.e. the actor's hands) collide and thus create a causal physical contingency. When analyzed independently, children with Asperger syndrome (mean CA: 2.21 years, MA: 1.29 years) showed a significant preference for the upright, clapping figure during this latter animation (Klin, David, Gorrindo, Ramsay, & Jones, 2009).

Notably, these studies indicate a lack of preference for biological motion in children with autism rather than an inability per se to distinguish between animate and inanimate entities. That is, despite some initial deficits, children with autism are capable of recognizing animacy by detecting cues such as imperfect contingency patterns. However, this recognition does not come along with the motivation
to interact with animate beings that has been observed in typically developing children (see section 3 for a discussion of a number of neuroscientific findings that speak in favor of this).

2.2. Social cognitive (dys)functions in autism

On pluralist accounts, social understanding in everyday life can be achieved by various means and methods. In the following, I will discuss a variety of social cognitive skills and capacities that are typically acquired within the first years of life and may be intact or impaired in individuals with autism, without claiming that this list is exhaustive.

2.2.1. Embodied goal recognition

Three-month-old typically developing infants already exhibit sensitivity toward other people’s goal-directed behavior (Sommerville, Woodward, & Needham, 2005). Around sixth month, infants are capable of encoding an agent’s goal when observing embodied, goal-directed behaviors such as grasping movements (Woodward, 1998). A number of studies have shown that encoding embodied goals and emotions is underpinned by automatically activated mirror neurons. For example, mirror neurons in the premotor cortex and posterior parietal cortex have been observed to fire both when I grasp an object as well as when I observe another person grasping an object (see Rizzolatti & Craighero, 2004 for a review). In typically developing infants, mirror neuron activity has been found already in six-month-olds when observing grasping movements (Nyström, 2008). In contrast, abnormalities in the mirror neuron system have been observed in people with autism when they observe goal-directed movements such as grasping gestures (Oberman et al., 2005). It is controversial whether mirror neuron activity should be understood in terms of simulation (Goldman, 2006) or whether this is problematic for conceptual reasons (see Gallagher 2007; Gallagher & Zahavi, 2008 for a discussion). Notably, Hamilton, Brindley, and Frith (2007) found that not only do typically developing children (mean CA: 4.1 years, MA: 4.7 years) whose mirror neuron system is intact perform successfully in tasks that require goal-directed imitation, but despite having a dysfunctional mirror neuron system, children with autism (mean CA: 8.1 years; MA: 4.3 years) succeed in these tasks as well. The authors hypothesize that:

While it is possible that the children with autism show normal performance on behavioral testing but use different neural systems to pass these tasks, this is an unlikely and complex explanation of the data. We suggest instead that, when confronted with an explicit imitation or action recognition task, children with autism are able to use their mirror neuron system to achieve the same behavioral performance as typical children. (p. 1866).

2.2.2. Teleological reasoning

Children may also encode action goals on the basis of teleological reasoning principles, for example, by considering what Csibra and Gergely (2007) have called the “efficiency principle.” “When observing an ongoing action, one can infer the likely goal of the action by assessing what end state would be efficiently brought about by the action given the particular situational constraints” (p. 7). This capability also seems to be present in autism. Carpenter, Pennington, and Rogers (2001) investigated whether children with autism (mean CA: 49.4 months, MA: 26.2 months) understood another person’s behavior as being efficient or not in virtue of a particular goal in an imitation task adopted from Meltzoff (1995) that has been passed by typically developing children at 18 months, showing that individuals with autism performed as well as typically developing children (or just slightly worse) in reproducing an action which leads to achieving the goal that the other person is apparently pursuing rather than imitating his or her actual action, which turned out to be inappropriate in virtue of achieving the given goal. Moreover, Castelli, Frith, Happé, and Frith (2002) found that individuals with Asperger syndrome, when observing two triangles moving about on a screen, were equally capable of identifying the shapes’ movements as goal-directed (e.g. as “chasing” one another) as were controls. However, they performed significantly worse than controls in tasks that required identifying interactive movements with implied intentions (e.g. “tricking”).
2.2.3. Social rules and scripts
Considering social rules and scripts that are relevant in particular social contexts may also help to predict an agent's behavior (and to respond appropriately in interactive contexts). From age 2 onwards, typically developing children comprehend rules and protest if another person does not observe these rules in the appropriate context, for example, when breaking rules in a game (Rakoczy, Warneken, & Tomasello, 2008). Betz, Higbee, and Reagon (2008) found that although 4–5-year-old preschoolers with autism showed only little initial engagement in interactive games, their engagement increased considerably when they were taught the rules of games like “Crocodile Dentist,” and persisted above 80% during the maintenance phase with only single or no prompts by the experimenter. Around ages 3–4, children build scripts that classify the typical course of an event such as a birthday party (Fivush & Hamond, 1990). Not only 4.5-year-old typically developing children but also children with autism (mean CA: 11.11 years; MA: 9.3 years) can use everyday scripts for predicting an agent's behavior in everyday events such as going shopping (Baron-Cohen, Leslie, & Frith, 1985).

2.2.4. Stereotypes
Particular behaviors and preferences are associated with particular social group memberships such as gender; girls are expected to play with dolls, whereas boys are expected to play with toy cars. Developmental studies have shown that typically developing children acquire an understanding of such stereotypes around age 3.5 (Reis & Wright, 1982). Seven to seventeen-year-old children with autism are generally not impaired in achieving social understanding by means of the “beauty is good” stereotype (Da Fonseca, Santos, Rosset, & Deruelle, 2011). Moreover, not only typically developing children (mean CA: 7 years, MA: 87 months), but also children with autism (mean CA: 96 months, MA: 80 months) who failed to pass theory of mind tasks were capable of making use of gender or race stereotypes for the purposes of explicit behavior interpretation (Hirschfeld, Bartmess, White, & Frith, 2007). For example, they correctly answered the test question, “Here are two children. One of them has four dolls. Which one has four dolls?” (p. R451) by pointing to the girl rather than the boy in a picture. However, considering the findings reviewed in the next section, it seems plausible to assume that such understanding is achieved by way of explicit theorizing processes rather than associations.

2.2.5. Agent-specific dispositions
Developmental research suggests that infants are also able to account for agent-specific dispositions to act when encoding the agent’s goal. For example, Woodward (1998) found that six-month-olds expect an agent to grasp for the one of two objects they have observed the agent repeatedly grasping before, but only in interactive settings where the agent has visual access to both objects (Luo & Johnson, 2009). These findings suggest that infants form “associations of person-specific identity”—associations of (a set of) dispositions, preferences, habits, and so on with a specific person—early in ontogeny (Fiebich & Coltheart, 2015). Notably, Egyed, Kiraly, and Gergely (2013) found that these person-specific associations are only formed in observational settings. In interactive settings, by contrast, infants tend to generalize the preference of the agent for one object over another and ascribe it to the likeability of the object rather than to the preference of that particular agent. From one year onwards, typically developing children consider only the agent's visual attention as an indicator of a person-specific preference. That is, they expect the agent to act on that object the agent is looking at (Vaish & Woodward, 2010). Although people with autism are capable of spontaneously grasping what another person sees (Schwarzkopf, Schilbach, Vogeley, & Timmermans, 2014), they do not consider another person's visual attention to be an indicator of that person's disposition to act (Baron-Cohen, Campbell, Karmiloff-Smith, & Walker, 1995). As pointed out by Baron-Cohen, gaze-direction … allows young normal children … to work out which of several objects a person wants … Children with autism in contrast are relatively blind to such information from gaze-direction, even though they can answer the explicit question, “What is Charlie looking at?” (2009, p. 9).
Unlike 12-year-old typically developing children, children with autism (mean CA: 13 years, MA: 112 months) fail to consider the agent’s head turn as an indicator of the agent’s intention in action (Vivanti, McCormick, Young, & Rogers, 2011). Moreover, typically developing 2.5-year-olds expect an agent to search for an object in a location where the agent has seen it before in an anticipatory-looking paradigm (Southgate, Senju, & Csibra, 2007) whereas even adults with Asperger syndrome who pass linguistic versions of the false belief task (see below) fail in doing so (Senju, 2012).

In line with these findings, Baron-Cohen (1995) argues that the deficits of people with autism in, for example, accounting for eye gaze in behavior prediction is not based upon eye gaze discrimination per se but rather results from an impairment in using gaze to understand the intentions of others, which is due to abnormal processing of eye gaze on a neural basis (the “eye direction detection mechanism”). This assumption is supported by neuroscientific research. Typically, in processing observed eye movements, the superior temporal sulcus (STS) region plays a crucial role, as a number of early functional neuroimaging studies of neurologically normal adults show (Hoffman & Haxby, 2000). This region is sensitive to whether the gaze is perceived to be consistent with the subject’s expectation regarding the intention of the person making the eye movement (Pelphrey, Singerman, Allison, & McCarthy, 2003). In a follow-up study, Pelphrey, Morris, and McCarthy (2005) showed that although the same brain regions were activated during the observation of gaze shifts in subjects with autism, they did not differentiate between congruent and incongruent trials, indicating that brain activity in subjects with autism was not modulated by the context of the perceived gaze shift. The authors conclude that “these results demonstrate a difference in the response of brain regions underlying eye gaze processing in autism” and that “lack of modulation of the STS region by gaze shifts that convey different intentions contribute to the eye gaze processing deficits associated with autism” (p. 1038).

2.2.6. Mental state reasoning
Children are also able to predict an agent’s behavior on the basis of mental state reasoning, that is, by understanding the agent’s behavior as guided by mental states such as emotions, desires, and beliefs. Beliefs are representations of the world and, as such, they may be false. A number of developmental studies have shown that by age 5, typically developing Western children pass tasks that require predicting another person’s behavior as guided by his or her false belief, for example, about an object’s location (see Wellman et al., 2001 for a review), whereas children with autism may struggle with passing these tasks or pass them with considerable delay (Frith, 2003).

2.3. Compensatory strategies of explicit mental state reasoning in autism
In sum, individuals with autism are capable of encoding an agent’s (embodied) goal on the basis of teleological reasoning, stereotypes, social rules, and norms, but they show difficulties in understanding an agent’s behavior in terms of person-specific dispositions or mental states. However, despite these difficulties, some individuals with Asperger syndrome, who exhibit the kinds of social and communicative deficits characteristic of autism but have no history of language delay, pass linguistic versions of even second-order false belief tasks (Bowler, 1992). In addition, Grossman, Klin, Carter, and Volkmar (2000) found that, like typically developing children (mean CA: 11.5, mean verbal IQ: 115.0), children with Asperger syndrome (mean CA: 11.8 years, mean verbal IQ: 115.8) do not have any difficulties with the recognition of basic emotions such as anger or joy.

These findings indicate that some people with autism are capable of making behavior judgments on the basis of mental state attribution—but they do so in an atypical manner. This can be illustrated by studies of the ability to recognize and attribute emotions as well as studies of the ability to attribute beliefs in false belief tasks.
2.3.1. Understanding other people's emotions

Compared to typically developing individuals, individuals with autism show diminished interactive spontaneous responses to other people's emotional expressions (Sigman, Kasari, Kwon, & Yirmiya, 1992; see also Neufeld, Ioannou, Korb, Schilbach, & Chakrabarti, 2015 for a discussion of how facial mimicry in emotional expression is modulated as a function of autistic traits). This might be due (at least partially) to divergent cognitive processing of social cues. As indicated in the previous section, neuroscientific studies suggest that the recognition of embodied intentions and emotions on the basis of basic observation-execution matching is underpinned by mirror neurons (“low-level simulation”) and needs to be distinguished from higher level forms of empathy and theory of mind. EEG evidence shows mirror neuron dysfunction in people with autism, and a number of studies have suggested a link between the mirror neuron network and automatic emotion recognition (Dapretto et al., 2006; but see Dumas, Soussignan, Hugueville, Martinerie, & Nadel, 2014 for a critical discussion that the relevant EEG signatures may be artifactual in nature).

In line with the neuroscientific data, behavioral studies suggest that rather than recognizing and attributing emotions on the basis of cognitively “cheap” simulating processes, people with autism succeed in doing so in an entirely inferential way by recognizing single (or sets of) bodily expressive features that are indicative of a particular basic emotion. Rump, Joyce, Minshew, and Strauss (2009), for example, have shown that children with autism (mean CA: 6.4 years, verbal MA standard score: 97.89), unlike typically developing children (mean CA: 6 years, verbal MA standard score: 105.61), exhibit particular difficulty in identifying facial expressions of anger and fear, leading to the speculation that these two emotions require integration of information from the mouth, eyes, and forehead, and if the children with autism were relying on processing these expressions in a more featural and less holistic manner, this could account for the difficulties they exhibited. (p. 1439)

Furthermore, people with autism are capable of inferring what emotion another person is experiencing by referring to the socio-situational context. For example, Baron-Cohen (1991) has shown that children with autism (mean CA: 13.78 years, MA: 6.91 years) succeed in understanding another person's basic emotions when they are caused by situational circumstances rather than by the other person's belief. Children with autism perform as well as controls (mean CA: 5.3, MA: 5.3) in identifying situation-induced emotions, for example, by taking the situation “Jane is having a birthday party” into account when answering the test question “How does she feel?” correctly with “happy.” Belief-induced emotions, however, are difficult for children with autism to understand, and they perform significantly worse than controls when the task requires them to take into account another person's belief about whether there is a desirable object inside a box (which makes the person “happy”) or there is not (which makes the person “sad”). In line with this, Baron-Cohen, Spitz, and Cross (1993) found that emotions such as surprise, when they involve an assumption about another person's prior belief, are particularly difficult for children with autism (mean CA: 12.6 years, MA: 5.3 years) to understand, whereas typically developing children (mean CA: 4.3, MA: 4.3) do not show such difficulties.

Understanding another person's behavior as guided by mental states relies on simulating or theorizing processes in typically developing individuals. In general, it is controversial among theory theorists, simulation theorists, and other theorists what the (social) cognitive processes are that underlie theorizing or simulation processes, and whether particular neuroscientific findings speak in favor of one theory over the other (see Apperly, 2008 for an overview). Some theory theorists, for example, have pointed to the dedicated role of language and concept acquisition in the development of a theory (e.g. Gopnik, 1998). Developmental research suggests that people with autism are impaired in what Goldman (2006) has called “high-level simulation.” Here, people create so-called “pretend states” by E-imagining (enactment-imagining) the thoughts and feelings that they would experience in the situation of the other person. Then people feed their own decision-making mechanisms with these pretend states and attribute the outcome to the other person in behavior predictions or explanations. One of the social cognitive prerequisites for engaging in high-level simulation is visual E-imagination that involves visualizing what is in another person's sight and how things look from another person's perspective, as
as any consequent beliefs about these objects (Goldman, 2006, p. 149). Developmental research has found that typically developing children understand at around one year of age what is in another person's visual field (Luo & Baillargeon, 2007), but they do not understand until three years of age how an object appears to another person from his or her visuo-spatial viewpoint (Moll & Meltzoff, 2011). In contrast, children with autism (mean CA: 8 years, MA: 4 years) exhibit difficulties in tasks that require mental rotations in order to comprehend how things appear to others from their perspective (Hamilton, Brindley, & Frith, 2009). Moreover, simulation routines are supposed to rely on models or concepts of the self—which seem to be abnormal in the autistic population (Lee & Hobson, 1998).

Taken together, this suggests that people with autism successfully understand other people as mental beings by means of theorizing rather than simulation processes—though, as we will see in the next section, in a different manner. Taking into account contextual cues and theorizing processes may not just help people with autism to identify other people's emotions, but also to identify other people's beliefs.

### 2.3.2. Understanding other people's beliefs

As reported by Baron-Cohen and colleagues (1985), children with autism (mean CA: 11.11 years, MA: 5.5 years) are not only able to identify causal relations as well as controls (mean CA: 4.5 years, MA 4.5 years), but are also able to predict another person's behavior in everyday events such as, “She goes to the sweet shop. She opens the door. She buys sweets. She goes out.” (p. 121). The successful performance by people with autism in linguistic versions of false belief tasks may also be based on knowledge of action sequences in that paradigm, such as, “He sees the object being hidden in location A. He leaves the room. The object is moved from location A to location B in his absence. He comes back. He searches for the object in location A.” A number of studies suggest that people with autism can be taught folk-psychological knowledge that enables them to pass the false belief task. For example, borrowing from an approach by Baron-Cohen and Howlin (1993), Ozonoff and Miller (1995, p. 422–423) taught children with autism (mean CA: 13.8 years) that perception influences knowledge (i.e. “a person will know x only if s/he saw or heard about x,” Baron-Cohen & Howlin, 1993, p. 473) and discussed this folk psychological knowledge in more complex scenarios so that these children were able after the training not only to pass explicit false belief tasks of first-order but also those of second-order. “At the end of the training, most [children with autism] were able to articulate that since C had not seen B speak with A, he could not know that A knew of the revised plans” (Ozonoff & Miller, 1995, p. 423). Taught folk psychological knowledge might also help those with autism to attribute belief-induced emotions to other people.

Theories are likely to be employed also by typically developing children in experimental task settings such as the false belief task. As pointed out by Stich and Nichols (1992, p. 66), the explanation of the findings from false belief tasks offered by the experimenters is one that presupposes theory being employed. In false belief tasks, children not only predict an agent's behavior by applying folk psychological rules about how the agent's mental states motivate the agent to act, they also identify the agent's mental states by means of folk psychological rules such as, “an agent who has not perceived an unexpected change in her environment will believe that her environment has remained the same” (see Perner, 1999, p. 412 for a discussion). Folk psychological theories involve folk psychological rules about what mental states are and how they interrelate and motivate agents to act. Gopnik (1998), for example, argues that theories presuppose the possession of mental state concepts, that is, theory change relies essentially on conceptual change. This view is supported by cross-cultural research, which illustrates that children who grew up in Eastern countries such as Japan, where they acquire mental state terms such as “belief” later than their Western peers, are also delayed in passing the false belief task (see Fiebich, 2016 for a review; Gopnik, 1998 for the correlation between language and concept acquisition). Notably, successful performance on implicit (i.e. nonverbal) false belief tasks seems to rely on other social cognitive processes, and the compensatory strategies that enable individuals with autism to pass the explicit false belief tasks cannot be employed in the implicit versions of that task (see section 3.1. for a discussion). The behavioral studies reviewed above suggest that in understanding
other people's behavior as being guided by mental states, people with autism employ a theory as a default procedure in an effortful and conscious manner. Personal reports point in the same direction. For example, in Oliver Sacks (1995) *An anthropologist on Mars*, Temple Grandin describes how she is able to “decode” other people's emotions in an inferential manner and predict the behavior of others by correlating the present situation with similar experiences and observations of the past in a “strictly logical process” (p. 248).

Such reports, as well as the neuroscientific evidence, suggest that people with autism make use of theories in a wholly inferential and conscious manner when seeking to achieve social understanding. For example, Lieberman points out that in 91% of the 45 studies that investigated the neural foundations of theory of mind in nonautistic individuals, the dorsomedial prefrontal cortex (Brodmann's area 8/9) has been reported as active in mentalizing tasks and thus seems to play a major role in mentalizing in general (Lieberman, 2010, p. 153). Happé and colleagues (Happé et al., 1996) have shown significantly less activity in medial prefrontal cortex in individuals with Asperger syndrome (compared to controls) when reading stories that required mentalizing, plus significant activation of the neighboring left medial prefrontal cortex, Brodmann's area 9/10. This latter area was also activated in controls, but to a lesser extent than Brodmann's area 8/9. Happé and colleagues hypothesize that:

One explanation for this abnormal pattern of activation is that the Asperger subjects were using a more general-purpose reasoning mechanism in order to infer mental states. Area 9, which covers a large expanse of cortex, has been implicated in a number of brain imaging studies of problem solving and general cognitive ability. (p. 200, emphasis added)

3. Summary and outlook

3.1. Autism and social cognition from a pluralist perspective

Recall that PT differs from TT and ST with respect to its account of (i) the cognitive mechanisms of mental state reasoning, (ii) the frequency of mental state reasoning, and (iii) the scope of social cognition. Unlike traditional accounts of social cognition, a pluralist account highlights that social understanding in typically developing individuals can be achieved by various means, including theory and simulation but also a variety of other factors such as considering social rules and norms, agent-specific dispositions, and so on. A pluralist account of social cognition trumps traditional theories in accounting for the multifaceted nature of autism spectrum disorder (Fiebich, 2015) as well as other mental disorders such as schizophrenia and bipolar disorder (Gallagher & Varga, 2015). The analysis has shown that individuals with autism are well able to understand other people's behavior on the basis of teleological reasoning, social rules and norms, and stereotypes. Individuals with autism symptomatically prefer to engage in stereotypical behaviors and insist on routines when dealing with objects in their ecological environment, and the same is likely to hold true when they engage with their social environment. Categorizing socio-situational contexts allows these individuals to apply rules and scripts, whereas categorizing another individual into social group memberships allows them to account for stereotypical behaviors in situations of social understanding.

It is an open empirical question whether the (social) cognitive mechanisms which underlie the successful behavioral performance of people with autism in studies that investigate social understanding based on teleological reasoning and stereotype categorization are the same as those in typically developing individuals. Future research may also determine the factors that lead to one (set of) (social) cognitive process(es) or procedure(s) rather than another in a given situation of social understanding—such as, for example, fluency. PT predicts that social cognition in typically developing individuals works in an economical way. That is, individuals are prone to make use of the least cognitively effortful (social) cognitive processes or procedures in a given situation. This, in turn, diminishes the frequency of mental state reasoning, since other (social) cognitive processes such as associations are assumed to be less cognitively effortful. It would be interesting to explore the role of fluency in social cognition in autism and the conditions under which experiences of cognitive strain and ease can be induced.
Most research has investigated the (social) cognitive (dys)functions of mental state reasoning in autism. The analysis has shown that some individuals with autism may overcome their difficulties in understanding other people's behavior in terms of mental states by employing theories that need to be sharply distinguished in various respects from those that typically developing people use in situations of social understanding. First, folk psychological theories should be understood as psychological generalizations; they can be employed in contexts that allow for such generalizations, and their adequacy depends on *ceteris paribus* clauses. However, typically developing individuals usually theorize in a fast and cognitively effortless manner, rather than in an effortful and deliberative manner like people with autism.

Second, people with autism employ behavioral rather than folk psychological theories. That is, the theories that people with autism apply require only behavioral rules. Despite being capable of deducing other people's emotions, desires, and maybe even beliefs, and correctly predicting or explaining their behavior on the basis of such rules, people with autism may still lack a “profound understanding” of what having mental states actually comes to. That is, they seem to lack a phenomenal experience that typically comes along with understanding other people's emotions and intentions (see Zahavi & Parnas, 2003 for a discussion). Hence, they may still be called “mind-blind” (Baron-Cohen, 1995) on a phenomenological level (Zahavi & Parnas, 2003):

They [i.e. people with autism] can see gestures and can identify the associated social meanings. They do not, however, experience the gesture in the right way. Similarly, individuals with autism can see and identify faces, but do not see them “as” emotional faces until explicitly asked to evaluate them (until their attention is explicitly directed). Implicitly, they do not process faces “as” emotional. (Hudgens-Haney, 2010, p. 24)

It is true that typically developing individuals also account for an agent's behavior as well as the socio-situational context when attributing emotions to the agent. For example, Mitchell and Hamm (1997) found that when considering a scenario involving a male agent M, a female agent F, and an organism H in which, “M reaches his arm to touch F, and … H rushes up to them and moves between M and F, facing and staring at M while touching him” (p. 179), individuals agreed that H felt left out and jealous, independently of whether H was a human being or a dog.

Still, behavioral and folk psychological rules differ in significant ways, as becomes clear in the controversial debate over whether human infants employ behavioral or folk psychological theories when forming behavior expectations in experimental settings such as the false belief task. In this task, children observe an agent hiding an object in location A. In the agent's absence, the object is moved from location A to location B. Then, in the verbal version of this task, children are asked where the agent will search for the object. Only those children who understand that the agent has a false belief about the object's location will point to location A. In the non-verbal version of this task, infants' looking times or anticipatory gazes are measured as an indicator of implicit, nonverbal false belief understanding. Intriguingly, developmental studies have shown that children do not pass the verbal version of this task by ages 4–5 (Wellman et al., 2001) but anticipatory gaze indicates an implicit false belief understanding already in 2.5-year-olds (Southgate et al., 2007). Perner and Ruffman (2005) have tried to solve this developmental paradox by arguing that preverbal infants do not have a folk psychological understanding of other people's beliefs at all but rather employ behavioral rules such as, “people look for objects where they last saw them” (p. 215) when passing nonverbal versions of the false belief task.

However, preverbal infants perform successfully in various versions of nonverbal false belief tasks; hence, if they passed these tasks by means of behavioral rules, they would need to be equipped with a large number of different behavioral rules. In line with many other developmental findings, it seems more likely to assume that infants pass non-verbal versions of the false belief task by means of a basic understanding of agent-specific perceptual and motivational states that precedes a full-fledged false-belief folk psychology, which emerges later in ontogeny (see Fiebich, 2015 for a discussion). This interpretation is in line with the finding that individuals with autism continue to fail in nonverbal versions of the false belief task, although they may pass verbal versions of this task (Senju, 2012), indicating that individuals with autism employ a compensatory behavioral strategy that is essentially
tied to linguistic skills. This may also be the reason why especially those with Asperger syndrome succeed in employing that strategy.

### 3.2. Autism and social interaction from a pluralist perspective

The social cognitive (dys)functions in individuals with autism seem to be closely interrelated with their lack of motivation to engage in social interactions (see also Gallagher, 2004 for a discussion) as well as their failure to account for context-dependencies in a domain-general manner.

#### 3.2.1. Motivation

Recall that the behavioral findings reviewed above indicate that individuals with autism are able to distinguish between animate and inanimate beings early in ontogeny, but this does not come along with a preference to interact with animate beings, either in childhood or later on. Neuroscientific research suggests that everyday social understanding in typically developing individuals draws primarily on effortless and automatic social cognitive processes that are essentially linked to emotional engagement and an interactive stance toward the person whose behavior needs to be understood—and that precisely these processes are impaired in people with autism (see Schilbach et al., 2013 for a discussion). Simple cues such as self-directed facial expressions and eye-contact are typically already sufficient to establish emotional engagement (Schilbach et al., 2006), which leads to a faster processing of nonverbal gestures and coordination in interactive settings in typically developing individuals, but not people with autism (Schilbach, Eickhoff, Cieslik, Kuzmanovic, & Vogeley, 2012). Moreover, typically developing individuals are driven by an intrinsic motivation to interact with other people as an end in itself (Godman, 2013). This is displayed by brain activity in the ventral striatum, a core component of reward-related neurocircuity, once gaze-based interaction with another human is established in typically developing humans (Pfeiffer et al., 2014), but not in people with autism (Schmitz et al., 2008; see also Timmermans & Schilbach, 2014 for a discussion). That is, people with autism experience social interactions as not being as rewarding as do typically developing people; hence, they are less motivated to engage in social interactions on either level of ontogeny, which in turn may lead to a delay in the development of those (social)cognitive skills that are acquired primarily via social interaction. For example, although children with autism are capable of discriminating behavioral cues that are indicative of animacy (e.g. imperfect contingency patterns), they lack a preference for engaging with animate over inanimate entities. Hence, children with autism are less engaged in social interactions compared to their typically developing peers, which in turn may result in delayed acquisition of more sophisticated social cognitive competencies (see Gergely, 2001 for a discussion).

This is supported by research that illustrates that although children with autism are not impaired per se in discriminating the gaze direction of other people, they show a lack of attention in simple visual orienting tasks (Bryson et al., 2004) as well as in dyadic (child-adult) and triadic (child-adult-object) interactions (see Leekam, López, & Moore, 2000 for an overview) and in joint attention (Dawson et al., 2004). Astington and Jenkins (1999) found in a longitudinal study that children's language competencies foster successful performance in the false belief task. Moreover, the development of joint attention and language abilities are interlinked, and the measure of gestural nonverbal joint attention has been found to be a significant predictor of language development in individuals with autism as well (Mundy, Sigman, & Kasari, 1990).

#### 3.2.2. Context-dependencies

Notably, the compensatory strategy that some individuals with autism develop to understand other people's behavior in terms of mental states may be sufficient in experimental observational settings, such as verbal versions of the false belief task, but not in everyday social interactions. Although individuals with autism are capable of interpreting other people's actions adequately (e.g. when discriminating between natural and robotic motion or whether an interaction of two agents presents a fighting or dancing scene), they still fail to adequately exploit that capability during real-life social interactions.
People with autism remain impaired in meeting the challenges of interactive encounters in everyday life (Fisher & Happé, 2005). This may be due to various reasons. For example, making cognitively demanding inferences solely on the basis of explicit knowledge of behavioral rules makes it hard to account for ambiguities and context-dependencies. A number of studies have illustrated the difficulties in processing context-dependent information that people with autism face in situations of social understanding (see Happé, 1994 for a review). It is an open question whether the difficulties that people with autism face in interactions are specifically social in nature or whether they are due to disturbances of domain-general functions such as hierarchically structured learning. People with autism or schizophrenia may be generally impaired in such learning competencies as are required in economic games, in which the adviser’s intentions need to be inferred, as well as in other contexts (Diaconescu et al., 2014).

3.2.3. Knowing-how
Moreover, a fundamental distinction between “knowing how” and “knowing that” (Ryle, 1949), according to which practical knowledge (knowing how) is not reducible to propositional knowledge (knowing that) but rather consists in practical abilities, may account for such difficulties. The ability of typically developing individuals to engage successfully in the various contexts of social understanding in everyday life can be conceived as a skillful know-how that allows for the employment of social cognitive skills domain-generally and adaptation to changing environments (Hutto, 2008). The deliberative theorizing processes of people with autism do not seem to go beyond a knowing-that people typically behave in certain ways in specific contexts (Klin, Jones, Schultz, & Volkmar, 2003). This also suggests that the function of mental state reasoning in typically developing individuals is not only to predict or explain behavior but also to regulate behaviors in interactions.

Being excluded from the regulative influences of other people, individuals with autism will not develop habits of agency that conform to shared norms of what it is to experience, think, and act in recognizable normal ways. Hence they will be deprived of the very kinds of interactions that give rise to ordinary psycho-practical know-how. (McGeer, 2009, p. 315)

Finally, it may not only be due to the individual with autism when interactions between individuals with autism and typically developing individuals fail. The typically developing interaction partner may have difficulty understanding the gestures and utterances of the individual with autism and hence contribute to the unsmooth dynamics of interaction.

Notes
1. Methodologically, I distinguish social cognitive processes that occur automatically and, typically, unconsciously from social cognitive procedures that may be subject to conscious and deliberative control.
2. Note that, in principle, TT and ST could be extended to account for the inference of person-specific features as well (see Reeder & Trafimow, 2005 for a discussion of how motives may be attributed to other people via theory and simulation).
3. Nativist theory theorists have also pointed to the dedicated role of executive functions in successful performance on explicit false belief tasks in typically developing infants by pointing to, for example, a simultaneous execution of a false-belief representation, response-selection, and response-inhibition that is supposed to be required in these tasks, but is cognitively too demanding for preverbal infants (see Baillargeon, Scott, & He, 2010 for a discussion).
4. Notably, Hamilton and colleagues (2007) did not investigate the neural correlates of the individuals with autism themselves to support their hypothesis, but made assumptions based on an interpretation of the neuroscientific findings of others. As pointed out by Sinigaglia (2010), mirror neurons have been found to fire both when an individual observes a goal-directed action or an emotional expression of another person and when the individual performs the goal-directed action or experiences the emotion herself. But “whereas mirroring in the emotional system has been mostly accepted, mirroring for action has recently become a target of criticism” (p. 227). For example, it is controversial whether action mirroring enables an immediate understanding of the observed motor act (Sinigaglia, 2010), whether the primary function of action mirroring is an “emulative action reconstruction” that allows for interpreting the observed action in a second step (Csibra, 2007), or whether action mirroring supports the recognition of motor goals at all (see Grafton, 2009 for a discussion).
5. Alternatively, these results could be explained in terms of behavioral rules.

6. Notably, typically developing children also seem to employ theories in an inferential and conscious manner when passing explicit versions of the false belief task. Indeed, Clements and Perner (1994) have shown that children's looking behavior indicates an implicit, nonverbal, and unconscious understanding of other people's false beliefs already around 3 years of age, but children do not seem to have conscious access to that knowledge until ages 4–5, when they pass the explicit false belief task that requires them to indicate verbally where the agent who has a false belief about an object's location will search for the object. Still, the neuroscientific data reviewed here suggest a difference in degree between typically developing individuals and individuals with autism.

Disclosure statement

No potential conflict of interest was reported by the author.

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