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RESEARCH ARTICLE

Differences in self-other control as cognitive mechanism to characterize theory of mind reasoning in autistic and non-autistic adults

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Abstract

In cognitive science, altered Theory of Mind is a central pillar of etiological models of autism. Yet, recent evidence, showing comparable Theory of Mind abilities in autistic and non-autistic people, draws a more complex picture and renders previous descriptions of Theory of Mind abilities in autism and their role in autistic symptomatology insufficient. Here, we addressed self-other control as a potential candidate cognitive mechanism to explain subtle Theory of Mind reasoning differences between autistic and non-autistic adults. We investigated flexible shifting between another's and one's own congruent or incongruent points of view, an ability that is important for reciprocal social interaction. Measuring response accuracy and reaction time in a multiple-trial unexpected location false belief task, we found evidence for altered self-other control in Theory of Mind reasoning in autistic adults, with a relative difficulty in flexibly considering the other's perspective and less interference of the other's incongruent viewpoint when their own perspective is considered. Our results add to previous findings that social cognitive differences are there but subtle and constitute one step further in characterizing Theory of Mind reasoning in autism and explaining communication and interaction difficulties with non-autistic people in everyday life.

Lay Summary

Researchers found that autistic people have problems solving Theory of Mind tasks and concluded that this problem explains communication and interaction difficulties in autism. However, in recent years, many studies found only little differences between autistic and non-autistic participants in Theory of Mind tasks. This challenges the idea that Theory of Mind difficulties cause autistic symptoms. To explain the subtle differences between autistic and non-autistic adults, we tested in this study how flexibly and efficiently they use their Theory of Mind to attribute beliefs to others and themselves. This is an important ability for smoothly interacting with others. In our task, we compared the response accuracy and reaction time of autistic and non-autistic adults to determine how well they handle another person's and their own perspective. Autistic adults had more difficulties in flexibly switching toward the other's perspective. This can be a problem in real life social interactions, in which the perspective of the interaction partner must be continuously monitored to have a smooth and balanced conversation. Autistic participants were also less distracted by the other's perspective when it did not match one's own viewpoint. This can be an advantage in situations where such an influence might be distracting. With other earlier findings, our study shows that social cognitive differences between autistic and non-autistic people are there but subtle. This finding helps to better understand Theory of Mind in autism and explain communication and interaction difficulties with non-autistic people in everyday life.

KEYWORDS
autism, false belief reasoning, perspective-taking, self-other control, theory of mind

INTRODUCTION

Autism spectrum condition (hereafter autism) is clinically characterized by social interaction and communication difficulties (World Health Organization, 2019). Cognitive science has identified altered social cognitive processes as the underlying mechanism causing these difficulties (Happé et al., 2017). Particularly, atypical Theory of Mind that is, difficulties with the attribution of mental states to others and oneself, is a prominent explanation of autistic symptoms (Frith, 2012).

An important empirical basis for this hypothesis is the finding that autistic children and adults have problems passing the false belief task. In this task, participants must explain and predict the behavior of a story protagonist (e.g., Sally will look for the marble in the basket) in terms of her false belief (e.g., Sally thinks the marble is in the basket) about a certain state of the world (e.g., the ball has been transferred from the basket to a box while Sally was away). Children become able to solve this task by attributing a false belief to an agent between 3 and 5 years of age (Wellman et al., 2001). Autistic children lag behind with this milestone of Theory of Mind development and autistic adults seem to still lack spontaneous sensitivity to an agent's false belief (Baron-Cohen et al., 1985; Senju et al., 2009). Further, also other tasks requiring reasoning about the mental states of others and oneself revealed inferior performance of autistic compared to non-autistic participants (Baron-Cohen, Wheelwright, Hill, et al., 2001; Happe, 1994).

Yet, recent empirical evidence draws a more complex picture and renders previous descriptions of Theory of Mind abilities in autism insufficient. First, measuring Theory of Mind beyond early childhood is difficult because appropriate tasks are rare (for an overview, see Livingston et al., 2019). For example, Oakley et al. (2016) showed that the validity of the Reading the Mind in the Eyes task, a prominent measure in cognitive autism research, is questionable as it measures other aspects than Theory of Mind abilities.

Second, there are studies in which autistic participants performed as well as non-autistic participants on Theory of Mind tasks. Recent studies for example found no performance differences between autistic and non-autistic adolescents in a classical false belief task (Schaller & Rauh, 2017) and in a task measuring second order false beliefs and further advanced Theory of Mind abilities (Scheeren et al., 2013). Based on such findings, it was argued that autistic adults, especially those with average or above-average intelligence and good verbal skills, employ compensatory strategies in tasks that require conscious verbal reasoning about mental states (see Livingston & Happé, 2017), but that they fail tasks that measure the spontaneous non-verbal consideration of another's false belief (e.g., anticipatory looking behavior; Schneider et al., 2013; Senju et al., 2009). Yet, besides the replicability issue of such spontaneous false belief tasks (Barone et al., 2019; Poulin-Dubois et al., 2018), performance differences in these tasks are way subtler than previously assumed (Deschrijver et al., 2016; Schuwerk et al., 2015).

Third, the link between social cognition as assessed in the lab and actual social functioning turns out to be weak. Morrison, DeBrabander, Jones, Ackerman, and Sasson (2020) found that performance in paradigms measuring social cognition (among them a Theory of Mind task) did not predict the outcome of dyadic interactions. Another study showed that, unlike general (neuro-) cognitive functioning and demographic characteristics, social cognitive skills only minimally and indirectly explained variance in social cognitive functioning in autistic adults (Sasson et al., 2020).

Based on such and further evidence, Gernsbacher and Yergeau (2019) concluded that the Theory of Mind deficit hypothesis lacks a solid empirical basis. In contrast, a large body of research shows that autistic people can attribute false beliefs and do have a Theory of Mind. Therefore, the Theory of Mind deficit hypothesis is unable to explain why many autistic people experience difficulties with communication and social interaction.

In this study, to better characterize the subtle differences in Theory of Mind reasoning between autistic and non-autistic people, we asked how flexibly and efficiently they use their Theory of Mind to attribute beliefs to themselves and others. We aimed to identify a cognitive mechanism of Theory of Mind reasoning that works differently in autistic and non-autistic adults. Finding such a mechanism would constitute one step further in characterizing Theory of Mind reasoning in autism and explaining communication and interaction difficulties with non-autistic people in everyday life.

In the last two decades, psychologists have made large progress in characterizing the cognitive processes involved in Theory of Mind reasoning (e.g., Apperly, 2010). The essential challenge for a cognitive system to succeed in the false belief task is to distinguish between and flexibly juggle one's own and another's belief in relation to reality. The cognitive process dealing with this challenge has been described as decoupling, necessary to reason about another's mental state that does not correspond to one's own perception of reality. Already in the 1980ies, it was proposed that the decoupling mechanism could be affected in autism (Leslie, 1987).

More recently, research in the related domain of motor representations of other's and one's own movements found differences in self-other distinction between autistic and non-autistic people (Brass & Wiersema, 2021). Reviewing literature from social cognitive neuroscience, Sowden and Shah (2014) introduced the term self-other control, which describes "the ability to hold in mind and manage neural representations of both the self and of other people" (p. 1). This entails controlling and switching between different perspectives to flexibly enhance or inhibit the one's own or another's viewpoint and is crucial for successful reciprocal social interaction (see also Decety & Sommerville, 2003). Empirical evidence for altered self-other control in autism comes from research on simple motor representations (Spengler et al., 2010), but has not been comprehensively extended to more complex mental state representations, such as one's own and other's false and true beliefs.

A previous study by Bradford et al. (2018) investigated how efficiently autistic adults can switch between another's and their own perspective in a multiple-trial unexpected content false belief task. They found that both, autistic and non-autistic adults made fewer errors and were faster in responding from their own perspective, suggesting an egocentric bias in belief attribution. This added to previous evidence of an egocentric bias, the tendency to perceive and judge the world from one's own point of view resulting in an interference of one's own perspective when another person's perspective must be considered. This effect has been observed in autistic (Begeer et al., 2012; cf., Lavenne-Collot et al., 2023) as well as non-autistic children and adults (Epley et al., 2004; Flavell et al., 1981; Samson et al., 2010; Surtees & Apperly, 2012). Error rates and reaction times in Bradford et al.'s study were also comparable between the groups for shifting between one's own and the other's perspective. Interestingly, autistic adults had specific difficulties answering false belief probe questions, indicating that switching from one perspective to another's incongruent (and false) belief is particularly challenging.

Sommer et al. (2018) used a classical unexpected location false belief task to compare functional brain activity of autistic and non-autistic adults. In this multiple-trial fMRI task, participants had to first compute another's false or true belief based on what the character had or had not seen. In the subsequent response phase of the trial, participants had to choose either the character's belief or their own view on the situation to answer the trial correctly. No behavioral group differences were observed. In addition, no neural differences between autistic and non-autistic adults were observed in the phase of the trial in which the character's and one's own beliefs had to be computed. In the subsequent response phase, in which participants had to switch to the requested perspective and inhibit the other one, subtle differences in the neural level were observed. Adults with autism showed increased activity in the frontal and temporoparietal areas, presumably related to increased processing demands such as episodic retrieval, stimulus contextualization, and attentional control when juggling different perspectives.

To follow up on this finding, we adapted the task by Sommer et al. (2018); (see also Schuwerk, Döhnel, et al., 2014) to tap into the process of self-other control in belief attribution in autistic adults. Previous studies showed that this task is age-appropriate and by changing the sequence of events in a trial, we were able to use accuracy rate and response time as sensitive measures. The task is an example of several paradigms studying the cognitive basis of Theory of Mind in adults (see Apperly et al., 2009). In multiple trials, a story character either ends up with a false or true belief about the whereabouts of an object (in one of two boxes). The participant always knows where the object is. Thus, one's own knowledge and the character's belief can be congruent (both know/belief where the object is) or incongruent (agent has a false belief/participant knows where it is; factor congruency). In the question phase of a trial, participants are asked to indicate either where the character believes the object is located or where they themselves think the object is (factor perspective). In the case of congruent beliefs, there is no mismatch of mental representations and response options; in the case of incongruent beliefs, there are two competing response options. In each trial, participants must quickly compute their own and the other's perspective and then later switch to the requested one to give the correct response as fast as possible.

We predicted that if self-other control is altered in autism, we should observe more errors and longer reaction times in the autism group vs. the comparison group when the other's perspective compared to one's own perspective must be considered. With our design, we could further test if self and other perspective judgments differ depending on whether these points of view are congruent or incongruent.

METHOD

Following best practice recommendations, we report how we determined the sample size, all data exclusions, all manipulations, and all measures in this study. Material, data, and analysis scripts of this study can be found at OSF (https://osf.io/c6h3r/?view_only=3741a43151f04403b2a990f6ce3dbeee). To protect data privacy, we do not share the full demographic information.

Participants

A total of 59 adults took part in this study: 30 autistic participants (autism group; $M_{age} = 31.1$ years, SD = 12.5 years, five female) and 29 non-autistic participants (comparison group; $M_{age} = 33.5$ years, SD = 14.2 years, 11 female). One additional participant had to be excluded from the autism group because the tentative autism diagnosis could not be confirmed in the diagnostic process that was completed after data acquisition. All participants provided informed written consent and received monetary compensation for travel expenses. The ethics committee of the Department of Psychology and Education of the Ludwig-Maximilians-Universität München approved the study. The sample size was determined by the goal to test as many participants as possible, given limitations of personal and financial resources.

Autistic participants were recruited via local autism organizations, clinics and private-practice physicians. They all had to be diagnosed by a qualified clinical psychologist or psychiatrist, meeting the International Classification of Diseases-10th Revision criteria (World Health Organization, 1993). We obtained the diagnoses from individual medical reports, stating clinical evidence such as expert evaluations or evidence-based assessment of autism, including the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). Participants of the autism group were diagnosed with Asperger syndrome ($n = 22$), childhood autism ($n = 6$, one thereof classified as "high-functional"), and atypical autism ($n = 2$). Fourteen participants in the ASC group reported a diagnosed comorbid mental condition (major depression: n = 7, attention-deficit hyperactivity disorder: $n = 3$, adjustment disorder: $n = 2$, habit and impulse disorder: $n = 1$, mild mental retardation: $n = 1$). Four participants in the autism group reported an additional comorbid mental condition (phobic anxiety disorder: $n = 1$, bipolar affective disorder: $n = 1$, obsessive compulsory disorder: $n = 1$, specific spelling disorder: $n = 1$). The number of comorbid conditions in our sample matches the literature reporting high rates of comorbid conditions in autism (e.g., Mannion & Leader, 2013).

Participants from the comparison group were recruited from the participant pool of our lab. One participant in the comparison group reported a mental condition (major depression). The two groups were matched by age, verbal intelligence (a German multiple-choice vocabulary test; Merfachwahl-Wortschatz-Intelligenztest, MWT-B; Lehrl, 2005) and nonverbal intelligence (Culture-Fair Test 20-R; CFT-20-R; Weiß, 2006). Autistic and non-autistic participants had diverse educational and professional backgrounds. The autism and comparison group were comparable in their level of education. To corroborate group assignment, we assessed autistic traits of individuals from both groups via a short form of the *Autism Quotient* (*AQ*; cut-off criterion: score ≥17; Baron-Cohen, Wheelwright, Hill, et al., 2001; Baron-Cohen, Wheelwright, Skinner, et al., 2001; German version: Freitag et al., 2007). Descriptive statistics and group comparisons for these measures are provided in Table 1.

Task and procedure

Participants completed a multiple-trial version of a Sally-Anne task (Baron-Cohen et al., 1985). Stimuli, conditions, and trial sequence were the same as in previous studies (Schuwerk, Döhnel, et al., 2014; Schuwerk, Schecklmann, et al., 2014). Participants watched animated video clips in which a story character held a belief about the location of a self-propelled moving ball. At the beginning of each trial, the story character watched a ball jumping in one of two boxes. Subsequently, the boxes switched places. In the two *incongruent-beliefs* conditions, the ball jumped out of the box it initially entered and ended up in the other box. Crucially, the story character did not witness this event. Thus, the story character held the false belief that the ball was still in the box it initially entered, whereas the participants knew it was in the other box. In the *congruent-beliefs* conditions, the ball also performed self-propelled movements that were out of the story character's sight, but it ended up in the same box it entered. Hence, the story character and the participants had a true belief about the whereabouts of the ball. After

TABLE 1 Mean scores (standard deviation in brackets) of demographics and control measures, separately for the autism and the comparison group.

			Group comparison		
	Autism group	Comparison group	*t* value	*p* value	Effect size (Hedge's *g*)
Sample size	$n = 29$	$n = 30$			
Chronological age in years	31.13 (12.46)	33.48 (14.16)	$t\,(55.56) = -0.28$	$p = 0.502$	−0.17
Verbal IQ (MWT-B[a])	108 (15)	115 (15)	$t\,(56.95) = -1.97$	$p = 0.054$	−0.50
Non-verbal IQ (CFT-20-R[b])	102 (21)	110 (15)	$t\,(52.99) = -1.63$	$p = 0.109$	−0.42
AQ[c] (short form)	20.37 (7.75)	6.21 (5.09)	$t\,(50.26) = 8.32$	$p < 0.001$	2.12

Note: Results from independent-groups *t* tests are provided for a group comparison.
[a]Mehrfachwahl-Wortschatztest (German multiple choice vocabulary test).
[b]Culture-fair test 20-R (non-verbal IQ in terms of general mental capacity).
[c]Autism-Spectrum Quotient (short form, cut-off criterion: score ≥ 17).

these events had taken place, the scene froze, and participants were either asked about the story character's belief about the ball's location ("Where does he think the ball is located?") or about their own belief about the ball's location ("Where do I think the ball is located?"). The combination of the prior incongruent- or congruent-beliefs animation and the test questions led to four conditions: *other-incongruent*, *other-congruent*, *self-incongruent*, *self-congruent*. In additional filler trials, participants saw the same events as described above, but were asked which of the boxes was light-/dark-brown. The filler trials were included to increase task demands and to avoid the predictability of the test questions.

The participants were instructed to respond as fast and accurately as possible by pressing one of two response buttons (left button for left box, right button for right box). Reaction time was recorded from the onset of the test question phase until button press. If no response was provided within 2 s, the trial was coded as missed. Figure 1 displays an example of the stimuli and provides details on the trial sequence. The participants were familiarized with the task by a standardized instruction and a short practice. In the standardized instruction, an experimenter explained all conditions, response options, and correct answers, including corrective feedback if participants' answers were incorrect. In the subsequent practice phase, they completed several trials from each condition until they were confident that they understood how to correctly answer trials from each condition and were familiar with the timings of the trials.

A total of 90 trials were administered (15 trials per condition and 30 filler trials). The trials were presented in a pseudo-randomized order using Presentation (17.0) (Neurobehavioral Systems Inc., Albany, CA). The total duration of the task was approximately 12.5 min, depending on how fast the participants replied. Stimuli were presented with a size of approximately 13.3° × 10.2° on a Dell Latitude E6520 laptop in a dimly lit and quiet room.

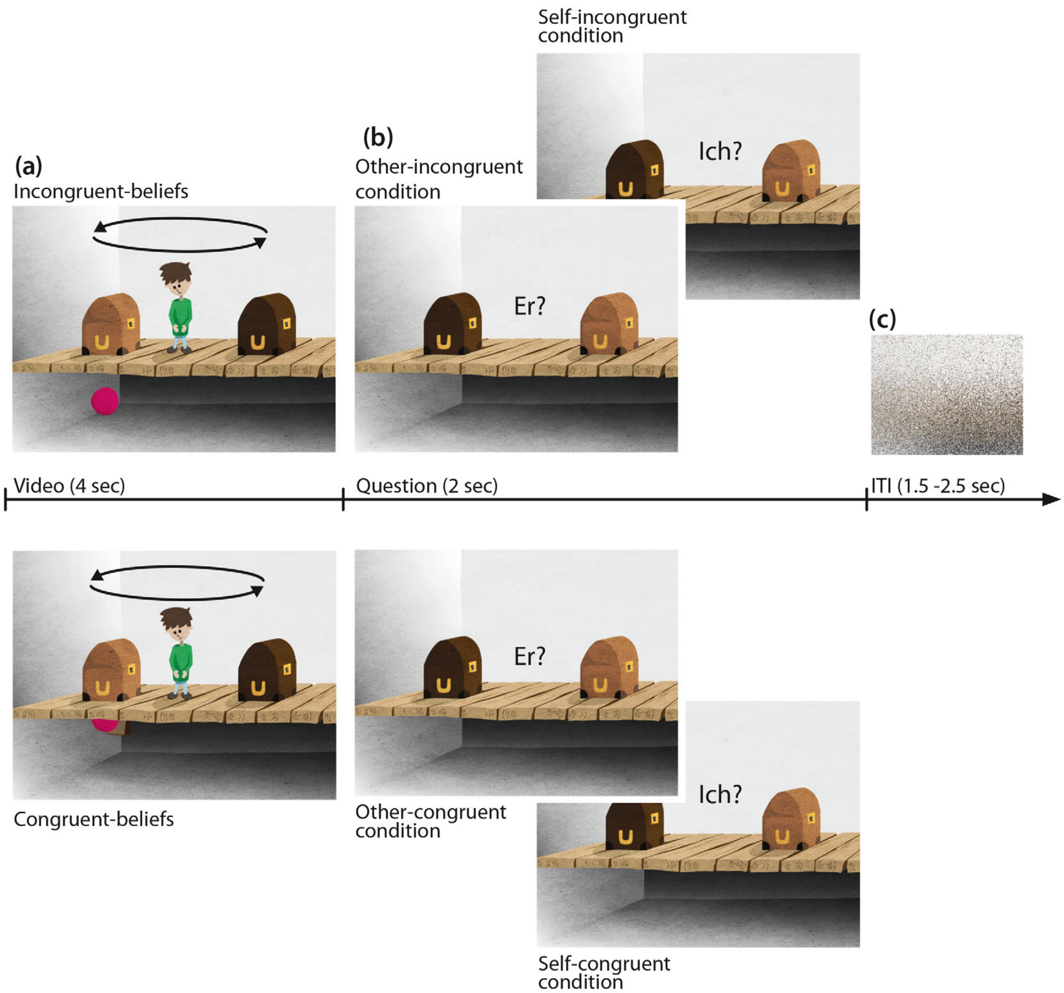

FIGURE 1 Stimuli, conditions, and trial sequence: (a) In the 4 s-long movie, the story participants had to compute the story character's incongruent or congruent belief about the ball's location (compared to their own belief). (b) In the subsequent test 2 s-long test phase, they were asked about the story character's or their own belief ("Er?"—"Where does he think the ball is located?"; "Ich?"—"Where do I think the ball is located?") and indicated this response via button press. (c) The trial ended with a time-varying intertrial interval (ITI; 1.5–2.5 s).

The task was administered in a test session in which also other measures for a larger research project were collected. After participants gave their informed written consent, they performed a set of behavioral tasks. Breaks between the tasks were taken if required. Subsequently, participants completed the IQ measures and the AQ.

Data analysis

For data processing and analyses, we used the statistical software R 4.0.2 (R Core Team, 2020). Response accuracy and reaction times were analyzed with a 2 × 2 × 2 repeated measures analysis of variance (ANOVA). The between-participants factor was group (autism vs. comparison). The within-participants factors were perspective (other vs. self) and congruency of beliefs (incongruent vs. congruent). The significance level for all analyses was set at $p \leq 0.05$. Follow-up t tests were corrected for multiple comparisons using the Bonferroni method.

TABLE 2 Mean response accuracy (% correct, standard deviation in brackets) for each condition and experimental group.

Condition	Autism group	Comparison group
Other-incongruent	72 (29)	97 (6)
Other-congruent	70 (32)	95 (7)
Self-incongruent	88 (14)	97 (7)
Self-congruent	88 (17)	97 (4)

RESULTS

Response accuracy

Table 2 shows the summary statistics for response accuracy per condition for each experimental group. The 2 × 2 × 2 repeated measures ANOVA showed a significant main effect of group. Participants from the autism group (M = 79% correct, SD = 25% correct) made more mistakes than participants from the comparison group (M = 96% correct, SD = 6% correct), $F(1,57) = 25.23$, $p < 0.001$, $\eta_G^2 = 0.190$. Also, the main effect perspective was significant, $F(1,57) = 16.66$, $p < 0.001$, $\eta_G^2 = 0.064$. Overall, participants made more mistakes when the other's perspective had to be judged (M = 83% correct, SD = 25% correct) as compared to one's own perspective (M = 92% correct, SD = 13% correct). No main effect of congruency was observed, $F(1,57) = 0.28$, $p = 0.596$, $\eta_G^2 < 0.001$. When both experimental groups are collapsed, the participants made an equal number of mistakes when judging incongruent (M = 88% correct, SD = 20% correct) and congruent perspectives (M = 87% correct, SD = 21% correct).

We found a significant interaction between the factors group and perspective, $F(1,57) = 12.57$, $p < 0.001$, $\eta_G^2 = 0.049$. Response accuracy for judging the other's and one's own perspective differed between participants from the autism and the comparison groups (Figure 2). Post hoc t tests showed that participants with autism made significantly more mistakes (M = 71% correct, SD = 30% correct) than participants from the comparison group (M = 96% correct, SD = 7% correct) when the other's

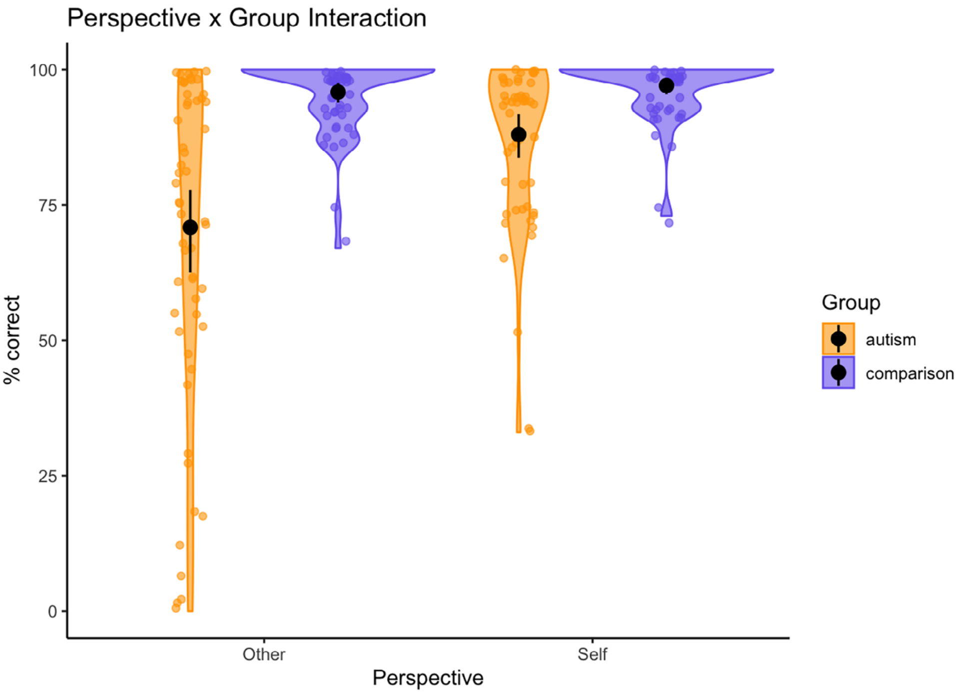

FIGURE 2 Response accuracy (% correct) for judging the other's and one's own perspective for the autism and the comparison group. Colored dots illustrate mean response accuracy of each participant. The colored areas show the probability density functions of observations in each condition. The black dots and lines indicate the condition means and their 95% confidence intervals. This Figure illustrates the finding that the number mistakes in perspective judgments differed between experimental groups. Autistic participants made more mistakes than participants from the comparison group both in the other's belief and in the own belief condition. Further, participants with autism made more mistakes when the others belief had to be considered compared to self-perspective judgments. Accuracy rates did not differ between self and other judgements in the comparison group.

perspective had to be considered, $t(65.29) = -6.26$, $p < 0.001$, $g = -1.12$, $CI_{95\%} = [-33.01, -16.98]$. Also, when one's own perspective had to be judged, autistic participants made more mistakes ($M = 88\%$ correct, $SD = 15\%$ correct) than non-autistic participants ($M = 97\%$ correct, $SD = 6\%$ correct), $t(75.91) = -4.24$, $p < 0.001$, $g = -0.77$, $CI_{95\%} = [-13.30, -4.80]$. Participants from the autism group made significantly more mistakes when they had to judge the other's perspective than when their own perspective had to be considered, $t(59) = -4.71$, $p < 0.001$, $g = -0.67$, $CI_{95\%} = [-24.44, -9.86]$. This difference in perspective judgments was not observed in the comparison group, $t(57) = -1.13$, $p = 1.000$, $g = -0.19$, $CI_{95\%} = [-3.35, -0.94]$.

Neither a group × congruency interaction, $F(1,57) = 0.12$, $p = 0.734$, $\eta_G^2 < 0.001$, nor a perspective × congruency, $F(1,57) = 0.37$, $p = 0.544$, $\eta_G^2 < 0.001$, or a three-way interaction was observed, $F(1,57) = 0.00$, $p = 0.962$, $\eta_G^2 < 0.001$.

Reaction time

The mean reaction times per condition and group are shown in Table 3. In the 2 × 2 × 2 repeated measures ANOVA, we found a significant main effect of group, $F(1,57) = 7.63$, $p = 0.008$, $\eta_G^2 = 0.098$. Autistic participants reacted slower ($M = 1083$ ms, $SD = 285$ ms) than non-autistic participants ($M = 922$ ms, $SD = 208$ ms). No main effect of perspective was observed, $F(1,57) = 2.59$, $p = 0.113$, $\eta_G^2 = 0.003$. Reaction times were equally long for other- ($M = 1018$ ms, $SD = 285$ ms) and self-perspective judgments ($M = 990$ ms, $SD = 249$ ms). We found a significant main effect of congruency, $F(1,57) = 83.96$, $p < 0.001$, $\eta_G^2 = 0.036$. Reaction times were longer for incongruent- beliefs ($M = 1051$ ms, $SD = 265$ ms) than for congruent-beliefs judgments ($M = 957$ ms, $SD = 252$ ms). Neither a group × perspective, $F(1,57) = 0.32$, $p = 0.574$, $\eta_G^2 < 0.001$, nor a group × congruency, $F(1,57) = 1.01$, $p = 0.318$, $\eta_G^2 < 0.001$, nor a perspective × congruency interaction, $F(1,57) = 1.34$, $p = 0.253$, $\eta_G^2 = 0.001$, was observed. The three-way interaction between group, perspective and congruency was significant, $F(1,57) = 9.29$, $p = 0.003$, $\eta_G^2 = 0.009$.

To break down this three-way interaction, we performed two 2 (perspective: other vs. self) × 2 (congruency: incongruent vs. congruent) repeated measures ANOVAs, one for each group. For the ASC group, we observed no significant main effect of perspective, $F(1,29) = 1.90$, $p = 0.179$, $\eta_G^2 = 0.005$. Reaction times were comparably long for other- ($M = 1102$ ms, $SD = 301$ ms) and self-perspective judgments ($M = 1064$ ms, $SD = 269$ ms). The main effect of congruency was significant, $F(1,29) = 28.11$, $p < 0.001$, $\eta_G^2 = 0.037$. Autistic participants reacted slower in the incongruent ($M = 1137$ ms, $SD = 288$ ms) compared to the congruent-beliefs condition ($M = 1028$ ms, $SD = 274$ ms). There was no significant perspective × congruency interaction, $F(1,29) = 1.43$, $p = 0.241$, $\eta_G^2 = 0.003$.

In the comparison group, we also found no significant main effect of perspective, $F(1,28) = 0.74$, $p = 0.397$, $\eta_G^2 = 0.002$. Reaction times did not differ significantly between the other- ($M = 932$ ms, $SD = 216$ ms) and self-perspective conditions ($M = 913$ ms, $SD = 202$ ms). As in the autism group, a significant main effect of congruency was observed, $F(1,28) = 12.81$, $p = 0.001$, $\eta_G^2 = 0.037$. Again, reaction times were slower when incongruent beliefs ($M = 962$ ms, $SD = 206$ ms) than when congruent beliefs ($M = 883$ ms, $SD = 205$ ms) had to be judged. Unlike in the autism group, the perspective × congruency interaction was significant, $F(1,28) = 12.08$, $p = 0.002$, $\eta_G^2 = 0.024$. Post hoc t tests revealed that when the other's perspective had to be considered, reaction times were equally large for trials in which the participant's belief about the ball's location was incongruent ($M = 939$ ms, $SD = 215$ ms) or congruent ($M = 924$ ms, $SD = 221$ ms) to the protagonist's belief, $t(28) = -0.46$, $p = 1.000$, $g = -0.070$, $CI_{95\%} = [-85.15, -53.77]$. In trials in which one's own perspective had to be judged, the participants from the comparison group reacted slower when the protagonist's belief was incongruent ($M = 984$ ms, $SD = 198$ ms) compared to when it was congruent ($M = 842$ ms, $SD = 183$ ms) to one's own perspective, $t(28) = -6.49$, $p < 0.001$, $g = -0.720$, $CI_{95\%} = [-186.61, -97.11]$. In the incongruent trials, there was no reaction time difference between other- and self-perspective judgments, $t(28) = -1.44$, $p = 0.646$, $g = -0.209$, $CI_{95\%} = [-108.10, 18.92]$. In congruent trials, reaction times were slower for other- compared to self-perspective judgments, $t(28) = 3.27$, $p = 0.011$, $g = 0.379$, $CI_{95\%} = [30.49, 132.69]$.

TABLE 3 Mean reaction time in ms (standard deviation in brackets) for each condition and experimental group.

Condition	Autism group	Comparison group
Other-incongruent	1171 (296)	939 (215)
Other-congruent	1033 (295)	924 (221)
Self-incongruent	1103 (280)	984 (198)
Self-congruent	1023 (256)	842 (183)

DISCUSSION

In this study, we addressed self-other control as a potential candidate cognitive mechanism to explain Theory of Mind reasoning differences between autistic and non-autistic adults by investigating flexible shifting between another's and one's own congruent or incongruent points of view, an ability that is important for reciprocal social interaction.

Looking at response accuracy of performance in a multiple-trial unexpected transfer false belief task, we found that autistic adults made overall more mistakes than non-autistic adults, irrespective of whether they were asked about their own or another's belief and irrespective of whether their own point of view matched or mismatched the character's belief. In line with our hypothesis, results revealed that response accuracy for judging the other's and one's own perspective differed between participants from the autism and the comparison group. Unlike participants from the comparison group, autistic adults made more mistakes when the other's belief compared to one's own belief had to be considered. In both, other- and self-perspective judgment, autistic adults performed worse than non-autistic adults. Notably, this finding was independent of whether the perspectives were congruent or incongruent.

Reaction time results showed that autistic adults responded overall slower than non-autistic adults. Both groups were slower in correctly solving trials with incongruent compared to congruent beliefs and reaction times were equally long for other- and self-perspective judgments. Non-autistic adults' reaction times for self-perspective judgments differed depending on the story character's viewpoint on the same situation: Although the other's perspective was irrelevant in the self-condition, reaction times were slower when the other's belief about the object's location was incongruent to what the participants knew about the whereabouts of the ball. The involuntary influence of another's perspective was previously termed *altercentric interference* and has been observed in other Theory of Mind studies with children and adults (Kampis & Southgate, 2020; Samson et al., 2010). This effect was not observed in the reaction times of autistic adults tested in the current study. In other words, they were less affected by the incongruent and irrelevant other's perspective when making self-perspective judgements.

Our study evidences altered self-other control in autistic adults and adds to previous evidence from research on motor representation of one's own and other's movements (for an overview, see Sowden & Shah, 2014). Notably, the effect we observed differed from the findings on the imitation of simple finger movements. Spengler et al. (2010) found increased imitation of another's finger movements, indicating a stronger influence of another's action on one's own behavior. In our study in the domain of mental state representations, we observed the opposite effect, namely, reduced salience of the other's perspective. Unlike participants form the comparison group, who showed a ceiling effect in accuracy rates, autistic adults in our study particularly had difficulties in switching toward the other's perspective. Especially the large variance in response accuracy for other-perspective judgments in the autism group, ranging from 0%–100% correct trials, is striking.

Reaction times revealed evidence for altercentric interference in non-autistic adults, an effect that was absent in the autistic adults. Altercentric interference describes the involuntary influence of another's perspective on self-perspective judgments. In sum, this pattern of results points to a certain direction of altered self-other control in Theory of Mind reasoning in autistic adults: the difficulty of switching to the other's perspective, and less influence of the other's perspective on self-perspective judgments. These findings agree with Bradford et al. (2018), who also reported less efficient perspective switching in autistic vs. non-autistic adults with a particular difficulty in considering the other's perspective when it is incongruent to one's own view on the situation. With Sommer et al.'s (2018) finding of subtle neural differences in the response phase of the same paradigm, our findings suggest that not the initial computation of different perspectives, but the subsequent flexible and efficient switching to one or the other seems to work differently in autism.

Together, findings from Bradford et al. (2018), Sommer et al. (2018), and the present study are important because they provide an explanation of the discrepancy between early studies finding reduced Theory of Mind abilities in autistic participants (see Frith, 2012) and several later studies who documented intact Theory of Mind abilities (e.g., Scheeren et al., 2013; for an overview, see Gernsbacher & Yergeau, 2019). The core conceptual understanding that (1) other people have mental states which guide their behavior and that (2) these mental states can differ from one's view on reality is an ability that both autistic and non-autistic people possess. In appropriate tasks, both groups show this ability. However, autistic adults seem to have difficulties in the flexible and efficient use of the attributed mental state in relation to one's own perspective. Tasks like the present one that demand such a fast and flexible handling, reveal a group difference in this domain.

Notably, the observed group differences cannot be explained by differences in general cognitive functioning. Although the autism and comparison groups were matched for verbal and nonverbal IQ, we found that autistic participants made overall more mistakes and reacted slower than the non-autistic comparison group. Yet, in our factorial design, the main conclusions are based on results which are independent of this overall group difference. Moreover, the task demands for self- and other-judgments, for which we observed key group differences in accuracy rates, were identical in terms of cognitive load. These group differences were independent of the factor congruency, which poses higher cognitive processing demands in the case of incongruent perspectives.

The finding of altered self-other control in Theory of Mind reasoning in autistic adults, with a relative difficulty in flexibly considering the other's perspective and less interference of the other's incongruent perspective when their own perspective is considered, may provide an additional piece of a cognitive explanation of communication and interaction difficulties. The difficulty in efficiently switching toward the other's perspective, as observed in the current task, is likely aggravated in actual social interaction, which is much more unstructured, unpredictable, and requires the parallel processing and production of nonverbal social signals as well as following and shaping the informational content. A weaker influence of another's incongruent perspective can have several impacts. On the one hand, it could make it more difficult for autistic people to align with their (non-autistic) social environment. A recent theoretical account from developmental psychology suggests that altercentrism, the spontaneous influence of others on one's own cognitive processes, serves as crucial mechanism for cooperation and living in complex social groups (Kampis & Southgate, 2020). On the other hand, a potentially reduced altercentrism can also be advantageous for the autistic individual and also the social group she or he is part of. First, autistic people might be less susceptible to social influence, which can lead to conformity issues as observed in the groupthink phenomenon (Yafai et al., 2014; for contradicting findings see Lazzaro et al., 2019). Second, translating this to everyday social interactions, being less affected by what others think can lead to more unbiased and honest conversations, a quality many autistic people have. However, at the current point, these interpretations are speculative. More empirical work is necessary to further explore this phenomenon.

Future research must take the next step toward linking findings on cognitive differences in Theory of mind reasoning in real social interactions and the outcome of these interactions. In a recent study, Alkire et al. (2023) went in this direction by measuring the use of Theory of mind in dyads consisting of autistic and non-autistic children and adolescents. To achieve this, they coded a 5-min unstructured conversation to measure the presence or absence of spontaneous Theory of Mind use and linked this to performance in two behavioral Theory of Mind tasks. They found that autistic participants produced more Theory of Mind-related violations of conversational norms, such as over- or under-informative, irrelevant, or ambiguous utterances, or implausibly assuming common or uncommon ground in the conversation. This behavior was related to performance in the non-interactive experimental Theory of Mind tasks. No group differences were observed in the positive examples of Theory of Mind use, namely the use of appropriate, relevant, clear utterances that correctly consider what the communication partner knows or does not know in the situation, as well as articulating the other's perspective or explicitly referring to the interaction partner's mental state.

Our study has limitations that must be addressed in future research. First, it investigated Theory of Mind reasoning, a core ability for social interaction, in an abstract non-interactive task entailing a third-person view on a certain situation. This feature of classical false belief tasks weakens the generalizability of our findings to real-life interaction contexts (Schilbach et al., 2013). Second, with our task, we could only test Theory of Mind reasoning as conceptualized by non-autistic researchers. Although this may be well suited to test autistic Theory of Mind reasoning when interacting with non-autistic others (which makes up a large part of most autistic people), this falls short of characterizing cognitive processes when autistic people interact with other autistic people, a situation, which only recently received scientific attention (for an overview, see Davis & Crompton, 2021). For example, a study showed that communication between autistic adults is as effective as between non-autistic adults and that communication was negatively affected only in a mixed group (consisting of autistic and non-autistic adults; Crompton et al., 2020). Another study by Morrison, DeBrabander, Jones, Faso, et al. (2020) suggests greater social affiliation in dyads of two autistic adults compared with mixed dyads. Moreover, also non-autistic people have problems in interpreting facial expressions and mental states of autistic people (Brewer et al., 2016; Epley et al., 2016). These findings support the theoretical explanation that communication and interaction difficulties are not attributable to autistic social cognitive deficits, but rather stem from a mismatch between autistic and non-autistic cognitive and behavioral styles (Bolis et al., 2017; Milton, 2012). Future research must find ways to study the cognitive basis of Theory of Mind reasoning in different interactional contexts.

In sum, the present findings add to previous evidence that autistic adults have a Theory of Mind and that differences in its social cognitive basis are subtle. We show that self-other control is a potential candidate mechanism that works differently in autistic and non-autistic adults. This cognitive mechanism is likely important for engaging in reciprocal and smooth interaction with others and diagnosis-related differences might impact interaction quality, especially in dyads of autistic and non-autistic people.

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DATA AVAILABILITY STATEMENT

Material, data, and analysis scripts of this study can be found at OSF: https://osf.io/c6h3r/?view_only=3741a43151f04403b2a990f6ce3dbeee.

ETHICS STATEMENT

The ethics committee of the Department of Psychology and Education of the Ludwig-Maximilians-Universität München approved the study.

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