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The Influence of Autistic Traits on Situational Alignment in Conversation: An fNIRS Hyperscanning Study¹

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Abstract

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Full Text

The Influence of Autistic Traits on Situational Alignment in Conversation: An fNIRS Hyperscanning Study1

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Abstract: Interactive alignment theory holds that linguistic alignment is a means of achieving situational alignment, while situational alignment is the direct cause of maintaining conversation. Existing behavioral methods only observe the state of linguistic alignment and have not yet directly and effectively detected the mechanism of situational alignment. Meanwhile, individuals on the autism spectrum commonly exhibit conversational impairments, yet how autistic traits influence situational alignment remains unknown. This study used a map task to isolate the process of situational alignment, employed hyperscanning technology to record inter-brain synchronization signals between interlocutors, and examined how levels of autistic traits influence the neural mechanisms of situational alignment. The results showed that autistic-trait scores could stably predict inter-brain synchronization in the left TPJ region, but not in the right TPJ region, revealing a lateralization effect. This lateralization effect indicates that, in achieving situational alignment, individuals with higher autistic traits rely mainly on the form of verbal interaction; this may reflect their engagement in verbal interaction and the coordination process of role relationships, and may also be related to the double-empathy hypothesis for this group. This study is the first to reveal a lateralization effect in the influence of autistic traits on situational alignment, providing evidence for understanding the cognitive mechanisms of conversational impairments in the ASD population.

Keywords: autistic traits; situational alignment; hyperscanning; temporoparietal junction; lateralization

Autistic Traits Modulate Neural Synchronization in Situation Model Alignment: Evidence from an fNIRS Hyperscanning Study

Abstract: Interactive Alignment Theory posits that linguistic alignment serves as a means to achieve situational alignment, which in turn is the direct cause for sustaining conversation. However, existing behavioral methods can only observe the state of linguistic alignment and have not yet directly and effectively detected the mechanism of situational alignment. Meanwhile, individuals on the autism spectrum commonly exhibit, yet how autistic traits influence situational alignment remains unknown. The present study employed the map task paradigm to isolate the situational alignment process, used hyperscanning technology to record inter-brain synchronization signals between conversational partners, and examined how autistic trait levels modulate the neural mechanisms of situational alignment. We found that autistic traits could stably predict interpersonal brain synchronization (IBS) in the left temporoparietal junction (TPJ), but not the right TPJ, revealing a lateralization effect. This lateralization suggests that individuals with higher autistic traits may rely more heavily on verbal interaction to achieve alignment, potentially reflecting their active processing style, relational coordination difficulties, and the double empathy problem. Our findings provide novel neural evidence for the cognitive mechanisms of conversational difficulties in the ASD population.

1 This study is an interim outcome of the Youth Project of the Ministry of Education Humanities and Social Sciences Research, "Behavioral and Neural Research on Conversational Synchronization in Chinese-Speaking Children with High-Functioning Autism from a Developmental Perspective" (23YJC740083), and the Youth Project of the Jiangsu Provincial Social Science Fund, "Neural Mechanisms of Turn-Taking Processing in Chinese-Speaking Children with High-Functioning Autism" (23YYC012).

Key words: autistic traits; situation alignment; hyperscanning; temporoparietal junction (TPJ); lateralization effect

1. Introduction

Conversation is the core mode of human social interaction and also the primary form in which language is used. In recent years, research in psycholinguistics and neurolinguistics has begun to focus on the cognitive mechanisms of conversation—that is, how humans coordinate language comprehension and production and sustain conversational flow in natural and flexible contexts. Among many theoretical accounts, the interactive alignment theory occupies an important position. This theory holds that interlocutors reduce cognitive load through alignment at multiple levels of language and maintain the progress of conversation by promoting alignment of situation models (Pickering & Garrod 2004; Pickering & Garrod 2006; Pickering et al. 2021). Previous studies have mostly tested the rationality of interactive alignment theory from different linguistic levels such as phonology, vocabulary, and syntax, but have paid relatively little attention to the differences between situation alignment and linguistic alignment, nor have they isolated the independent process of situation alignment. At the same time, autistic groups generally show conversational difficulties (e.g., Cheng Yanhua and Ma Bosen 2022). As an extended manifestation of autism-spectrum impairments in the typical population, how autistic traits affect individuals' conversational performance and the alignment process of situation models has also attracted scholarly attention. Accordingly, the present study uses hyperscanning[1] to explore the mechanism by which autistic traits influence situation alignment in conversation.

2. Literature Review and Problem Formulation

2.1 Linguistic Alignment in Conversation

Alignment phenomena in conversation are manifested at many linguistic levels. At the phonetic level, studies of English have found that acoustic indicators such as intensity, speech rate, and fundamental frequency in both interlocutors' speech become increasingly similar as conversation proceeds (Levitan & Hirschberg 2011); Xia et al. (2023) found a significant alignment effect for intensity features in a corpus of ordinary-language games. At the syntactic level, when one speaker produces "it has no spots," the other speaker tends to respond with "it has no antennae" ; that is, both speakers repeatedly use the abstract syntactic structure "pronoun-verb-negative determiner-noun" (Dideriksen et

[1]Hyperscanning specifically refers to a technical approach that can simultaneously record the neural activity of two or more participants during an interactive task. At present, this technique mainly relies on two neurolinguistic methods: electroencephalography (EEG) and functional near-infrared spectroscopy (Functional Near-Infrared Spectroscopy, fNIRS). The present study uses fNIRS equipment.

al. 2023). Studies based on English corpora have also shown that clear syntactic alignment occurs in both free conversation and task-based conversation (Reitter & Moore 2014). These studies indicate that linguistic alignment is widespread and also support the rationality of interactive alignment theory.

2.2 The Separation of Linguistic Alignment and Situation Alignment

According to interactive alignment theory, the higher the degree of alignment in linguistic form, the greater the overlap between the situation models constructed by interlocutors. However, linguistic alignment is only a means of achieving situation alignment; the core that truly drives conversational operation lies in situation alignment. It should be noted that this situation alignment does not correspond completely to linguistic form, because the situation model is the psychological representation of the situation world to which language points, rather than a simple reproduction of linguistic symbols. Although existing studies have confirmed the existence of alignment phenomena at the level of language production, they have still been unable to provide direct evidence at the situational level. The present study argues that the core reason is that situation models are hidden within the interlocutors' brains and are dynamically updated as conversation unfolds, making them difficult to capture with external behavioral indicators. To address this problem, the present study extends the dimension of investigation to the neural level, using inter-brain synchronization (IBS), a hyperscanning technique,

the core metric as a route for quantifying situational alignment. Inter-brain synchrony reflects the extent to which multiple people are jointly engaged in the same cognitive processing through the consistency of conversational partners' patterns of brain activity (Holroyd 2022; Schilbach & Redcay 2025; Mu Xindi et al. 2024). Relevant studies have found that the IBS values of conversational partners communicating face to face are significantly higher than those of partners communicating back to back (Jiang et al. 2012). In the latter condition, because visual contact is absent, situational alignment becomes difficult; therefore, changes in IBS values in fact reflect differences in the degree of situational alignment. In addition, social interactions, such as conversations between strangers and conversations between romantic partners, can increase understanding between interlocutors and thereby enhance IBS values in multiple brain regions (De Felice et al. 2024; Sievers et al. 2024). Thus, inter-brain synchrony (IBS) provides a quantifiable neural-representational index for the originally implicit and dynamically updated process of situational alignment, thereby advancing research on situational alignment from indirect inference at the behavioral level to direct investigation at the neural level.

Different regions of inter-brain synchrony can reflect differences in the associated language alignment and situational alignment. In social interaction, regions showing significant inter-brain synchrony are mainly concentrated in the mentalizing system, including the medial prefrontal cortex, dorsolateral prefrontal cortex, bilateral temporoparietal junctions, cuneus, and cingulate gyrus (Jiang et al. 2021). Among these, inter-brain synchrony in the left temporoparietal junction (TPJ) and frontal regions constitutes the neural basis of language alignment. For example, lexical alignment and semantic alignment are respectively related to the degree of synchrony in the frontal lobe, left TPJ, and parietal regions, and the left TPJ is significantly associated with whether a conversational task succeeds (Chen et al. 2022; Wang Cheng et al. 2026). In addition, when conversational partners both use double-object sentences or prepositional-object sentences to describe pictures, the synchronization signal in the left TPJ is significantly enhanced (Liu et al. 2019). It should be noted that all of the above studies used strictly structured tasks, such as taking turns to describe pictures or naming objects. Participants in the experiments only needed to achieve language alignment by using the same syntactic structures or words, and did not need to construct mental representations of the other person; therefore, these studies cannot reflect the process of situational alignment. By contrast, some studies that did not allow participants to communicate verbally found that inter-brain synchronization activity in the right TPJ region is a typical neural basis of situational alignment. For example, Zhou et al. (2023) and colleagues required two participants to complete a spatial navigation task; during the task, participants could only see the other person’ s hand movements and could not communicate through language. The results showed that inter-brain synchrony in the right TPJ increased significantly. One study used a prisoner’ s dilemma task and found that inter-brain synchrony in the right TPJ and right inferior parietal lobule in the high-autistic-trait participant group was significantly weaker than in the low-autistic-trait participant group (Li et al. 2024). This indicates that when language communication is not needed to achieve alignment, the right TPJ region plays a greater role.

2.3 The Influence of Autistic Traits on Conversational Performance

Interactive alignment theory explains conversational mechanisms in terms of general cognitive processes; however, the operation of conversation is still influenced by social and individual factors. For example, individuals with higher needs for social approval and stronger social skills perform better in conversational alignment (see Wynn et al. 2023 for details). At the individual level, autistic traits are a series of autism-like characteristics widely distributed in the typical population; the stronger the degree of such traits, the closer one’ s cognitive and linguistic characteristics are to those of autistic groups (Becker et al. 2021; Zhang Gaode 2026, etc.). One study found that, during natural conversation between autistic adults and their conversational partners, inter-brain synchrony in the TPJ region was significantly weaker than in the control group, and inter-brain synchrony was negatively correlated with the degree of communication impairment. This suggests that autistic traits influence conversational performance through activity in the TPJ region (Quinones-Camacho et al. 2021). However, this study did not distinguish between the brain-region differences of language alignment and situational alignment, nor did it compare activity in the left and right TPJ regions. Feng et al. (2024) selected 120 university students according to their scores on the autistic-trait scale (BaronCohen AQ), and paired them into high-high trait, high-low trait, and low-low trait groups. The conversational partners in each group were then asked to discuss two types of topics in sequence: objects and emotions. The results found that only the low-low

the trait group showed significantly enhanced inter-brain synchrony in the right TPJ. Further correlational analyses indicated that the synchrony strength in this region was significantly negatively correlated with the interlocutors' mean AQ scores. In addition, some studies have found that individuals with high autistic traits also show significantly enhanced inter-brain synchrony in the left superior temporal gyrus during conversation, and this region is also closely related to the TPJ (Peng et al. 2024). In sum, considering the difficulty of involving autistic participants in neuroimaging experiments, researchers have often investigated the effects of autistic traits on the neural mechanisms of conversation. Relevant studies indicate that high-trait groups often exhibit abnormal inter-brain synchrony during conversation in brain regions of the mentalizing system, especially the TPJ.

2.4 Problem Statement

From the perspective of the cognitive mechanisms of conversation, achieving situational alignment through the alignment of linguistic symbols is key to maintaining conversation. However, inferring situational alignment from linguistic performance is only an indirect approach, and it is necessary to directly examine the mechanisms by which situational alignment occurs. As a core trait of autistic populations, autistic traits have a direct impact on individuals' conversational performance; examining the process by which they affect situational alignment can help elucidate the causes of conversational impairments in autistic populations. Although published hyperscanning studies have shown that the bilateral TPJ regions are key areas in which inter-brain synchrony emerges, because the experimental designs did not separate the process of situational alignment, it remains difficult to examine the unique effects of autistic traits on the two regions. Based on the Map Task, the present study designs two conversational conditions, simple and complex. In the simple task, situational alignment is relatively explicit and easy to achieve, requiring no additional effort; the complex condition, by contrast, requires interlocutors to expend greater cognitive effort to achieve situational alignment. According to the subtraction principle, subtracting the two conditions can isolate the neural mechanisms of situational alignment, after which we examine how autistic traits exert their influence. Given the important role of the TPJ in social activities, we predict that autistic traits will affect inter-brain synchrony in the bilateral brain regions.

This study also makes important improvements in the handling of variables. Previous studies have typically treated autistic traits as a between-group variable in data analysis, but this design logic has two drawbacks. First, taking Peng et al. (2024) as an example, the AQ score range of the high-trait group was 23 to 41, whereas that of the low-trait group was 10 to 19; the span of trait levels within each group approached or exceeded 10 points. Large within-group differences may create a risk of heterogeneity among participants within the same group, thereby increasing the likelihood of positive findings. Second, a between-group design can only yield the conclusion that "there is a significant difference between the high-trait group and the low-trait group," and cannot reveal the continuous gradient by which inter-brain synchrony changes with the level of autistic traits. In contrast, the present study incorporates autistic traits into the regression model as a continuous variable, an approach that can capture the change in inter-brain synchrony corresponding to each one-unit increase in AQ score. At the same time, this approach can avoid confounding variables such as medication and comorbidity in clinical research, and can finely reveal the neural gradient effect of autistic traits along a continuum, thereby providing a detailed entry point for understanding the conversational performance of autistic populations.

3. Methods

3.1 Participants

The AQ scale was distributed through Wenjuanxing in Heilongjiang, Jilin, Inner Mongolia, Shandong, Jiangsu, and other regions for preliminary screening. Based on 374 valid questionnaires, criteria for high and low autistic traits were determined. Referring to previous research, the mean $\pm$ 1 standard deviation was used as the cutoff value (Peng et al. 2024): that is, individuals with questionnaire scores above 27 were classified as high autistic-trait individuals, those below 17 as low autistic-trait individuals, and those from 17 to 27 as medium autistic-trait individuals. A total of 66 participants were recruited from the three grouping intervals to take part in the offline experiment and were matched into 33 conversational dyads. The dyad members were required not to know each other, to be of the same sex, and to belong to the same autistic-trait category. Their

Of these, 5 conversational dyads were excluded because the signal quality of the participants was poor, and the remaining 28 dyads were included in the analysis. Participants were 18–28 years old; 5 conversational dyads were male.

3.2 Experimental Design and Task

The experiment adopted a two-factor design. The categorical variable was the brain region of interest (left and right TPJ regions), the continuous variable was the interlocutors' trait loneliness, and the dependent variable was the inter-brain synchronization index corresponding to situational alignment. The cognitive activity of situational alignment was isolated using the map task. The map task

Figure 1. Simple-scenario task and complex-scenario task. Subpanels: simple scenario (drawer), simple scenario (instructor), complex scenario (drawer), complex scenario (instructor).

Figure 1: Figure 1. Simple-scenario task and complex-scenario task. Subpanels: simple scenario (drawer), simple scenario (instructor), complex scenario (drawer), complex scenario (instructor).

is a classic task-oriented dialogue task: the map held by one interlocutor (the drawer) contains only landmarks, whereas the map held by the other interlocutor (the instructor) contains both landmarks and a route. The landmarks on the two maps are not entirely identical and contain discrepancies. The task requires the two parties to communicate only verbally to help the drawer draw a route from the starting point to the endpoint. In the classic task, interlocutors are allowed to communicate through eye gaze and gestures, and they are also informed that their maps differ.[2] Referring to the design of subsequent studies, the present study concealed from both parties the fact that the landmarks on their maps differed, in order to increase the cognitive activity involved in situational alignment (Wehrle et al. 2023, Wehrle et al. 2024). The experimental procedure was divided into a practice experiment and a formal experiment. In the practice experiment, each conversational dyad completed a task containing only five landmarks. After the practice experiment ended, the experimenter showed them the route-drawing result and provided necessary explanations and supplementary instructions. The map materials used in the formal experiment are shown in Figure 1. In the simple scenario, the starting point, endpoint, and ten landmarks were exactly the same for the two interlocutors. In the complex task, the interlocutors had the same starting point and endpoint, but there were three discrepant landmarks: the Great Lakes and the ancient temple were located at the same position, the cornfield and the adventure park were located at the same position, and the adventure park and the moored boat were located at the same position. To prevent participants from being unable to complete the task, the three discrepant points were placed in the middle section of the route. During the experiment, an opaque partition was placed between the interlocutors to prevent nonverbal interaction. Before the experiment, the drawer was encouraged to actively communicate with the instructor and to avoid responding only with backchannel feedback. The experimental environment and procedure are shown in Figure 2. The entire experiment lasted 20 minutes.

Figure 1. Simple-scenario task and complex-scenario task

3.3 Hyperscanning Data Acquisition

Functional near-infrared imaging equipment produced by NIRx (NIRSport2 system) was used to record brain-activity signals. To cover the relevant brain re-

[2] An introduction to the map task can be found at: https://groups.inf.ed.ac.uk/maptask/index.html

gions, a 4$×$4 acquisition template was set up over each of the left and right brain regions for each interlocutor, with the covered areas mainly being the two

lateral frontal-lobe and TPJ regions, using a total of 20 channels. The distance between probes was 30 mm. Positioning used the EEG128 system as the template. The optode arrangement and channel locations are shown in Figure 2. Referring to previous studies, the regions of interest (ROI, region of interest) in this study were the left and right TPJ, corresponding respectively to channels 6, 8 and 16, 18. Because the two conversation tasks in the simple scenario and the complex scenario were non-timed tasks, marks were entered manually, with separate markings made at the beginning and end of each task.

Figure 2. Experimental procedure and optode arrangement

Visible labels in the figure: Practice experiment; Rest for 1 minute; Simple task; Complex task; Rest for 1 minute; Formal experiment.

3.4 Hyperscanning Data Processing

Data analysis was conducted in the MATLAB 2013b operating environment. First, the signals were preprocessed: channels with oversaturated light intensity in the data were removed; the raw light-intensity data of each channel were converted into optical-density data; and motion artifacts in the raw signals were removed using spline interpolation (Scholkmann et al. 2010). A 0.005–0.50 Hz band-pass filter was used for processing, in order to avoid signal interference caused by physiological signals such as heartbeat and respiration. According to the modified Beer–Lambert law, the relative changes in the optical-density data of each channel were converted into relative changes in hemoglobin concentration. Because oxygenated hemoglobin has a better signal-to-noise ratio and is more sensitive to experimental conditions (Pinti et al. 2020), subsequent analyses used only the oxygenated-hemoglobin data. The wavelet coherence analysis package in the MATLAB statistical software package was used to calculate inter-brain synchronization activity (IBS values) for the two conversation tasks. For the selection of the frequency band of interest, with reference to other recent studies on interpersonal interaction, a relatively broad frequency band that can avoid global physiological signals was selected (0.01–0.2 Hz). Because the durations of the two conversation conditions were different, the IBS values within the two conversation tasks were averaged.

Table 1. Brain regions corresponding to channels

Hemisphere	Channel No.	Emitter	Receiver	Brain region	MNI coordinates X	MNI coordinates Y	MNI coordinates Z	Probability
Right hemisphere	1	1	1	Posterior inferior frontal region	64	8	6	59.93%
Right hemisphere	2	1	2	Inferior central region	69	-4	25	92.70%
Right hemisphere	3	2	1	Middle temporal gyrus	70	-8	-12	100.00%
Right hemisphere	4	2	2	Superior temporal gyrus	72	-20	8	78.48%
Right hemisphere	5	2	3	Middle temporal gyrus	72	-36	-9	56.92%
Right hemisphere	6	3	2	Supramarginal gyrus	71	-34	29	42.50%
Right hemisphere	7	3	3	Superior temporal gyrus	69	-50	11	50.00%
Right hemisphere	8	3	4	Angular gyrus	62	-62	28	63.21%
Right hemisphere	9	4	3	Fusiform gyrus	64	-61	-5	100.00%

Hemisphere	Channel No.	Emitter	Receiver	Brain region	MNI coordinates X	MNI coordinates Y	MNI coordinates Z	Probability
Right hemisphere	10	4	4	Third visual cortex	56	-75	12	44.09%

Hemisphere	Channel No.	Emitter	Receiver	Brain region	MNI coordinate X	MNI coordinate Y	MNI coordinate Z	Probability
Left hemisphere	11	5	5	Posterior inferior frontal region	-62	8	6	60.93%
Left hemisphere	12	5	6	Inferior central region	-66	-3	24	87.94%
Left hemisphere	13	6	5	Middle temporal gyrus	-68	-7	-14	100.00%
Left hemisphere	14	6	6	Superior temporal gyrus	-70	-20	5	65.08%
Left hemisphere	15	6	7	Middle temporal gyrus	-71	-34	-11	57.37%
Left hemisphere	16	7	6	Supramarginal gyrus	-69	-33	27	17.90%

Hemisphere	Channel No.	Emitter	Receiver	Brain region	MNI coordinate X	MNI coordinate Y	MNI coordinate Z	Probability
Left hemisphere	17	7	7	Superior temporal gyrus	-69	-48	8	48.10%
Left hemisphere	18	7	8	Angular gyrus	-61	-62	27	62.02%
Left hemisphere	19	8	7	Fusiform gyrus	-64	-60	-6	99.31%
Left hemisphere	20	8	8	Third visual cortex	-57	-74	10	46.24%

3.5 Data Analysis Rationale

Wavelet coherence analysis was used to extract the IBS value of each ROI under each conversational condition for every dyad. The simple-scenario task was then used as the baseline, and the increase in IBS under the complex-task condition was obtained as the dependent variable. The AQ scores of each dyad were averaged and centered to serve as a continuous-variable index. Models were then built within a Bayesian inference framework and estimated using Markov Chain Monte Carlo (MCMC) sampling. Statistical inference was conducted using the Bayes Factor (BF) and the Highest Density Interval (HDI) of the posterior distribution. Data analysis and visualization were performed with Positron software (2026.03.0). The raw data and code are available at:

https://osf.io/gj83q/overview?view_only=ddbabdf2aede4cfca3385abc517c7bee.

4. Results

First, we found that in the simple scenario, all describers were able to draw the route accurately. In the complex scenario, participants were also able to complete the task, but there were clearly more correction marks. Second, a Bayesian paired-samples T test was used to examine conversation time under the two conversational scenarios. Conversation time was longer in the complex scenario, $BF10 = 2.79 \times 10^{10}$, indicating that interlocutors needed more time to align the situation model. In addition, a correlation test was conducted between autistic traits and the time required for scenario alignment (time in the complex scenario minus time in the simple scenario), showing moderate-strength evidence supporting the absence of a relationship between autistic traits and the duration of scenario alignment, $BF10 = 0.30$. Finally, this study examined how autistic traits affected the regions of interest. Autistic traits and brain regions were entered as independent variables; model building and comparison began with the full model, and the optimal model was determined using LOO values. The final model results are shown in Table 2.

Table 2 Optimal model results

	β	Error	l-89%HDI	u-89%HDI	Rhat	Bulk_ESS	Tail_ESS
Intercept	0.01	0.01	-0.01	0.02	1.00	5957	9959
AQ score	0.00	0.00	0.00	0.00	1.00	7821	10117
ROI	0.03	0.03	-0.02	0.07	1.00	2081	828
AQ×ROI	0.01	0.00	0.00	0.01	1.00	2152	551

As can be seen from the table, the 89% HDI for the IBS value in the right TPJ includes 0, and the β value is 0.00,[3] indicating that for each one-unit increase in autistic traits, there is no marked change in inter-brain synchronization between the interlocutors. In addition, inter-brain synchronization differs between the left and right TPJ regions, but the 89% HDI includes 0, and thus no stable experimental effect is observed. Finally, the 89% HDI for the interaction between brain region and AQ score does not include 0, indicating that the interaction is stable: in the right TPJ, when autistic traits increase by one unit, the interlocutors' inter-brain synchronization does not show an obvious increase or decrease; however, in the left TPJ, inter-brain synchronization shows a significant increase. This indicates that during the process of situational alignment, autistic traits affect the TPJ regions in the two hemispheres in different ways. The left panel of Figure 3 shows inter-brain synchronization in the left TPJ for participants with high autistic traits; the middle panel of Figure 3 shows inter-brain synchronization in the left TPJ for participants with low autistic traits; and the right panel of Figure 3 shows the linear relationship between autistic traits and inter-brain synchronization for the two ROIs.

Figure 3. Effects of autistic traits on inter-brain synchronization[4]

[3]The β value is very small and is displayed as 0; in fact, it is not 0.

[4]In the left and middle panels of Figure 3, the horizontal axis represents the time of data recording, the vertical axis represents frequency, and color represents the strength of inter-brain synchronization. In the left panel of Figure 3, the right-hand circle represents synchronization under the complex-situation task, and the left-hand circle represents synchronization under the simple-situation task (participants completed the simple task first and then the complex task); it can be seen that the activation level of the former is markedly higher than that of the latter. Conversely, in the middle panel of Figure 3, synchronization during the complex-situation task is lower than during the simple-situation task. The left and middle

5. Discussion

This study used fNIRS hyperscanning technology and a map task, setting up two conversational conditions—simple and complex—to isolate the independent process of situational alignment in conversation and to examine the influence of autistic traits on this alignment process. At the behavioral level, conversation time was significantly longer in the complex situation, supporting the validity of the experimental task. At the neural level, interlocutors' autistic traits positively predicted inter-brain synchronization in the left TPJ, but did not predict synchronization in the right TPJ, indicating a lateralized effect of autistic traits on situational alignment. These results provide experimental evidence for understanding the neural mechanisms by which autistic traits influence situational alignment in conversation.

5.1 Lateralized effects of autistic traits on situational alignment

In the map task, there was a systematic information gap between the director and the matcher. Completing the task under the complex condition not only required both interlocutors to accurately understand each other's verbal content, but also required them to identify and coordinate the conflicting information in their respective maps. During this process, both parties not only maintained representations of their own maps, but also needed to infer the locations of the other party' s landmarks. We believe that,

The complete process by which two interlocutors move from detecting informational conflicts to negotiating their resolution and ultimately drawing the route is, in essence, a dynamic process of forming situation alignment. It is generally believed that, in addition to brain regions related to language decoding/encoding, conversation also involves many higher-order regions associated with language and nonlanguage functions, such as the superior temporal sulcus, the TPJ region, the medial prefrontal cortex, and the dorsolateral prefrontal cortex. The TPJ regions in both hemispheres are core areas of the mentalizing system and are closely related to complex social abilities such as intention understanding and psychological theorizing (Stephens et al. 2010; Jiang et al. 2021). The results of the present study show differences in activity between the bilateral TPJ regions, indicating that, in the process of situation alignment, the influence of autistic traits shows a lateralization effect. In two nonverbal interaction studies—one involving a cooperative navigation task and the other a competitive "snake" task—the inter-brain synchrony of the right TPJ was significantly higher than that in the baseline condition, suggesting that it plays an important role in forming and monitoring shared knowledge (Zhou et al. 2023; Cao et al. 2026). Although the map task in the present study also depends on cooperation between participants, the experiment required speakers to negotiate contradictory information in the map through verbal description. Under this condition, situation alignment relies more on language-based mentalizing

panels of Figure 3 both show synchronization results for a single participant, rather than group averages.

processes. In other words, the relatively lower involvement of the right TPJ in language-dominant social interaction does not negate the role of the right TPJ in social interaction; rather, it suggests that the left and right hemispheric TPJ may show functional differentiation in situation alignment: the right TPJ serves more in understanding the intentions behind nonverbal behaviors, whereas the left TPJ is more deeply involved in constructing situation representations mediated by language.

5.2 Explanation of the Lateralization Effect of Autistic Traits

Regarding the lateralization effect of autistic traits, we propose three possible explanations. First, the lateralization effect may reflect that groups with high autistic traits invest more linguistic interaction resources in situation alignment. The left TPJ is a key brain region for language-related mentalizing processes; synchrony in this region gradually increases as conversation proceeds, and it can reflect the frequency of turn-taking between interlocutors (Nguyen et al. 2021). Studies have also found that the function of this region lies in coordinating conflicts between real events and counterfactual events in order to maintain the coherence of language processing (Van Hoeck et al. 2013; Ferguson et al. 2015; Wang & Xu 2025). In the present study, because both interlocutors held maps, situation alignment could be achieved easily at the beginning of the task; however, as the task progressed, the two sides discovered contradictions between their maps and therefore needed to revise their existing cognitive representations and reconstruct representations of the other person' s map. During this process, interlocutors had to continuously compare, through language, the differences between the other person' s map and their own map, and coordinate the route direction. For participants with higher autistic traits, their inherent cognitive style tends to rely on explicit rules and precise information, while their tolerance for ambiguity and ambiguity in linguistic descriptions is relatively low. Therefore, the increased synchrony in the left TPJ region reflects their investment of more cognitive resources in verbal communication and in coordinating the situation representations of both parties.

Second, the lateralization effect may also reflect the coordination of role relationships in the conversational task. Two hyperscanning studies examined the emergence of leadership during task solving and found that synchronous activity in both the left and right TPJ regions was closely related to leadership relationships (Jiang et al. 2015; He et al. 2023). Individuals with high autistic traits often show anxiety and avoidance in uncertain and unstructured social situations, but they can perform well, or even better, in tasks with clear structures and explicit rules. In the present study, the role division and task goals of the map task were both very clear, constituting a "highly structured social situation." Therefore, the enhanced synchrony in the left TPJ region in the high-autistic-trait conversational group indicates that, under appropriate structured conditions, they can fully leverage their advantages in systematic cognition, form corresponding role relationships, and efficiently collaborate with their partners to complete the task.

Finally, the lateralization effect may also be related to the double-empathy problem in groups with autistic traits. This theory holds that the social difficulties of autistic groups are not a one-sided "empathy deficit," but are caused by differences in experience and perception between them and typically developing individuals, resulting in

a bidirectional breakdown in understanding; when the traits of the two interacting parties are similar, this breakdown is markedly attenuated (Milton et al., 2024). Behavioral research has shown that when autistic individuals are assigned to converse with unfamiliar typically developing individuals or with other autistic individuals, autistic individuals report a stronger preference for communicating with members of their own group and disclose more personal information (Morrison et al. 2020). In hyperscanning research, the inter-brain synchrony in the left superior temporal gyrus of speakers in the high–high autism-trait group was significantly higher than that in the high–low and low–low autism-trait groups. The authors argued that this is because the social difficulties of people with autistic traits lie in differences in communication style; when the two parties have similar styles and similar traits, inter-brain synchrony is higher (Peng et al. 2024). The left superior temporal gyrus is part of the TPJ brain region and is also closely related to theory of mind and intention understanding. In the present study, the AQ scores of the speakers in each group were similar; the higher inter-brain synchrony shown by speakers with high autistic traits is therefore likely to reflect their greater ability to engage smoothly in mentalizing interaction and achieve situational alignment when interacting with similar peers.

There are two aspects of this study that could be improved. First, the experiment recorded language data from only some of the conversation groups, and no correlation analysis was conducted between linguistic alignment and inter-brain synchrony. This prevents us from further clarifying the relationship between multi-level alignment in conversation and brain activity. Future studies could recruit more participants and separately calculate linguistic indices of prosodic, lexical, and syntactic alignment, examining their respective neural bases while exploring the relationships among linguistic manifestations. Second, all participants in this study came from groups with autistic traits and were not clinically diagnosed cases. Thus, the conclusions of this study can only speak to the influence of autistic traits on situational alignment, and remain applicable only to typically developing populations. This also explains, to some extent, the finding that the time consumed by situational alignment was not affected by autistic traits. Given the relatively high demands that hyperscanning tasks place on participants' cooperation, future studies of clinically diagnosed autistic individuals should use parent–child or family/friend conversations as the experimental setting (Piazza et al. 2020), so as to avoid resistance among autistic populations to the experimental task.

6. Conclusion

According to interactive alignment theory, the establishment of situational alignment begins with low-level alignment at the linguistic level; therefore, linguistic alignment is regarded as a necessary but not sufficient condition for situational alignment. After isolating the process of pure situational alignment, the present study used hyperscanning technology and found that the influence of autistic traits on the alignment mechanism shows a lateralized effect: it primarily enhances synchrony in language-related mentalizing brain regions. Compared with previous studies, this study extends the perspective of conversational research on autistic traits and autistic populations from linguistic alignment to situational alignment, helping to provide a more comprehensive understanding of the conversational performance of this group. At the same time, interactive alignment theory is a general cognitive model proposed on the basis of cognitive science, whereas autistic traits are a typical individual factor. The significant relationship between the two revealed in this study also reflects the influence of individual factors—including personality and emotional factors—on language-processing processes.

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