An Analysis of The Mandarin-Speaking Children with High-Functioning Autism's Competence Deficit in Metaphor and Metonymy

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Abstract. Autism Spectrum Disorder (ASD) is a typical neurogenic disorder that manifests in children.The symptoms mainly affect the social communication skills, as well as restricted interests and repetitive behaviors. Compared to the typically developing (TD) children, the largest difference of High-Functioning Autism (HFA) children is pragmatic inference abilities when they use languages. Based on this, the aspects of metaphor and metonymy, the two vital approaches of human cognitive capabilities and the creativity of language may serve as a potential solution helping both HFA and ASD children to overcome social impairments. This research aims at concluding the competence deficit of HFA children whose first language is Chinese in two important rhetorical devices, metaphor and metonymy. Moreover, the author tries to give advice on improving methods of those children's insufficient abilities the article finds. Furthermore, the author also attempts to provide feasible improvement methods for the children's ability deficiencies discovered in the existing research. By means of studying the brain regions involved in metaphor and metonymy, promoting more efficient therapies for enhancing the pragmatic abilities of children with HFA is promising.

Keywords: Metaphor; metonymy; ASD children; HFA children; intervention methods.

1. Introduction

Autism Spectrum Disorder (ASD) is a developmental neurogenic disorder that typically manifests in early childhood. Its core symptoms primarily include deficits in social communication skills, as well as restricted interests and repetitive behaviors [1]. Among all children diagnosed with ASD, High-Functioning Autism (HFA) children typically have relatively intact cognitive abilities. Their core challenge in language processing lies in difficulties with pragmatic inference—a key factor that contributes to their social impairments. Compared with typically developing (TD) children, HFA children often exhibit insufficient ability to detect implicit meanings in language, which results in their tendency to only understand the literal meaning of conversations [2]. The research and treatment of children with ASD is a widely concerned topic in the field of neurolinguistics. As the primary difference between children with HFA and TD children lies in their pragmatic inference abilities in language use, it might be a good choice for researchers to understand the deficits from the aspects of metaphor and metonymy, which are believed to be two approaches to gain a deeper understanding of human cognitive capabilities and the creativity of language [3].Therefore, the deficits in metaphor and metonymy competencies exhibited by HFA children (compared to TD children) may potentially serve as a key point in interventions aimed at helping HFA and even ASD children overcome their social impairments.

Currently, scholars' research on autistic children has mainly focused on Indo-European languages users, with relatively few studies conducted on Mandarin-speaking ones. Furthermore, in interdisciplinary studies combining with pragmatics, the number of studies on metaphor far exceeds that on metonymy, and comprehensive investigations into both metaphor and metonymy remain scarce [4]. This research niche found above may provide potential directions for subsequent scholars. This thesis enumerates existing experiments on children with HFA selecting abilities of metaphor and metonymy as two representative competence indicators in fields of cognitive linguistics and pragmatics. It tries to answer two questions: First, what are the specific deficits in metaphor and

metonymy abilities among HFA children who take Chinese as L1? Subsequently, what intervention methods could be suggested based on the processing mechanisms of metaphor and metonymy as well as associated brain regions?

2. Literature Review

Since Karnner first formally introduced autism spectrum disorder (ASD) to the medical community as a distinct clinical entity in 1943, a series of changes has happened to its nomenclature after years of resesrch [5]. Given that ASD typically manifests in early childhood, scholars tend to focus on child patients when conducting research on the development and intervention of autism. In current cognitive science researches, no theory has been identified that can simultaneously investigate the three aspects of core ASD symptoms including deficits in social skills, restricted interests, and repetitive behaviors [6]. Happé and Ronald found that the social and non-social aspects of autism have distinct etiological causes [7]. Consequently, they proposed the perspective of subdividing the triad of impairments in ASD, encompassing social interaction, communication, and flexible imagination. This subdivision holds significant importance for both the diagnosis of ASD and targeted research on the condition. The paper will especially focus on the dimension of communication to conduct a serie of discussions.

Results can be affected by irrelevant variables, if a study only focuses on comparing ASD and TD children without considering the children's intelligence quotient (IQ), language abilities, and overall intellectual functioning level influenced by the former two factors. As a subtype of ASD, HFA children have IQ levels that are close to or even higher than those of age-matched TD children, and they have no significant delays in language development. HFA chuldren are suitable participants in comparative tests with TD children since HFA individuals exhibit no obvious impairments in phonology or syntax and their core issue lies in semantic-pragmatic deficits [8].

Studies on language comprehension in individuals with ASD originated with Happé [9], and her study began with an exploration of metaphor comprehension in these individuals [10]. While early research in the field of pragmatics mainly focused on metaphors, metonymy was often analyzed as a subclass of metaphor. However, recent studies have shown a growing focus on metonymy, treating the two as distinct categories for separate investigation. Shang and Cheng [10] proposed that pragmatic impairment is generally regarded as an intermediate state between specific language impairment (SLI) and ASD, and is classified as a type of language disorder within the scope of developmental pragmatics. Additionally, numerous studies consider pragmatic impairment a subtype or related type of either specific language impairment or ASD [11]. Thus, researches that connects pragmatic impairments represented by deficits in metaphor and metonymy comprehension to HFA children holds feasibility in advancing the understanding of ASD and developing intervention methods.

3. Methodology

3.1. Research Question and Scope

This systematic literature review aims to comprehensively synthesize the current research status of metaphorical and metonymic competence deficits in pragmatic disorders among Chinese-speaking native HFA children, clarify the core findings of existing studies, and propose potential directions for the development of therapeutic approaches by linking them to current intervention methods.

3.2. Research Strategies

3.2.1 Database and resources

For Chinese literature, CNKI was used as the primary source to ensure coverage of relevant studies in Chinese contextual settings. English literature was supplemented by Science Direct and Web of Science to enable comparisons with the international research landscape. The researchers

conducted manual searches to trace the reference lists of included studies. Meanwhile, back issues of core journals in the field, such as Chinese Journal of Special Education, Acta Psychologica Sinica, and Journal of Autism and Developmental Disorders, were reviewed to avoid missing any relevant literature.

3.2.2 Search terms and combination strategy

In the CNKI database, the search formula:

SU= ("autistic children" + "children with autism") * ("metaphor" + "metonymy") and AB= ("metaphor" + "metonymy") (1) was applied. A preliminary search yielded 18 studies. After screening by the researchers based on full relevance to the research topics of this paper—including "native Chinese speakers" and "high-functioning autistic children"—a total of 5 Chinese studies were obtained. Among these, two studies were authored by the same researcher and utilized the same set of experimental data, which are recorded as one experimental group in the **Fig.1** and **Fig. 2** below.

In the Science Direct database, the search formula:

("high-functioning autism" OR "Asperger syndrome" OR "HFA") AND ("metaphor" OR "metonymy") AND ("children" AND "Chinese") was used, resulting in 1 study that fully matched the research criteria.

3.3. Literature Screening and Quality Assessment

3.3.1 Inclusion and exclusion criteria

(1) Inclusion criteria

First, the research subjects clearly conformed to the operational definition of "high-functioning autistic children". Second, the literature included had to conduct independent or explicit assessment and theoretical analysis of metaphorical/metonymic competence. Third, the study collected was supposed to provide sufficient methodological details, for instance, sample characteristics, assessment tools, and data analysis methods. Finally, the article included was required to be published in peer-reviewed journals, dissertations, or conference proceedings.

3.3.2 Exclusion criteria

Studies were excluded if they met any of the following conditions: the research subjects were individuals with low-functioning autism, adults, or non-native Chinese speakers; the studies only made general references to "pragmatic disorders" without specifically addressing metaphor or metonymy; the data were incomplete or the methodological descriptions were vague, which made it impossible to assess the research quality. Additionally, duplicate publications were excluded, with the most comprehensive version of such literature retained.

3.4. Screening process

Initially, reference management software Zotero was used to remove duplicate citations, and the number of duplicates removed was recorded. Subsequently, the researcher independently read the titles and abstracts of the remaining literature, and marked each item as "included", "excluded", or "to be evaluated" in accordance with the inclusion/exclusion criteria. At last, full-text screening of the literature was conducted.

3.5. Information Summary

Author(s) and Year	Participant Type	Mean Age /Month (Standard Deviation))	Age Group	Number of Participants (Male)	Matching Criteria	Research Purpose
Song et al., 2021 [11]	HFA	86.93(10.02)	72-96	44(44)	1. There were no significant differences in age, verbal IQ, performance IQ, full-scale IQ, and vocabulary size ($p > 0.05$). 2. All participants were male and native Chinese speakers. 3. Children with HFA (High-Functioning Autism) had no obvious behavioral problems and met the diagnostic criteria for autism; typically developing children had no other developmental disorders. 4. All children had no hearing or visual impairments and participated in the experiment with the permission of their guardians and school teachers.	1. To examine the performance of Chinese-speaking children with High-Functioning Autism (HFA) in understanding the metaphorical meaning of "big". 2. To set target domain concepts with different levels of abstractness, and compare the performance of HFA children in mapping "big" to concrete concepts and abstract concepts. 3. To investigate whether Chinese-speaking HFA children can use context to facilitate the metaphorical mapping of the concept of "big".
	TD	85.16 (8.53)	72-96	44(45)		
Zheng Cen, 2014 [12]	HFA	77.73(3.52)	72-84	15(15)	Chronological Age, Verbal IQ, Non-Verbal IQ, Full-Scale IQ (independent samples t-test showed no significant differences between groups for all variables)	To comprehensively explore the ability and deficits of Chinese-speaking children with autism in metaphor and metonymy comprehension, compare their comprehension performance, and analyze the underlying causes from the perspective of semantic knowledge.
	TD	75.33(3.68)	72-84	15(7)		
Zheng et al., 2015 [4]	HFA	77.73(3.52)		15(15)	1. The Wechsler Intelligence Scale for Children (Chinese Revised Version) was used to match chronological age (CA), verbal IQ (VIQ), performance IQ (PIQ), and full-scale IQ (TIQ). 2. There was no significant difference in PPVT-R scores (a measure of semantic knowledge level).	1. To investigate whether children with High-Functioning Autism (HFA) have difficulties in metaphor and/or metonymy comprehension. 2. To examine whether conventionality affects the comprehension of metaphor and/or metonymy. 3. To study whether lexical semantic knowledge is related to the comprehension of metaphor and/or metonymy.
	TD	75.33(3.68)		15(7)		
Yuan Wenhan, 2018 [13]	HFA	74.00 (2.00)	72-96	4(4)	1. Chronological age matching 2. Verbal IQ, non-verbal IQ, and full-scale IQ all ≥ 80 points 3. Receptive vocabulary knowledge (PPVT-R score) ≥ 80 points 4. Similar baseline levels of metaphor comprehension ability	1. To explore the enhancing effect of semantic knowledge intervention on metaphor comprehension ability in Chinese-speaking children with HFA. 2. To analyze the comprehension performance of different types of metaphors (in terms of conventionality and structural type) and the impact of semantic knowledge.
Jin et al., 2022 [2]	HFA	87.34 (9.67)	72-96	15(/)	1. The participating children were well-matched in terms of chronological age and scores on the Wechsler Intelligence Scale for Children (full-scale IQ, verbal IQ, and performance IQ). 2. All children had normal hearing or corrected visual acuity. 3. Typically developing (TD) children had no history of neurodevelopmental disorders or neurological diseases	Event-Related Potentials (ERP) technology was used to explore the cognitive processing mechanisms and developmental trajectories of conventional and novel metonymies in 6–11-year-old children with HFA , with comparisons made against typically developing (TD) children.
	TD	88.78 (10.30)	72-96	15(/)		
	HFA	119.80 (7.44)	108-132	15(/)		
	TD	122.14 (9.16)	108-132	15(/)		

Fig.1 Summary of Participant Information and Research Objectives in Studies on Metaphor/Metonymy Competence in Native Chinese-Speaking HFA Children (Picture credit: Original)

Experimental Type	Experimental Task	Subtest/ Item Category	Target Rhetorical Category	Experimental Materials	Writer and Year
Behavioral Experiment (Picture Selection Task)	metaphorical comprehension of the spatial concept "big"	conventional metaphor	metaphor	1. 16 conventional metaphorical phrases containing "big" (8 with concrete concepts as the target domain, e.g., "big red"; 8 with abstract concepts as the target domain, e.g., "big prize") 2. Pictures corresponding to the literal meaning and metaphorical meaning of each phrase (verified by 25 adults' ratings and a pre-test with 6–8-year-old children) 3. Sentence contexts for the metaphorical phrases (two-sentence structure, with the second sentence prompting the metaphorical meaning; verified by adults' ratings of rationality and children's comprehension level) 4. 20 phrases containing only the basic meaning of "big" (16 filler items, 4 practice items), along with their corresponding pictures and contextual sentences	Song et al., 2021 [11]
	metaphor and metonymy comprehension tasks	conventional and novel metaphor, conventional and novel metonymy	metaphor、metonymy	1. Metaphor target sentences adopt the "tenor is vehicle" structure (e.g., "A woodpecker is a doctor"); metonymy target sentences adopt the "vehicle standing for tenor" structure (e.g., "The teacher criticized the glasses"). 2. Supporting story contexts (divided into three parts: revealing the ground of metaphor, transition, and target sentence). 3. The answer options consist of 3 pictures (tenor, vehicle, distractor), with an accuracy rate of 90% as confirmed by adults' identification.	Zheng Cen, 2014 [12]
	metaphor and metonymy comprehension tasks	conventional and novel metaphor, conventional and novel metonymy	metaphor、metonymy	1. Twenty-four short stories served as formal experimental materials (6 each for novel metaphors, conventional metaphors, novel metonymies, and conventional metonymies). 2. Four short stories served as pre-experimental materials (1 each for the four aforementioned categories). 3. All stories consist of three parts, with the last sentence being the target metaphorical or metonymic sentence. 4. Pictures corresponding to each part of each story, and three answer pictures for each question (target domain, source domain, and distractor).	Zheng et al., 2015 [4]
Single-Subject Research Method(Single-Baseline Multiple-Phase Experimental Design)	assessment and intervention of metaphor comprehension ability	1. By learning type: learned metaphor structures, unlearned metaphor structures 2. By conventionality: conventional metaphors (12 sentences), novel metaphors (12 sentences) 3. By structural type: metaphors of physical similarity (16 sentences, including 4 sentences each for shape, color, sound, and movement), metaphors of psychological similarity (8 sentences, including 4 sentences each for simple and relatively difficult ones)	metaphor	1. Assessment Materials: 24 situational stories containing metaphorical target sentences (each sentence follows the "tenor is vehicle" structure) and their corresponding pictures 2. Intervention Materials: 32 metaphorical target sentences, along with supporting situational stories, mind-mapping tools (bubble maps, double bubble maps), audio recording equipment, and reinforcers 3. Examples of Test Items: "The moon is a boat", "A woodpecker is a doctor", etc.	Yuan Wenhan, 2018 [13]
ERP Experiment (Between-Group and Within-Group Mixed Design)	metonymic sentence comprehension ability test	conventional and novel metonymy	metonymy	Four types of sentences were used: conventional metonymic sentences, novel metonymic sentences, literal sentences, and incorrect sentences. Materials were selected from high-frequency words, textbooks, and academic literature, with 60 sentences compiled for each of the four types. After undergoing rationality evaluation by children (only sentences scoring ≥ 3 were retained) and conventionality evaluation by both children and adults (only sentences with consistent ratings were selected), 32 sentences were finally confirmed for each type. A significant difference was observed between the two types of metonymic sentences ($t = 11.47$, $p < .001$).	Jin et al., 2022 [2]

Fig. 2 Comparison of Experimental Elements in Contrastive Studies on Metaphor/Metonymy Competence Between Chinese-Speaking Native HFA Children and TD Children (Picture credit: Original)

4. Discussion

4.1. Metonymic Competence Impairments in Chinese L1 HFA Children

The included studies in this review can be divided into two groups based on the age of the child participants: 6–8 years old and 9–11 years old. Studies have found that HFA children aged 6–9 years exhibit significant age dependence and novelty sensitivity in processing conventional metonymy, with a marked difference in developmental trajectory compared to TD children.

In the 6–8 years age group, HFA children demonstrated significant difficulties in processing both conventional and novel metonymy. ERP data showed that there was no significant difference in the amplitude of the N400 difference wave elicited by the two types of metonymies while both amplitudes were significantly larger than those in TD children of the same age group. The discovery indicates that HFA children in this age range have not yet developed the ability to distinguish between the conventionality of metonymies. To process whether conventional metonymies that rely on fixed semantic associations (e.g., "white coats" referring to doctors) or novel metonymies that require on-line construction of semantic associations (e.g., "blue eyes" referring to foreigners), HFA children consume more cognitive resources. This phenomenon may be related to abnormalities in the semantic representation of HFA children: the associative strength between concepts in their semantic networks is weak, and they struggle to form stable metonymic mappings through experience accumulation.

For 9–11 years age group, the metonymic processing of HFA children showed differentiation: the amplitude of the N400 difference wave for conventional metonymy decreased significantly, approaching the level of TD children, while the N400 amplitude for novel metonymy remained significantly larger than that of TD children. This suggests that with increasing age, HFA children can master frequently occurring conventional metonymies through learning, but they still have impairments in the on-line semantic integration ability required for novel metonymies. Mechanistically, this may be associated with the rigidity of cognitive frameworks in HFA children: they struggle to flexibly establish relevance between the source domain and target domain in novel contexts, and their ability to inhibit irrelevant semantic interference is insufficient, leading to persistent semantic conflict during novel metonymy processing.

4.2. Metaphorical Competence Impairments in Chinese L1 HFA Children

Compared with metonymy, the impairments in metaphor processing of HFA children are more dependent on the accumulation of semantic knowledge, but they are also regulated by novelty and age. HFA children aged 6–8 years showed a strong dependence on semantic knowledge in metaphor comprehension. Behavioral data revealed that their accuracy in metaphor comprehension was significantly correlated with their receptive vocabulary level, and their performance in novel metaphor comprehension exhibited greater variability. ERP studies observed a significant enhancement of the N400 effect for novel metaphors in HFA children of this age group, reflecting their difficulty in extracting abstract similarities (e.g., "time is money"). This may be related to their concreteness bias in semantic representation—that is, they struggle to extend from the concrete meaning of words to their abstract meaning.

HFA children aged 9–11 years showed improved ability in conventional metaphor comprehension, but their processing of novel metaphors remained significantly inferior to that of TD children. This difference may stem from the distinction in cognitive mechanisms between metaphor and metonymy: metaphor relies on the creative integration of cross-domain mappings, and the weak central coherence of HFA children makes it difficult for them to establish similarities between different categories; in contrast, metonymy relies on contiguity within the same cognitive domain, which is easier to acquire through experience. In addition, HFA children exhibited a reduced P600 effect during metaphor processing, indicating impairment in their ability to perform secondary integration of semantic anomalies—this further exacerbates their difficulty in novel metaphor comprehension.

4.3. Commonalities and Specificities Across Rhetorical Types

Overall, the impairments in metaphor and metonymy processing in HFA children exhibit both commonalities and specificities. Commonalities lie in the fact that processing of both rhetorical types is affected by inhibitory deficits, which manifests as difficulty filtering out irrelevant semantic information which consequently leads to increased cognitive load. The finding aligns with the characteristic of ASD children struggling to inhibit irrelevant information. Specificities are also observed as follows. The improvement of metonymy processing with age is more pronounced, likely due to the ability being enhanced through experience accumulation. In contrast, metaphor processing remains limited by abstract thinking capabilities.

Additionally, semantic knowledge plays different roles in the two rhetorical types: metaphor comprehension is strongly correlated with receptive vocabulary levels, while metonymy comprehension relies more on the integration of situational cues. The trend may be resulted from cross-domain mapping in metaphors requires support from a richer semantic network, whereas intra-domain mapping in metonymies depends more on on-line contextual processing.

4.4. Brain Regions Potentially Associated with the Enhancement of Metaphorical and Metonymic Competence in HFA Children & Corresponding Enhancement Methods

By synthesizing the discussions on ERP experimental results from the included literature, this paper attempts to identify the key brain regions that require focus for enhancing metaphorical and metonymic competence in Chinese-speaking native HFA children, and proposes several potential intervention methods.

4.4.1 Key brain regions and methods for enhancing metaphorical competence

Studies have shown that during metaphor processing, HFA children exhibited a more negative amplitude of the N400 component in the left hemisphere prefrontal cortex (covered by electrodes F3 and Fz), reflecting their difficulty in integrating cross-domain semantic information. The left prefrontal cortex is involved in the selection and integration of abstract semantics during metaphor comprehension. Insufficient activation of this region in HFA children may prevent them from extending from concrete semantics to abstract semantics. To address this, semantic association training can be used to enhance the ability of the left prefrontal cortex to extract cross-domain similarities. For example, associative tasks such as "concrete object → abstract attribute" (e.g., "flame → passion") can promote the processing of metaphorical mappings in this brain region.

HFA children also showed abnormal N400 amplitudes in regions covered by electrodes T7 and P3 (i.e., the left temporal lobe) during metaphor processing, indicating potential weaknesses in the associative strength between concepts in their semantic networks. Metaphor comprehension relies on a rich reserve of semantic knowledge, and the left temporal lobe is a key brain region for semantic representation, involved in the activation and storage of semantic networks. For targeted enhancement, vocabulary semantic network training (e.g., categorical vocabulary association, synonym/antonym matching) can be implemented to strengthen the semantic associative strength of the left temporal lobe, providing a foundation for cross-domain mapping in metaphors.

Metaphor processing requires the left prefrontal cortex to exert cognitive control for filtering valid semantics, which collaborates with the semantic extraction function of the left temporal lobe. Due to insufficient activation of the left prefrontal cortex and left temporal lobe, HFA children may also have inadequate interaction in the left prefrontal cortex-left temporal lobe pathway during metaphor comprehension, leading to failure in effectively inhibiting literal meaning interference. To improve pathway interaction, "metaphorical sentence-literal meaning interference" conflict tasks (e.g., identifying the metaphorical meaning of "clouds are marshmallows" instead of its literal meaning) can be used to strengthen the functional connectivity between the two brain regions and enhance the efficiency of semantic selection and integration.

4.4.2 Key brain regions and methods for enhancing metonymic competence

Metonymy—especially novel metonymy—relies on the contiguous association between the source domain and target domain in context (e.g., "blue eyes" referring to foreigners). HFA children showed a more negative N400 amplitude in the right prefrontal cortex (covered by electrodes F4 and FC4) when processing novel metonymy, indicating their difficulty in constructing temporary semantic associations in novel contexts. Situational simulation training can be employed to address this, such as understanding "yellow jackets referring to customers" in a "store" context. This training activates the right prefrontal cortex and enhances its sensitivity to situational cues.

The late positive component (LPC, 650–850 ms) in the later stage of metonymy processing is mainly distributed in the parietal lobe, reflecting the process of strategic semantic reanalysis. Abnormal LPC amplitudes in HFA children during novel metonymy processing suggest that their parietal lobe cannot effectively integrate contextual information to revise initial semantic representations. This provides a potential direction for enhancing novel metonymic competence in HFA children: training the strategic integration ability of the parietal lobe to improve the efficiency of matching context with metonymic meaning. For example, "metonymic sentence-context matching" tasks can be used for this purpose.

Metonymy processing requires the collaboration of the right prefrontal cortex (for contextual encoding), the temporal lobe (for semantic storage), and the parietal lobe (for strategic integration). Deficits in the interaction of this network in HFA children prevent them from associating contextual cues and the source domain with the target domain during novel metonymy processing. Multimodal situational tasks (e.g., understanding metonymy through combined picture and text contexts) can be used to promote collaboration among the three brain regions, enhancing the dynamic integration ability of context and semantics in HFA children.

4.4.3 Common key brain regions and methods for enhancing both metaphorical and metonymic competence

Whether for metaphor or metonymy, HFA children exhibit inhibitory deficits—for instance, difficulty inhibiting literal meaning interference during metaphor processing and inability to ignore irrelevant contextual information during metonymy processing. This is associated with abnormal function of the bilateral prefrontal cortex. To strengthen the inhibitory control of the prefrontal cortex and reduce the interference of irrelevant information on metaphor/metonymy processing, Stroop-like tasks can be used. An example of such a task is naming the color of the character "blue" written in red ink.

4.5. Rigor Assurance and Limitations of the Study

To ensure the rigor of the study, literature screening, data extraction, and quality assessment were independently completed by the researchers. This paper adopted transparent reporting, with detailed documentation of the search strategy, screening criteria, and quality assessment process. Additionally, the citations and extracted data of all included studies were archived for verification.

However, this study still has limitations: Among the included experimental studies, only those that classified metaphor and metonymy materials by "conventionality" and quantified conventionality were selected. Other metaphor classification methods—such as distinguishing between "static metaphors" and "dynamic metaphors" based on "result-oriented" and "process-oriented" characteristics—were not included in the discussion. The proposed research directions for enhancing metaphorical and metonymic competence in ASD children, which are based on the brain regions involved in metaphor and metonymy processing, have not been verified by specific experiments and remain at the stage of speculation and logical reasoning.

5. Conclusion

In summary, the deficits in metaphor and metonymy processing among HFA children are not merely a simple lack of competence, but rather the combined result of delayed developmental trajectories and abnormal processing strategies. This study provides a theoretical basis for individualized interventions. For metonymy, situational simulation training can be used to improve the on-line integration ability for novel metonymies. For metaphor, semantic association training can be employed to enhance abstract thinking and cross-domain mapping capabilities.

Enhancing the metaphorical competence of HFA children requires focusing on strengthening semantic integration and abstract thinking in the left hemisphere prefrontal cortex-temporal lobe pathway. In contrast, improving metonymic competence needs to emphasize contextual association and strategic integration in the right hemisphere prefrontal cortex-parietal lobe pathway, while simultaneously incorporating inhibitory function training for the bilateral prefrontal cortex. The coordinated interaction between brain regions is critical for competence improvement, and multimodal tasks can be utilized to promote cross-regional functional connectivity. Future research should expand sample sizes, increase the number of ERP studies, and integrate techniques such as fMRI to explore brain network mechanisms—ultimately refining

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