

Pragmatics in children with autism spectrum disorder

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Abstract: Pragmatics examines how context influences language meaning, with a focus on implied meanings and social factors that impact communication. Children with autism spectrum disorder (ASD) face significant challenges in pragmatic skills, attributed to factors such as structural language deficits, theory of mind, executive function, comorbidities of ASD and parental pragmatic skills, which impact their social interactions and conflict resolution. They may exhibit behavioural responses similar to typically developing (TD) children while performing a pragmatic task. Still, their neural mechanism differs, particularly in the medial prefrontal cortex, temporal regions, temporal lobe, central parietal regions, limbic networks, and Default Mode Network (DMN). These deficits are often assessed using tools like the Children's Communication Checklist-2, Test of Pragmatic Language and neuroimaging, particularly Magnetic Resonance Imaging (MRI). It is of paramount importance to understand pragmatic impairment in children with ASD to provide appropriate interventions. This review aims to give an overview of the pragmatics in children with ASD, which can provide a foundation to comprehend their pragmatic challenges better and guide the development of targeted interventions to improve their social interactions and language skills.

Keywords: Pragmatics; Autism spectrum disorder (ASD); Neuro modalities; Social interaction

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1.0 INTRODUCTION

Pragmatics roots back to ancient Greece, Rome, and the Pre-Qin period in China, where the pragmatic questions have been consistently explored. To state some examples, the Greek philosopher Aristotle in his work *De Interpretatione* in the *Organon* has illustrated the issues in the realms of philosophy, logic, and rhetoric. Similarly, during the Pre-Qin period in ancient China, scholars focused on pragmatics by incorporating concepts from Confucianism's "Rectification of Names" and Taoism's "Nameless Thoughts" ([Niu, 2023](#)).

However, it was Charles Sanders Peirce who provided the prominent groundwork for the field of pragmatics ([Murphy & Murphy, 1990](#); [Short, 2007](#)). Inspired by Peirce, Charles Morris divided semiotics into three fields: syntactics (often referred to as syntax), semantics, and pragmatics. He described pragmatics as the relationship between signs and their interpreters ([Morris, 1938](#)). Pragmatics is a rapidly growing field in contemporary linguistics. In recent years, it has gained significant attention not only in the fields of linguistics and philosophy of language but also from

anthropologists, artificial intelligence researchers, cognitive scientists, psychologists, and semioticians ([Huang, 2007](#)).

Pragmatics is considered one of the essential aspects of communication, which studies how context (verbal and non-verbal) influences the meaning of language. It focuses on the implied meaning, not just the literal meaning, considering the social context, the backgrounds of the speakers and listeners, and the situational factors ([Norbury, 2014](#)). A study of pragmatics helps to understand how people use language in real-life situations. Additionally, it helps in understanding how social factors and individual choices influence language use, thereby contributing to effective communication ([Mey, 2006](#)). John Searle in "Speech Acts: An Essay in the Philosophy of Language" (1969) gives an example of "Can you pass the salt" to demonstrate the indirect speech act. He explains that although the direct meaning of the question is about the physical capability of passing the salt, the context is an indirect request for the listener to pass the salt ([Searle, 1969](#)).

It is acknowledged worldwide that children with autism spectrum disorder (ASD) suffer from deficits in communication and social interaction ([American Psychiatric Association, 2013](#)). More importantly, researchers have showcased that children diagnosed with ASD have pronounced impairment in pragmatic skills ([Baron-Cohen et al., 1985](#); [Geurts & Embrechts, 2008](#); [Wing et al., 2011](#); [Reindal et al., 2023](#)), which are assessed with the help of methods such as the Children's Communication Checklist-2, Targeted Observation of Pragmatics in Children's Conversations (TOPICC), and the Test of Pragmatic Language ([Phelps-Terasaki & Phelps-Gunn, 2007](#); [Adams et al., 2011](#); [Bishop, 2011](#); [Reindal et al., 2023](#)). Furthermore, the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5), issued by the American Psychiatric Association (APA), has stated the social and communication difficulties as a mandatory criterion for diagnosing ASD ([American Psychiatric Association, 2013](#)).

Pragmatics is essential for social development, and deficits in pragmatic knowledge among children with ASD can negatively impact their ability to handle social situations, resolve conflicts and communicate effectively ([Miranda et al., 2023](#)). Despite its importance, pragmatic impairments in children with ASD are under-recognised compared to structural language deficits. Therefore, it is crucial to study

pragmatic difficulties in children with ASD. This mini review aims to consolidate existing findings and provide an overview of the neural basis of pragmatics in children with ASD, then discusses the assessment methods used to evaluate pragmatic language abilities and finally explores the interventions for pragmatic deficits to have a better understanding of pragmatic challenges faced by children with ASD. The goal is to offer a clearer understanding of the pragmatic impairments in children with ASD, which would aid in more targeted clinical practices and future research.

2.0 PRAGMATIC LANGUAGE DEVELOPMENT IN CHILDREN

The pragmatic ability grows gradually under the influence of social interaction as cognitive and linguistic abilities mature in children ([Blank et al., 1979](#); [Alduais et al., 2022](#)). Pragmatic skills are developed in children even when their vocabulary and syntax are still limited ([Ingram, 1974](#); [Dore, 1975](#); [Alduais et al., 2022](#)). A case study by Blank et al. (1979) illustrated that a child with well-developed syntactic and semantic skills exhibited difficulty in appropriately using language in social contexts. To understand more about the pragmatics, it is integral first to comprehend how pragmatics is developed in children. The pragmatic language development in children with and without ASD is discussed below.

As children grow old, especially in the 18–47-month age range, the development of pragmatic skills becomes more evident, including understanding conversational norms like taking turns, staying on topic, and using language according to the situation ([Blank et al., 1979](#); [Longobardi et al., 2017](#); [Alduais et al., 2022](#)). At 12 months, infants begin to use nonverbal cues and can associate emotions with the target ([Mumme & Fernald, 2003](#); [Soussignan et al., 2018](#)). By 18 months, they can imitate others and understand the intentions of the speaker ([Meltzoff, 1995](#); [Alduais et al., 2022](#)). Between the ages of two and three, they can engage in basic conversations and start to understand the concept of taking turns in conversations ([Salomo et al., 2013](#)). When they turn four, they appreciate the social norms better and start to recognise indirect speech acts ([Alduais et al., 2022](#)). Moreover, adolescents' pragmatic skills are more refined, allowing them to participate in more sophisticated conversations, develop empathy, appreciate humour, irony, and sarcasm, and adapt their pragmatic skills to online platforms ([Bavin & Naigles, 2015](#); [Pfeifer & Berkman, 2018](#); [Branje et al., 2021](#)).

2.1 Pragmatic development in children with ASD

Children with ASD, especially those who face pragmatic problems, such as excessive use of memorised phrases without adjusting to the context and inability to follow social norms regarding communication, find it hard to communicate their desires and thoughts. Moreover, difficulties like inappropriate initiation (beginning conversations at unsuitable times or in awkward ways) and stereotyped language (repetitive or rigid speech patterns) can significantly hinder their ability to interact with peers, making socialising and forming relationships more challenging ([Miranda et al., 2023](#)). They also often face challenges such as grasping inferences ([Dennis et al., 2001](#)), understanding how tone of voice affects meaning ([Happe, 1993](#); [Andrés-Roqueta & Katsos, 2017](#)), using mental state verbs like believing, knowing, imagining, and remembering ([Tager-Flusberg, 1992](#)), and maintaining conversational coherence ([Fine et al., 1994](#); [Andrés-Roqueta & Katsos, 2017](#)).

As mentioned above, children with ASD often face challenges in pragmatic language, which can include difficulties with repetitive speech (echolalia), theory of mind, interpreting social norms, understanding non-verbal cues and conversation skills ([Kissine, 2012](#); [Au-Yeung et al., 2015](#); [Wong et al., 2022](#); [Vogindroukas et al., 2022](#); [Martin et al., 2023](#); [Yankovitz et al., 2023](#)). According to Wong et al. (2022), these children exhibit impairments in early pragmatic language skills, including difficulties understanding the listener's perspective (communicative intentions) and adjusting their communication accordingly (discourse management). While typical children recognise others' perspectives at the age of four ([Alduais et al., 2022](#)), children with ASD struggle to understand that other people's perspectives do not match theirs ([Kissine, 2012](#)). This is often referred to as "Theory of Mind" (ToM), which states that others have different thoughts, feelings, and perspectives ([Premack & Woodruff, 1978](#)).

In addition to ToM difficulties, they also suffer from social turn-taking. Social turn-taking refers to the back-and-forth engagement in a conversation. The unconventional brain activities hinder children with ASD from focusing on social information, which in turn affects joint attention ([Petinou & Minaidou, 2017](#)). It has been noted that factors such as problems in joint attention and challenges in interpreting social contexts may contribute to deficits in turn-taking ([Lee & Schertz, 2022](#); [Lee et al., 2023](#)).

Researchers have found that children with ASD comprehend irony and humour similar to typical children ([Kissine, 2012](#); [Au-Yeung et al., 2015](#); [Yankovitz](#)

[et al., 2023](#)). However, other researchers have observed that children with ASD were impaired in irony comprehension and humour compared to typically developing (TD) children, especially when it comes to ironic compliments and criticisms ([Ghaziuddin & Gerstein, 1996](#); [Wang et al., 2007](#); [Pexman et al., 2011](#); [Yankovitz et al., 2023](#)). The inability of children with ASD to understand the speaker's intention using circumstantial cues makes it difficult for them to interpret irony ([Wang et al., 2006](#)). Therefore, further research is needed to conclude the relationship between irony comprehension in children with and without ASD ([Fuchs, 2023](#)).

Besides verbal communication, research has found that children with ASD struggle with understanding non-verbal cues like body language, facial expressions, gestures, and eye contact ([Martin et al., 2023](#)). Their ability to integrate verbal and nonverbal communication seems to be impaired, which is considered to be one of the major challenges in ASD ([Vogindroukas et al., 2022](#)).

3.0 FACTORS INFLUENCING PRAGMATIC LANGUAGE DEVELOPMENT IN CHILDREN WITH ASD

3.1 Structural Language Deficits

The components of communication, such as semantics, syntax, phonology, comprehension and pragmatics, are independent of each other ([Blank et al., 1979](#)). It was found that children with ASD suffered from pragmatic impairments despite their structural language being intact and cognition being unimpaired ([McKernan & Kim, 2021](#)). Despite components of communication being distinct areas of communication, recent studies have found that structural language impairment negatively influences pragmatic ability, as deficits in syntax and vocabulary will cause reduced competence to use language effectively in social contexts ([Martin et al., 2023](#); [Reindal et al., 2023](#)).

3.2 Theory of Mind

Children with ASD suffer from pragmatic impairments, which many factors may contribute to, one of them being ToM, as they find it difficult to interpret the meaning of language, and anticipate others' motives ([Kissine, 2012](#); [Wong et al., 2022](#); [Liu et al., 2024](#)). The inability to understand the speaker's beliefs will hinder one's ability to perceive the speaker's intention and feelings, making it difficult to have an effective conversation ([Baixauli-Fortea et al., 2019](#)). Aykan and Nařacı (2018) developed a cartoon-based assessment to examine ToM using humor comprehension. They found that participants with higher autistic

characteristics cannot understand humour when ToM skills were involved. Another study suggests that children with ASD lack narrative skills that involve coherent and cohesive narration ([Kuijper et al., 2017](#)). They put forward that this deficit may be caused by ToM, as working memory and ToM are involved in many narrative skills. Interestingly, research has highlighted that this is a two-way relationship as pragmatic impairment may cause the child to have fewer chances to interact with society and thus lead to a lack of practice and improvement in ToM ([Chevallier et al., 2011](#)). Nevertheless, while ToM is a paramount factor, it does not account fully for the pragmatic impairment. Few individuals with ASD have intact ToM skills but still experience challenges with referential communication and the narrative tasks ([Baixauli-Forteza et al., 2019](#)).

3.3 Executive functions

Executive functions, including working memory, cognitive flexibility, planning, task initiation and inhibition, are crucial cognitive processes for decision-making and problem-solving ([Friedman & Sterling, 2019](#)). Impairment in executive functions may result in pragmatic difficulties ([Filipe et al., 2020](#); [Razavi et al., 2019](#)). For example, when working memory, one of the cognitive processes in executive function, is affected in an individual they might have difficulties in holding and manipulating information making it challenging to plan responses and coherent speeches as they might forget what they said, and children with ASD often have deficits in working memory, which can impact their linguistic and pragmatic skills ([Baixauli-Forteza et al., 2019](#)). It is affected in many children with ASD; however, it is not an integral marker of ASD, as some may have fully intact executive functions but still suffer from language impairment ([Weismer et al., 2018](#); [Friedman & Sterling, 2019](#)). Friedman and Sterling's review paper has underscored how the executive functions are affected in children with ASD. They stated that a shortfall of cognitive flexibility (or shifting), inhibition, and working memory show inconsistencies, as studies have showcased mixed results depending on factors such as ages of the participants, nature of tasks (verbal and nonverbal).

A study by Filipe et al. ([2020](#)) examined European Portuguese-speaking children with high-functional autism (HFA) who were age-, gender- and non-verbal intelligence-matched with TD children. They utilised the Pragmatic Protocol to assess pragmatic skills and the Behaviour Rating Inventory of Executive Function (BRIEF) - Parent form to measure executive functions. The analysis indicated that the children with HFA had

poor pragmatic and executive functions when compared to TD children. It was also revealed that pragmatic skills and executive functions are positively correlated (i.e. higher pragmatics skills scores are related to higher executive function scores). Therefore, they concluded that problems with executive functions can lead to difficulties in pragmatics. A positive relationship between executive function and pragmatic skills in children with ASD was also observed in a study by Razavi et al. ([2019](#)), which involved administering the BRIEF and the Children's Communication Checklist to the participants.

3.4 Comorbidities of ASD

In 2008, it was discovered that the majority of children with ASD, aged ten to fourteen, suffer from at least one comorbid disorder such as social anxiety disorder, epilepsy or attention-deficit/hyperactivity disorder ([Simonoff et al., 2008](#)). Many studies have been conducted to correlate pragmatic skills with comorbid disorders. For instance, a study by Davis et al. ([2011](#)) has examined the relationship between ASD and anxiety. They observed that anxiety decreases as communication deficits increase in children with ASD. Comorbidities such as anxiety or behavioural issues can cause issues in emotional regulation, which will in turn make it difficult for the children to engage with their surroundings effectively, thereby impairing their pragmatic skills ([Factor et al., 2019](#)). In parallel lines, when children with ASD have hearing difficulties, they will suffer from increased communication issues, thus worsening their pragmatic impairments ([Liu et al., 2024](#)).

Similarly, Baixauli-Forteza et al. ([2019](#)) tested children with ASD for their pragmatic skills using the Children's Communication Checklist - 2 assessment. They concluded that children with attention-deficit/hyperactivity disorder (ADHD), which is one of the most common comorbid conditions in ASD ([Simonoff et al., 2008](#)), have pragmatic disabilities which can be related to their attention problems. They observed that pragmatic scores decreased with an increase in attention deficits, which indicates elicited pragmatic deficits. Likewise, epilepsy, being a comorbid condition in children with ASD, can also affect the pragmatic skills of children with ASD as they experience difficulties in accurately interpreting speech. This directly contributes to challenges in discriminating speech sounds, identifying speech patterns, and comprehending words, ultimately impeding their ability to maintain effective social interactions ([Liu et al., 2024](#)).

3.5 Impact of parental pragmatic skills

The social environment shapes communication. In other words, social and cultural norms significantly influence how individuals communicate, the forms of language available to them, and how others perceive them (Mey, 2006). Numerous studies have focused on the relationship between pragmatic skills of parents and their children with ASD and have established that parents of children with ASD showcased higher rates of pragmatic violation when compared to parents of TD children and children with Down syndrome (Landa et al., 1992; Losh et al., 2008; Stern et al., 2017).

Stern et al. (2017) aimed to study the pragmatics of mothers with ASD and non-ASD language delay (LD) in their children. The child's language skills were assessed using the Preschool Language Scales, Fourth Edition (PLS-4), whereas the Pragmatic Rating Scale (PRS) was used to evaluate the mother's pragmatics. They were able to find that mothers of children with ASD had higher pragmatic violations compared to the mothers of children with LD. Moreover, mothers who displayed speaking too much or going off-topic and scored lower in PRS, indicating less effective communication, had children with higher expressive language abilities in ASD. Besides, research done in 1992 has found that most of the parents of children with ASD displayed pragmatic abnormalities, which were hypothesised to be caused by a genetic component to the pragmatic deficits (Landa et al., 1992). Children with ASD who are genetically closely related to a family member who has ASD are prone to have the same pragmatic deficits that the family member with ASD possesses (Liu et al., 2024).

4.0 NEURAL BASIS OF PRAGMATICS IN CHILDREN WITH ASD

The brain activation of children with ASD differs from that of TD children in several ways. These differences have been explored in numerous studies. Children with ASD may exhibit behavioural responses similar to TD children while performing a pragmatic task. However, their neural mechanisms differ, as pragmatic skills may be impacted by unusual neural activity (Márquez-García et al., 2022). For example, in response to incongruent sentences, children with ASD displayed activation in the right inferior frontal gyrus (RIFG), a response not observed in TD children. This suggests that individuals with ASD rely on compensatory mechanisms due to increased cognitive demand (Tesink et al., 2009). Moreover, infants with ASD presented abnormal brain overgrowth during the first and second years of life, especially in cerebellar, cerebral, and limbic structures, which are involved in higher-order cognitive processes

such as pragmatics, emotion and language, with this excessive growth followed by an abnormal deceleration of cerebral areas (Petinou & Minaidou, 2017). Aberrant in self-referential processing is also detected in children with ASD in response to irony and incongruent sentences, as evidenced by reduced activity of the medial prefrontal cortex compared to TD children (Wang et al., 2006; Tesink et al., 2009).

Furthermore, neuroplasticity refers to the brain's ability to form new neural connections that facilitate learning, adaptation to new experiences, and recovery from injury (Chen et al., 2024). This process is most active during early childhood, and although it happens throughout our lives, its sensitivity decreases during adolescence and adulthood compared to infants (Li et al., 2023). An anomaly of neuroplasticity is found in children with ASD, influenced by factors like genetics, neurotransmitter imbalances, neuroinflammation, and neural pathway disruptions, which affect the processing of information and social cognition, leading to inefficient social interaction (Chen et al., 2024).

Meanwhile, a recent functional magnetic resonance imaging (fMRI) study has explored the difference in functional connectivity of children with and without ASD who were made to watch videos on the Request speech act, for example, the speaker asking "May I get you something" to the partner, in a conversation. The fMRI results revealed irregular patterns of brain connectivity in the ASD group, particularly in somatomotor and limbic networks of the left hemisphere, which are integral for processing of emotion, motor and social cognition, in contrast to the integrated and efficient neural connectivity in TD children (Márquez-García et al., 2024). Likewise, the Default Mode Network (DMN) involved in ToM and self-referential processing has been shown to have atypical structural and functional networks in children with ASD. For example, they exhibit elevated cortical thickness in the posterior cingulate cortex and the ventral medial prefrontal cortex and increased connectivity within the core areas of the DMN (Padmanabhan et al., 2017). However, when it comes to functional connectivity, we could see inconsistent results regarding DMN connectivity. A study by Lynch et al. (2013) has shown an inconsistent connectivity profile among different DMN nodes. Using resting-state fMRI, they demonstrated hyperactivity in the posterior cingulate and temporal lobes, especially the medial and anterolateral temporal cortex. Nevertheless, they detected hypoactivity in the precuneus, visual cortex, basal ganglia, and posteromedial cortex (Lynch et al.,

2013). Additionally, the Salience/Ventral Attention network, which contributes to task switching, selective attention and monitoring errors, was noticed to have an idiosyncratic connection (Márquez-García et al., 2024). It is of utmost importance to know the neural basis of

pragmatics as it provides a foundation for assessments and interventions (Wang et al., 2006; Tesink et al., 2009; Chen et al., 2024; Márquez-García et al., 2024). Table 1 provides a summary of atypical brain activity of children with ASD.

Table 1: Overview of neural abnormalities in children with autism spectrum disorder

Reference	Neuro-modality used	Brain regions involved	Key findings
Wang et al. (2006)	fMRI	<ul style="list-style-type: none"> RIFG (increased activation) bilateral temporal regions (increased activation) medial prefrontal cortex (reduced activation) superior temporal sulcus (reduced activation) 	<ul style="list-style-type: none"> Children with ASD have difficulties employing social cues to understand the speaker's intention. Greater activation in the right IFG and bilateral temporal regions compared to TD children, as the ASD group put more effort into comprehending irony, thus utilising a compensatory strategy. Reduced activity in brain regions associated with mentalizing (such as the medial prefrontal cortex and superior temporal sulcus).
Tesink et al. (2009)	fMRI	<ul style="list-style-type: none"> RIFG (presence of activation) right vMPFC (absence of activation) 	<ul style="list-style-type: none"> RIFG was activated for speaker-incongruent sentences in children with ASD, implying a compensatory mechanism. No right vMPFC activation was observed in the ASD group, whereas decreased activity was noticed in TD children, indicating that ASD children might have irregular self-referential cognitive processing.
Lynch et al. (2013)	rs fMRI	DMN	<ul style="list-style-type: none"> Hyperactivity is observed in the posterior cingulate and temporal lobes, particularly in the medial and anterolateral temporal cortex. Hypo-activity of the praecuneus with the visual cortex, basal ganglia, and posteromedial cortex
Márquez-García et al. (2022)	ERP (P600 and N400)	<ul style="list-style-type: none"> N400 - left superior and middle temporal gyri P600 - left and right temporal lobes, left central parietal 	No significant differences in ERP between congruent and incongruent in children with ASD, whereas TD children showed differences in ERP.
Márquez-García et al. (2024)	fMRI	<ul style="list-style-type: none"> Left Somatomotor Left Limbic networks 	Irregular patterns of brain connectivity in the ASD group, particularly in somatomotor and limbic networks of the left hemisphere, in contrast to the integrated and efficient neural connectivity in TD children.

fMRI - functional magnetic resonance imaging
 rs fMRI - resting state functional magnetic resonance imaging
 ERP - event-related potential
 IFG - inferior frontal gyrus

vMPFC - ventral medial prefrontal cortex
 DMN - default mode network
 ASD - autism spectrum disorder
 TD - typically developing

5.0 ASSESSMENT OF PRAGMATIC LANGUAGE ABILITIES IN CHILDREN WITH ASD

Children with ASD may exhibit a broad spectrum of social communication problems, ranging from mild to severe; many also commonly experience pragmatic language difficulties ([Parsons et al., 2020](#); [Wong et al., 2022](#); [Vogindroukas et al., 2022](#); [Martin et al., 2023](#); [Reindal et al., 2023](#)). Proper assessment plays a significant role in the early detection of pragmatic language issues ([De La Torre Carril et al., 2021](#)). Having a proper assessment also helps clinicians or therapists better grasp the severity of the child's condition and design effective interventions that best fit the child's needs ([Cordier et al., 2019](#); [Wong et al., 2022](#)).

The most commonly employed assessment techniques in pragmatic assessment among children with ASD include behavioural observation, standardised pragmatic language tests, and assessment of understanding of pragmatic language ([Wong et al., 2022](#)). While standardised tests are the most popular instruments applied to evaluate pragmatic language in children with ASD, recent neuroimaging modalities are bringing fresh insights into how the brain of children with ASD works in terms of pragmatic language aspects ([De La Torre Carril et al., 2021](#); [Ayoub et al., 2022](#); [Wong et al., 2022](#)).

Standardised examinations have been extensively utilised to evaluate the pragmatic skills of children with ASD ([De La Torre Carril et al., 2021](#)). Several standardised assessments have been employed to assess pragmatic language competencies in children, including the Pragmatic Language Skills Inventory ([Gilliam & Miller, 2006](#)) and the Language Use Inventory ([Newcomer & Hammill, 2009](#)). Nonetheless, these standardised tests were developed earlier, and some of them have been replaced with updated or revised tests. This review focuses on two of them: the Test of Pragmatic Language (TOPL-2; [Phelps-Terasaki & Phelps-Gunn, 2007](#)) and the Children's Communication Checklist-2 (CCC-2; [Norbury & Bishop, 2005](#)).

5.1 The Children's Communication Checklist-2

The Children's Communication Checklist-2 (CCC-2) is a standardised questionnaire created by Bishop in 2003 to improve the Children's Communication Checklist, which was established earlier ([Andrés-Roqueta et al., 2021](#)). It is being used as a tool to examine multiple domains of communication, encompassing pragmatics, semantics, and morphology among children between the ages of 4 and 7 years old, specifically those with ASD

([Sharda et al., 2016](#); [Bahrami & Fekar-Gharamaleki, 2021](#); [Liu et al., 2024](#)).

The test comprises 70 items and typically takes around 15 minutes to complete ([Andrés-Roqueta et al., 2021](#)). It must be filled out by parents or adults who know the children well and have regularly interacted with them with a minimum of three to four days per week ([Andrés-Roqueta et al., 2021](#); [De La Torre Carril et al., 2021](#)). The adults will mainly provide information about the language and communication characteristics that they observed when their child was involved in different situations of conversation ([Norbury & Bishop, 2005](#)).

Importantly, the CCC-2 has been proposed to be an effective test in measuring pragmatic language ability in children with ASD, and some studies reported that the results correlate with formal diagnoses ([De La Torre Carril et al., 2021](#); [Dolata et al., 2022](#)). Aside from ASD, CCC-2 demonstrates usefulness in determining pragmatic language abilities across other neurodevelopmental disorders such as attention deficit hyperactivity disorder, Down syndrome, and developmental language disorder ([Dadgar et al., 2019](#); [de la Torre Carril & Pérez-Pereira, 2019](#); [Ferrara et al., 2020](#); [Andrés-Roqueta et al., 2021](#)). However, there have been reports of limitations regarding the psychometric qualities and clinical applicability of the CCC-2 ([Wellnitz et al., 2021](#)). Meanwhile, CCC-2 is a parent report instrument, which may be more subjective and sometimes might lead to bias having occurred ([Afreen, 2022](#); [Liu et al., 2024](#)). The validity of the CCC-2 primarily applies to children in Western countries, and to date, no validation has been conducted in Asian countries ([De La Torre Carril et al., 2021](#)).

5.2 Test of Pragmatic Language

The Test of Pragmatic Language, or TOPL-2 for short, was developed by Diana and Trisha Phelps to assess children's social communication skills along with detecting pragmatic language issues, particularly children with ASD or other developmental language disorders ([Phelps-Terasaki & Phelps-Gunn, 2007](#); [Wong et al., 2022](#); [Liu et al., 2024](#)). It stands out as a specialised tool that not only could assess general communication aspects but also as a tool for detailed examination of pragmatic language ([Arani et al., 2019](#)). Generally, the age of the children determines the number of items that need to be assessed in the TOPL-2. For example, children aged 8 to 18 require evaluation with 43 items, while those aged 6 to 7 need to be tested with 17 ([Caldwell, 2017](#)).

The TOPL-2 usually takes 45 minutes to 1 hour to complete and was created to be administered by professionals such as clinical psychologists and speech therapists ([Alduais et al., 2023](#)). It is administered individually and comes with a series of manuals, test pictures, questionnaires, and responses ([Phelps-Terasaki & Phelps-Gunn, 2007](#); [Arani et al., 2019](#)). The assessment started by displaying and telling a simple story about the picture from the picture book that relates an everyday social context to the child ([Arani et al., 2019](#)). Following this, the child is requested to interpret the situation based on the picture ([Arani et al., 2019](#)). The administrator will provide a correct (1 point) or wrong (0 point) score to the child's response (ability to generate a socially suitable response) based on item grading requirements ([Phelps-Terasaki & Phelps-Gunn, 2007](#); [Loukusa et al., 2018](#)).

Despite the promising advantage of TOPL-2, prior research has shown that TOPL-2 is not precise enough to detect children's pragmatic language and that appropriate grading of the children's answers requires ongoing interaction between the administrator and the children ([Lavi, 2016](#); [Loukusa et al., 2018](#); [Afreeen, 2022](#)). Furthermore, the TOPL-2 test does not provide an overview of functional details about pragmatic skills, making it difficult for clinicians and therapists to develop appropriate intervention or treatment goals for the children ([Bahrami & Fekar-Gharamaleki, 2021](#)).

6.0 NEUROIMAGING MODALITIES

Aside from standardised testing and semi-structured behavioural observations, neuroimaging techniques have been employed progressively to assess the neural correlates of pragmatic language abilities in children with ASD ([Kim et al., 2018](#); [Márquez-García et al., 2024](#); [Qian et al., 2024](#); [Simeoli et al., 2024](#)). Increasing evidence shows that conducting neuroimaging can reliably assess the neurological foundations of autistic and non-autistic brains, including structural and functional variations in the brain ([Ayoub et al., 2022](#)). So far, a substantial number of neuroimaging techniques, such as magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI), have been used to assess the pragmatic language ability of children with ASD ([Kim et al., 2018](#); [Márquez-García et al., 2024](#); [Qian et al., 2024](#)).

Functional magnetic resonance imaging (fMRI) is a neuroimaging technique that measures neural activity by detecting changes in blood oxygenation levels without the need for a contrast agent while they are thinking or executing a particular task ([Liu et al., 2021](#);

[Yen et al., 2023](#)). A recent study by Márquez-García et al. ([2024](#)) combines fMRI with video recording to investigate how children with ASD process pragmatically related language differently from children without ASD or other neurodevelopmental disorders. In the experiment, participants are required to watch 18 sets of video clips, where half of which have a semantic component (naming the objects), and the other half focuses on a pragmatic component (requesting the objects). While the participants watched the clips, their neural activity was monitored using fMRI on a 3 Tesla MRI scanner with a 32-channel head coil. The findings indicate that children with and without ASD exhibit differences in terms of the way they process pragmatics and other related languages. Meanwhile, it was also presented that children with ASD displayed different patterns of neural connectivity, specifically higher levels of idiosyncratic connectivity, during pragmatic language tasks when compared to children who are not diagnosed with ASD, which may further explain why children with autism have difficulty comprehending social cues during communication. Overall, as compared to fixed images or brief sentences, video stimuli are effective tools to be incorporated together with neuroimaging techniques, as they provide realistic representations of daily social communication, which is essential for comprehending how children with ASD use or understand pragmatic language in daily contexts ([Kotila et al., 2020](#)). Similar results from previous studies suggest that viewing films as an experimental stimulus lessens head movements and enhances attention during fMRI scanning ([Bolton et al., 2020](#); [Kotila et al., 2020](#)).

Furthermore, Kim et al. ([2018](#)) employed fMRI, using a 3 Tesla MRI scanner, to investigate the brain processes linked to pragmatic language understanding in autistic children while they performed a social language task, the Korean Autism Social Language Task (KASLAT). KASLAT is a tool that uses Korean idioms to evaluate pragmatic skills. During the experiment, the participants were presented with three distinct tasks: neutral (presented with dictionary-defined sentences and corresponding pictures), matched (presented with an idiom and a corresponding picture), and mismatched (presented with idioms and unmatched pictures). The participants were told to choose either the "First Button" if the picture and sentence corresponded or the "Second Button" if they did not. Essentially, the findings highlighted that when completing the social language task, children with autism demonstrated distinct patterns of neural activity, particularly in the right inferior frontal gyrus, and were less accurate at

understanding and interpreting idioms than children without autism.

Magnetic Resonance Imaging (MRI) is a noninvasive technique that creates high-resolution structural and functional images of the brain ([Schielen et al., 2024](#)). It is one of the promising tools that is being used in the research involving children and adolescents with ASD due to the high spatial resolution image produced, as well as it does not require the use of a contrast or radiation agent ([Ismail et al., 2016](#); [Stogiannos et al., 2022](#); [Pizzolorusso et al., 2023](#)). Interestingly, recent research has combined diffusion tensor imaging (DTI), a type of MRI, with machine learning to evaluate the pragmatic language skills of autistic and typically developing children ([Qian et al., 2024](#)). From the perspective of the autistic research area, machine learning refers to a way of training a computer to recognise a complex pattern of data, which may then be used as a biomarker in the early detection, diagnosis, and prediction of autism ([Simeoli et al., 2024](#)). In the Qian et al. (2024) study, the brain scanning of children was obtained when the children were in sedation. The obtained data were then processed and combined with machine learning to identify the children's pragmatic language ability. The results showed that compared to children without autism, children with autism had fewer connections in distinct brain areas.

Additionally, it was shown that children with autism exhibited aberrant connections in the frontal lobes, temporal lobes, and white matter connection pathways, which might further underline the pragmatic language difficulties observed in children with autism. With this, the application of MRI, utilising cutting-edge technology, yielded important insights into the differences in brain network connections and how these impact the pragmatic language skills of autistic children. This technique may assist future clinicians in identifying autistic children at risk for pragmatic language issues early, allowing for earlier access to therapies.

Despite the promising results, the existing research has a common limitation, which is that small sample sizes are being recruited in most of the research. For example, only 16 autistic children were included in the study by Márquez-García et al. (2024); 15 autistic children, on average 10 years old, were recruited for the Kim et al. (2018) study, and 92 autistic preschoolers were recruited for the Qian et al. (2024) study. The obtained sample size from the studies is insufficient to fully reflect the entire population, which might further cause sampling bias ([Rødgaard et al., 2022](#)). Meanwhile,

although the use of response pads ([Kim et al., 2018](#)) and video stimuli ([Márquez-García et al., 2024](#)) can reduce head movement, there is still a chance that children with autism who have trouble staying still will move their heads, which could affect the findings and assessment data ([Stogiannos et al., 2023](#)). With this, future research could consider increasing the number of participants recruited and providing pre-training to the children to prevent sensory overload or even anxiety ([Stogiannos et al., 2023](#)).

7.0 PRAGMATIC LANGUAGE INTERVENTIONS FOR CHILDREN WITH ASD

Children with pragmatic language difficulties sometimes struggle to express their opinions, which can negatively affect their social interactions and connection formation with others ([Miranda et al., 2023](#)). Early intervention is vital, as prior research indicates its ability to promote neuroplasticity when pragmatic interventions are employed at a young age ([Desarkar & Rajji, 2015](#); [Liu et al., 2024](#)). Earlier studies have found different interventions or approach to help children with ASD improve their pragmatic language skills ([Standiford et al., 2013](#); [Thomeer et al., 2015](#); [Sharda et al., 2018](#); [Pereira et al., 2022](#); [Marino et al., 2023](#)). This review focuses on four of them: music therapy, melodic-based communication therapy, telerehabilitation programs, and peer-mediated pragmatic language intervention. **Table 2** presents an overview of the pragmatic language intervention and its effectiveness in children with ASD.

7.1 Music intervention

Music intervention is a therapeutic approach that employs music as a treatment technique ([Burnett, 2022](#)). It has been frequently employed in both practical applications and research to enhance communication and expression in individuals with ASD ([Standiford et al., 2013](#); [Ruiz et al., 2023](#)). Previous studies indicate that children with ASD generally choose musical stimuli over verbal communication due to the challenges they have in expressing themselves ([Burnett, 2022](#); [Williams et al., 2024](#)). Sharda et al. (2018) conducted a study examining the impact of music therapy on communication and neural activation in children with ASD. During the training, the experimental group exposed the children to musical instruments, melodies, and rhythms to enhance abilities like communication, taking turns, and sensorimotor coordination. In the control group, the children engaged in an intervention that developed abilities identical to those in the experimental group but without the inclusion of musical instruments. Brain connectivity and functioning have been observed

before and after the experiment using resting-state functional magnetic resonance imaging (rsfMRI). Notably, the results indicate that, in contrast to the control group, children in the experimental group exhibited enhancements in social communication, particularly in pragmatics. Meanwhile, children in the experimental group exhibited enhanced functional connectivity between the bilateral primary auditory cortex and subcortical as well as motor areas, which is potentially linked to improvements in pragmatic language skills.

Moreover, an earlier study by Standiford et al. (2013) investigated the impact of melodic-based communication therapy on the pragmatic language skills of nonverbal children with ASD. The study comprises 12 nonverbal children with ASD who will be randomly allocated to either the melodic-based communication therapy (experimental group) or the control group. During the 5-week intervention, participants in the experimental group (n = 7) listened to a pre-recorded set of 25 target words, which ranged from various melodies to hand-clapping rhythms, and included singing and verbal articulation of the words. In the control group (n=5), participants utilised the same target words and stimuli as the experimental group throughout the training. However, the intervention in the control group involved the child imitating nouns and verbs from the therapist, followed by independent naming of the words. The findings demonstrated that pragmatic language scores improved for children in the experimental group, whereas no improvement was observed in the control group. Taken together, this indicated that melodic-based communication therapy might effectively enhance the pragmatic language in children with ASD.

7.2 Behavioural intervention

Behaviour-based intervention is primarily concerned with the reduction of inappropriate behaviours in an individual (Scott et al., 2023). Research indicates that interventions aimed at behaviour-based interventions effectively enhance communication in children with ASD (Paul, 2008; Li et al., 2023). The research conducted by Marino et al. (2023) involved children aged 8–13 years (n=16) in evaluating the effectiveness of a telerehabilitation program in improving social-pragmatic skills in children with ASD. Before the trial, qualified individuals will be randomly allocated to either the web-based intervention group (experimental group) or the conventional intervention group (control group). Both groups will participate in identical interventions, commencing with video training, followed by role-

playing and a discussion on the feasibility of applying the session to their daily life. However, the sole distinction between these two groups is in their location; the experimental group will participate online through video conferencing, while the control group will engage in a face-to-face setting. The results indicate that the pragmatic skills improvement seen in the experimental group was nearly equivalent to that in the control group. Together, these data indicate that telerehabilitation is as effective as traditional in-person intervention in enhancing pragmatic abilities in children with ASD.

Additionally, family and peer engagement-based intervention is one of the recommended approaches that effectively guides parents and even friends to assist children with ASD in tackling and improving pragmatic language skills (Chang & Locke, 2016; Parsons et al., 2020; Zhang et al., 2022). Prior research has discovered that the quality and amount of social contact with others may impact the social development of children with ASD (Sasson et al., 2017). One of the most prominent examples of family and peer engagement-based therapies used to improve pragmatic language in children with ASD is peer-mediated pragmatic language intervention (Parsons et al., 2020).

There are substantial studies that have investigated peer-mediated pragmatic language intervention. This intervention frequently includes video-based feedback, therapist guidance, and home-based practice during social play between the peer and child with ASD (Parsons et al., 2018, 2019, 2020). A recent study by Parsons et al. (2020) recruited 71 pairings (one child with ASD and one normally developing peer) to attend 10 weekly clinic play-based interventions. Parents were also engaged in the intervention by observing play during the session, being guided by the professional on intervention principles, and providing home-based practice. Notably, the results show substantial improvements in pragmatic language among normally developing peers, with the intervention's benefits lasting for three months. Furthermore, the results were also consistent between the clinic and home situations. The findings are broadly similar to a prior study that examined the same intervention (Parsons et al., 2018, 2019). However, some frequent concerns raised by the study include the ethical problem of the intervention's possible influence on typically growing peers, as well as the possibility of not administering the intervention appropriately in home-based treatments when a professional is not available.

Table 2: Overview of pragmatic language intervention and its effectiveness in children with ASD.

Study	Intervention	Sample Size	Duration of intervention	Description of intervention	Results
Parsons et al. (2020)	Peer-mediated pragmatic language intervention	71 pairings (1 ASD child + 1 normal developing peer) Age range: 6-11 years	10 weekly clinic play-based interventions	Intervention includes video-based feedback, therapist guidance, and home-based practice during the social play between the peer and child with ASD.	Substantial improvements in pragmatic language among normally developing peers. Results show consistency between the clinic and home situations.
Sharda et al. (2018)	Music Therapy	51 children with autism Age range: 6-12 years	8-12 weeks	Experimental Group (n=26): Engaged in musical instruments, melodies, and rhythms to enhance abilities like communication, taking turns, and sensorimotor coordination. Control Group (n=25): Engaged in an intervention that developed abilities identical to those in the experimental group, but without the inclusion of musical instruments.	Compared to the control group, children in the experimental group exhibited enhancements in pragmatics. Enhanced functional connectivity between the bilateral primary auditory cortex, subcortical, and motor areas.
Standiford et al. (2013)	Melodic-based communication therapy	12 nonverbal children with ASD who did not attend any musical lessons in the past 6 months Age Range: 5-7 years	5 weeks	Experimental Group (n=7): Listened to a pre-recorded set of 25 target words, ranging from various melodies to hand-clapping rhythms, singing the words, and lastly articulating the words verbally. Control Group (n=5): The child imitating nouns and verbs from the therapist, followed by independent naming of the words utilising the same target words and stimuli as the experimental group intervention in the control group.	Pragmatic language scores were enhanced for children in the experimental group, but no improvement was observed in the control group.
Marino et al. (2023)	Telerehabilitation program	16 ASD children with no physical disabilities. Age range: 8-13 years	4 months	Both groups participate in identical interventions, commencing with video training, followed by role-playing and a discussion on the feasibility of applying the session to their daily life. Experimental Group: Participate in the intervention online through video conferencing. Control Group: Participate in the intervention in a face-to-face setting.	Telerehabilitation is as effective as traditional in-person intervention in enhancing pragmatic abilities in children with ASD.

8.0 CONCLUSIONS

In summary, this mini review provides a general overview of pragmatics in children with ASD, establishing a basis for understanding their pragmatic issues and guiding the development of targeted therapies to enhance their social interactions and language abilities. Pragmatics is viewed as a fundamental component of communication that examines how context affects the interpretation of language, emphasising implied meaning rather than only literal meaning. Researchers have demonstrated that children diagnosed with ASD exhibit significant deficits in pragmatic skills, hindering their capacity to comprehend verbal and nonverbal cues, including body language and eye contact. This impairment is influenced by structural language deficits, theory of mind, executive functioning, comorbidities of ASD and parental pragmatic skills, all of which affect their social interactions and conflict resolution abilities. Children with ASD exhibit distinct neural mechanisms during pragmatic tasks compared to typically developing children, particularly in the medial prefrontal cortex, temporal regions, default mode network, temporal lobe, central parietal regions, and limbic networks.

Conducting thorough assessments is crucial, as it aids future clinicians in early identification of autistic children at risk for pragmatic language difficulties, thereby facilitating timely access to therapies and reducing the effects of these issues for children with ASD. It can often be assessed using behavioural

observation, standardised pragmatic language tests, and neuroimaging, which have the potential to reduce these impacts for children with ASD. In the future, researchers may investigate the integration of pragmatic evaluation and intervention with neuroimaging techniques or technology-based tools like virtual reality or augmented reality to enhance the pragmatic language abilities of children with ASD.

In addition to the individual aspect, the findings of this study may benefit children with ASD who struggle with pragmatic language functioning. Researchers in the future may use the findings from this research to create new pragmatic language interventions or enhance ones that already exist for children with ASD. While doing so, it also helps to provide a possible implication for the development of the Intersectoral Global Action Plan (IGAP), which aims to foster and support the recovery of neurological disorders, including ASD ([Owolabi et al., 2023](#)).

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REFERENCES

- Adams, C., Gaile, J., Lockton, E., & Freed, J. (2011). Targeted observation of pragmatics in children's conversations (TOPICC): adapting a research tool into a clinical assessment profile. *Speech and Language Therapy in Practice*, (Spring), 7–10.
- Afreen, F. (2022). Assessment of Pragmatic Language Skills in Children. *International Journal of Indian Psychology*, 10(4), 682–696. <https://doi.org/10.25215/1004.066>
- Alduais, A., Alfadda, H., Allegretta, S., & Trivkovic, T. (2023). Pragmatic Language Impairment: A Scientometric Review. *Applied Sciences*, 13(16), 9308. <https://doi.org/10.3390/app13169308>
- Alduais, A., Al-Qaderi, I., & Alfadda, H. (2022). Pragmatic Language Development: Analysis of Mapping Knowledge Domains on How Infants and Children Become Pragmatically Competent. *Children*, 9(9), 1407. <https://doi.org/10.3390/children9091407>
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing. <https://doi.org/10.1176/appi.books.9780890425596>
- Andrés-Roqueta, C., & Katsos, N. (2017). The Contribution of Grammar, Vocabulary and Theory of Mind in Pragmatic Language Competence in Children with Autistic Spectrum Disorders. *Frontiers in Psychology*, 8, 996. <https://doi.org/10.3389/fpsyg.2017.00996>
- Andrés-Roqueta, C., Garcia-Molina, I., & Flores-Buils, R. (2021). Association between CCC-2 and Structural Language, Pragmatics, Social Cognition, and Executive Functions in Children with Developmental Language Disorder. *Children*, 8(2), 123. <https://doi.org/10.3390/children8020123>
- Arani, K. Z., Zareei, J., & Farhangdoost H. (2019). Translation and psychometric analysis of the Persian version of the "TOPL-2" in children aged 9 and 14. *Function and Disability Journal*, 2(10), 77–82. <https://doi.org/10.34171/fdj.2.10>
- Au-Yeung, S. K., Kaakinen, J. K., Liversedge, S. P., & Benson, V. (2015). Processing of Written Irony in Autism Spectrum Disorder: An Eye-Movement Study. *Autism Research*, 8(6), 749–760. <https://doi.org/10.1002/aur.1490>

- Aykan, S., & Nalçacı, E. (2018). Assessing Theory of Mind by Humor: The Humor Comprehension and Appreciation Test (ToM-HCAT). *Frontiers in Psychology, 9*, 1470. <https://doi.org/10.3389/fpsyg.2018.01470>
- Ayoub, M.J., Keegan, L., Tager-Flusberg, H., Gill, S.V. (2022). Neuroimaging Techniques as Descriptive and Diagnostic Tools for Infants at Risk for Autism Spectrum Disorder: A Systematic Review. *Brain Sciences, 12*(5), 602. <https://doi.org/10.3390/brainsci12050602>
- Bahrami, B. and Fekar-Gharamaleki, F. (2021). The Pragmatic Assessments in Children: A Narrative Review. *Journal of Research in Rehabilitation Sciences, 17*(1), 1–8. <https://doi.org/10.22122/jrrs.v17i0.3526>
- Baixauli-Fortea, I., Miranda Casas, A., Berenguer-Forner, C., Colomer-Diago, C., & Roselló-Miranda, B. (2019). Pragmatic competence of children with autism spectrum disorder. Impact of theory of mind, verbal working memory, ADHD symptoms, and structural language. *Applied Neuropsychology: Child, 8*(2), 101–112. <https://doi.org/10.1080/21622965.2017.1392861>
- Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37–46. [https://doi.org/10.1016/0010-0277\(85\)90022-8](https://doi.org/10.1016/0010-0277(85)90022-8)
- Bavin, E. L., & Naigles, L. R. (Eds.). (2015). *The Cambridge handbook of child language* (2nd ed.). Cambridge University Press.
- Bolton, T. A., Freitas, L. G., Jochaut, D., Giraud, A., & Van De Ville, D. (2020). Neural responses in autism during movie watching: Inter-individual response variability co-varies with symptomatology. *NeuroImage, 216*, 116571. <https://doi.org/10.1016/j.neuroimage.2020.116571>
- Bishop, D. V. M. (2003). *The Children's Communication Checklist-2 manual* (2nd ed.). Harcourt Assessment.
- Blank, M., Gessner, M., & Esposito, A. (1979). Language without communication: a case study. *Journal of Child Language, 6*(2), 329–352. <https://doi.org/10.1017/s0305000900002336>
- Branje, S., de Moor, E. L., Spitzer, J., & Becht, A. I. (2021). Dynamics of Identity Development in Adolescence: A Decade in Review. *Journal of Research on Adolescence, 31*(4), 908–927. <https://doi.org/10.1111/jora.12678>
- Burnett, T. (2022). *Music as a tool to help children with autism spectrum disorder develop social skills* [Master's thesis, Lesley University]. Expressive Therapies Capstone Theses. Digital Commons: Lesley University.
- Caldwell, K. E. (2017). *Assessing pragmatic language in children through a brief assessment of idiom comprehension: A pilot study* [Master's thesis, Texas Woman's University]. TWU Institutional Repository.
- Chang, Y.-C., & Locke, J. (2016). A systematic review of peer-mediated interventions for children with autism spectrum disorder. *Research in Autism Spectrum Disorders, 27*, 1–10. <https://doi.org/10.1016/j.rasd.2016.03.010>
- Chen, Z., Wang, X., Zhang, S., & Han, F. (2024). Neuroplasticity of children in autism spectrum disorder. *Frontiers in Psychiatry, 15*, 1362288. <https://doi.org/10.3389/fpsyg.2024.1362288>
- Chevallier, C., Noveck, I., Happé, F., & Wilson, D. (2011). What's in a voice? Prosody as a test case for the Theory of Mind account of autism. *Neuropsychologia, 49*(3), 507–517. <https://doi.org/10.1016/j.neuropsychologia.2010.11.042>
- Cordier, R., Munro, N., Wilkes-Gillan, S., Speyer, R., Parsons, L., & Joosten, A. (2019). Applying Item Response Theory (IRT) modeling to an observational measure of Childhood Pragmatics: The Pragmatics Observational Measure-2. *Frontiers in Psychology, 10*, 408. <https://doi.org/10.3389/fpsyg.2019.00408>
- Dadgar, H., Bakhtiyari, J., & Khatoonabadi, A. R. (2019). Communication skills among Persian children with autism spectrum disorders, attention deficit/hyperactivity disorder and learning disability. *Early Child Development and Care, 191*(13), 2037–2044. <https://doi.org/10.1080/03004430.2019.1681418>
- Davis, T. E. III, Moree, B. N., Dempsey, T., Reuther, E. T., Fodstad, J. C., Hess, J. A., Jenkins, W. S., & Matson, J. L. (2011). The relationship between autism spectrum disorders and anxiety: The moderating effect of communication. *Research in Autism Spectrum Disorders, 5*(1), 324–329. <https://doi.org/10.1016/j.rasd.2010.04.015>
- De La Torre Carril, A., Durán-Bouza, M., & Pérez-Pereira, M. (2021). Capacity of the CCC-2 to Discriminate ASD from Other Neurodevelopmental Disorders. *Children, 8*(8), 640. <https://doi.org/10.3390/children8080640>
- De La Torre Carril, A., & Pérez-Pereira, M. (2019). Pragmatic abilities in children with ASD, ADHD, Down syndrome and typical development through the Galician version of the CCC-2. *Revista De Logopedia Foniatría Y Audiología, 39*(3), 105–114. <https://doi.org/10.1016/j.rifa.2019.03.003>
- Dennis, M., Lazenby, A. L., & Lockyear, L. (2001). Inferential language in high-function children with autism. *Journal of Autism and Developmental Disorder, 31*, 47–54. <https://doi.org/10.1023/A:1005661613288>
- Desarkar, P., Rajji, T. K., Ameis, S. H., & Daskalakis, Z. J. (2015). Assessing and Stabilizing Aberrant Neuroplasticity in Autism Spectrum Disorder: The Potential Role of Transcranial Magnetic Stimulation. *Frontiers in Psychiatry, 6*, 124. <https://doi.org/10.3389/fpsyg.2015.00124>
- Dolata, J. K., Suarez, S., Calamé, B., & Fombonne, E. (2022). Pragmatic language markers of autism diagnosis and severity. *Research in Autism Spectrum Disorders, 94*, 101970. <https://doi.org/10.1016/j.rasd.2022.101970>
- Dore, J. (1975). Holophrases, speech acts and language universals. *Journal of Child Language, 2*(1), 21–40. <https://doi.org/10.1017/S0305000900000878>
- Factor, R. S., Swain, D. M., Antezana, L., Muskett, A., Gatto, A. J., Radtke, S. R., & Scarpa, A. (2019). Teaching emotion regulation to children with autism spectrum disorder: Outcomes of the Stress and Anger Management Program (STAMP). *Bulletin of the Menninger Clinic, 83*(3), 235–258. <https://doi.org/10.1521/bumc.2019.83.3.235>

- Ferrara, M., Camia, M., Cecere, V., Villata, V., Vivencio, N., Scorza, M., & Padovani, R. (2020). Language and Pragmatics across Neurodevelopmental Disorders: An investigation using the Italian version of CCC-2. *Journal of Autism and Developmental Disorders*, 50(4), 1295–1309. <https://doi.org/10.1007/s10803-019-04358-6>
- Filipe, M. G., Veloso, A., Frota, S., & Vicente, S. G. (2020). Executive functions and pragmatics in children with high-functioning autism. *Reading and Writing*, 33(4), 859–875. <https://doi.org/10.1007/s11145-019-09975-2>
- Fine, J., Bartolucci, G., Szatmari, P., & Ginsberg, G. (1994). Cohesive discourse in pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, 24, 315–329. <https://doi.org/10.1007/BF02172230>
- Friedman, L., & Sterling, A. (2019). A Review of Language, Executive Function, and Intervention in Autism Spectrum Disorder. *Seminars in Speech and Language*, 40(4), 291–304. <https://doi.org/10.1055/s-0039-1692964>
- Fuchs, J. (2023). Ironic, isn't it!? A review on irony comprehension in children and adolescents with ASD. *Research in Autism Spectrum Disorders*, 108, 102248. <https://doi.org/10.1016/j.rasd.2023.102248>
- Geurts, H. M., & Embrechts, M. (2008). Language profiles in ASD, SLI, and ADHD. *Journal of Autism and Developmental Disorders*, 38(10), 1931–1943. <https://doi.org/10.1007/s10803-008-0587-1>
- Ghaziuddin, M., & Gerstein, L. (1996). Pedantic speaking style differentiates Asperger syndrome from high-functioning autism. *Journal of Autism and Developmental Disorders*, 26(6), 585–595. <https://doi.org/10.1007/BF02172348>
- Gilliam, J. E., & Miller, L. (2006). *Pragmatic Language Skills Inventory (PLSI)* [Rating scale/manual]. PRO-ED.
- Happe, F. G. E. (1993). Communicative competence and theory of mind: A test of relevance theory. *Cognition*, 48, 101–119. [https://doi.org/10.1016/0010-0277\(93\)90026-r](https://doi.org/10.1016/0010-0277(93)90026-r)
- Huang, Y. (2007). *Pragmatics* (2nd ed.). Oxford University Press.
- Ismail, M. M., Keynton, R. S., Mostapha, M. M., ElTanboly, A. H., Casanova, M. F., Gimel'farb, G. L., & El-Baz, A. (2016). Studying Autism Spectrum Disorder with Structural and Diffusion Magnetic Resonance Imaging: A Survey. *Frontiers in Human Neuroscience*, 10, 211. <https://doi.org/10.3389/fnhum.2016.00211>
- Ingram, D. (1974, April). Stages in the development of one-word utterances. In *Proceedings of the Sixth Annual Child Language Research Forum, Stanford, CA, USA* (pp. 8-10).
- Kim, N., Choi, U., Ha, S., Lee, S. B., Song, S. H., Song, D. H., & Cheon, K. (2018). Aberrant Neural Activation Underlying Idiom Comprehension in Korean Children with High Functioning Autism Spectrum Disorder. *Yonsei Medical Journal*, 59(7), 897. <https://doi.org/10.3349/ymj.2018.59.7.897>
- Kissine, M. (2012). Pragmatics, cognitive flexibility and autism spectrum disorders. *Mind & Language*, 27(1), 1–28. <https://doi.org/10.1111/j.1468-0017.2011.01433.x>
- Kotila, A., Hyvärinen, A., Mäkinen, L., Leinonen, E., Hurtig, T., Ebeling, H., Korhonen, V., Kiviniemi, V. J., & Loukusa, S. (2020). Processing of pragmatic communication in ASD: a video-based brain imaging study. *Scientific Reports*, 10(1), 21739. <https://doi.org/10.1038/s41598-020-78874-2>
- Kuijper, S. J., Hartman, C. A., Bogaerds-Hazenberg, S. T., & Hendriks, P. (2017). Narrative production in children with autism spectrum disorder (ASD) and children with attention-deficit/hyperactivity disorder (ADHD): Similarities and differences. *Journal of Abnormal Psychology*, 126(1), 63–75. <https://doi.org/10.1037/abn0000231>
- Landa, R., Piven, J., Wzorek, M. M., Gayle, J. O., Chase, G. A., & Folstein, S. E. (1992). Social language use in parents of autistic individuals. *Psychological Medicine*, 22(1), 245–254. <https://doi.org/10.1017/s0033291700032918>
- Lavi, A. (2016). *Clinical Assessment of Pragmatics (CAPs): A validation study* [Doctoral dissertation, Loma Linda University]. Loma Linda University Electronic Theses & Dissertations.
- Lee, K., Godina, F., & Pike, D. (2023). A Social Turn-Taking, Parent Mediated Learning Intervention for a Young Child with Autism: Findings of a Pilot Telehealth Study. *Early Childhood Education Journal*, 52, 755–767. <https://doi.org/10.1007/s10643-023-01467-x>
- Lee, K., & Schertz, H. H. (2022). Association of turn-taking functions with joint attention in toddlers with autism. *Autism : the International Journal of Research and Practice*, 26(5), 1070–1081. <https://doi.org/10.1177/13623613211039945>
- Li, Y., Feng, Y., Zhong, J. et al. (2023) The Effects of Physical Activity Interventions in Children with Autism Spectrum Disorder: a Systematic Review and Network Meta-analysis. *Review Journal of Autism and Developmental Disordersee*. <https://doi.org/10.1007/s40489-023-00418-x>
- Li, Y. N., Hu, D. D., Cai, X. L., Wang, Y., Yang, C., Jiang, J., Zhang, Q. L., Tu, T., Wang, X. S., Wang, H., Tu, E., Wang, X. P., Pan, A., Yan, X. X., & Wan, L. (2023). Doublecortin-Expressing Neurons in Human Cerebral Cortex Layer II and Amygdala from Infancy to 100 Years Old. *Molecular Neurobiology*, 60(6), 3464–3485. <https://doi.org/10.1007/s12035-023-03261-7>
- Liu, M., Li, B., Hu, D. (2021). Autism Spectrum Disorder Studies Using fMRI Data and Machine Learning: A Review. *Frontiers in Neuroscience*, 15, 697870. <https://doi.org/10.3389/fnins.2021.697870>
- Liu, Y., Tian, X., Mao, H., Cheng, L., Wang, P., & Gao, Y. (2024). Research on pragmatic impairment in autistic children during the past two decades (2001-2022): hot spots and frontiers-based on CiteSpace bibliometric analysis. *Frontiers in Psychology*, 15, 1276001. <https://doi.org/10.3389/fpsyg.2024.1276001>
- Longobardi, E., Lonigro, A., Laghi, F., & O'Neill, D. K. (2017). Pragmatic language development in 18- to 47-month-old Italian children: A study with the Language Use Inventory. *First Language*, 37(3), 252–266. <https://doi.org/10.1177/0142723716689273>

- Losh, M., Childress, D., Lam, K., & Piven, J. (2008). Defining key features of the broad autism phenotype: a comparison across parents of multiple- and single-incidence autism families. *American Journal of Medical Genetics: Neuropsychiatric Genetics*, 147B(4), 424–433. <https://doi.org/10.1002/ajmg.b.30612>
- Loukusa, S., Mäkinen, L., Kuusikko-Gauffin, S., Ebeling, H., & Leinonen, E. (2018). Assessing social-pragmatic inferencing skills in children with autism spectrum disorder. *Journal of Communication Disorders*, 73, 91–105. <https://doi.org/10.1016/j.jcomdis.2018.01.006>
- Lynch, C. J., Uddin, L. Q., Supekar, K., Khouzam, A., Phillips, J., & Menon, V. (2013). Default mode network in childhood autism: posteromedial cortex heterogeneity and relationship with social deficits. *Biological Psychiatry*, 74(3), 212–219. <https://doi.org/10.1016/j.biopsych.2012.12.013>
- Marino, F., Failla, C., Bruschetta, R., Vetrano, N., Scarcella, I., Doria, G., Chilà, P., Minutoli, R., Vagni, D., Tartarisco, G., Cerasa, A., & Pioggia, G. (2023). TeleRehabilitation of Social-Pragmatic Skills in Children with Autism Spectrum Disorder: A Principal Component Analysis. *International Journal of Environmental Research and Public Health*, 20(4), 3486. <https://doi.org/10.3390/ijerph20043486>
- Márquez-García, A. V., Vakorin, V. A., Kozhemiako, N., Magnuson, J. R., Iarocci, G., Ribary, U., Moreno, S., & Doesburg, S. M. (2022). Children with autism spectrum disorder show atypical electroencephalographic response to processing contextual incongruencies. *Scientific Reports*, 12, 8948. <https://doi.org/10.1038/s41598-022-12475-z>
- Márquez-García, A. V., Vakorin, V. A., Kozhemiako, N., Iarocci, G., Moreno, S., & Doesburg, S. M. (2024). Atypical Brain Connectivity During Pragmatic and Semantic Language Processing in Children with Autism. *Brain Sciences*, 14(11), 1066. <https://doi.org/10.3390/brainsci14111066>
- Martin, G. E., Lee, M., Bicknell, K., Goodkind, A., Maltman, N., & Losh, M. (2023). A longitudinal investigation of pragmatic language across contexts in autism and related neurodevelopmental conditions. *Frontiers in Neurology*, 14, 1155691. <https://doi.org/10.3389/fneur.2023.1155691>
- McKernan, E. P., & Kim, S. H. (2021). School-entry language skills as predictors of concurrent and future academic, social, and adaptive skills in kindergarteners with ASD. *The Clinical Neuropsychologist*, 36(5), 899–920. <https://doi.org/10.1080/13854046.2021.1950211>
- Meltzoff A. N. (1995). Understanding the Intentions of Others: Re-Enactment of Intended Acts by 18-Month-Old Children. *Developmental Psychology*, 31(5), 838–850. <https://doi.org/10.1037/0012-1649.31.5.838>
- Mey, J. (2006). Pragmatics: Overview. *Encyclopedia of Language & Linguistics*, 51–62. <https://doi.org/10.1016/B0-08-044854-2/00306-0>
- Miranda, A., Berenguer, C., Baixauli, I., & Roselló, B. (2023). Childhood language skills as predictors of social, adaptive, and behavior outcomes of adolescents with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 103, 102143. <https://doi.org/10.1016/j.rasd.2023.102143>
- Morris, C. H. (1938). *Foundations of the theory of signs*. University of Chicago Press
- Mumme, D. L., & Fernald, A. (2003). The infant as onlooker: learning from emotional reactions observed in a television scenario. *Child Development*, 74(1), 221–237. <https://doi.org/10.1111/1467-8624.00532>
- Murphy, J. P., & Murphy, A. R. (1990). *Pragmatism: From Peirce to Davidson*. Westview Press.
- Newcomer, P., & Hammill, D. D. (2009). *Pragmatic Language Observation Scale*. Hammill Institute on Disabilities.
- Niu, M. (2023). The origin and development of pragmatics as a study of meaning: Semiotic perspective. *Language and Semiotic Studies*, 9(1), 54–78. <https://doi.org/10.1515/lass-2023-0002>
- Norbury C. F. (2014). Practitioner review: Social (pragmatic) communication disorder conceptualization, evidence and clinical implications. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 55(3), 204–216. <https://doi.org/10.1111/jcpp.12154>
- Norbury, C. F., & Bishop, D. V. (2005). Children’s Communication Checklist - 2: a validation study. *Travaux Neuchâtelois De Linguistique*, 42, 53–63. <https://doi.org/10.26034/tranel.2005.2625>
- Owolabi, M. O., Leonardi, M., Bassetti, C., Jaarsma, J., Hawrot, T., Mankanjuola, A. I., Dhamija, R. K., Feng, W., Straub, V., Camaradou, J., Dodick, D. W., Sunna, R., Menon, B., Wright, C., Lynch, C., Chadha, A. S., Ferretti, M. T., Dé, A., Catsman-Berrepoets, C. E., Gichu, M., ... Servadei, F. (2023). Global synergistic actions to improve brain health for human development. *Nature Reviews Neurology*, 19(6), 371–383. <https://doi.org/10.1038/s41582-023-00808-z>
- Padmanabhan, A., Lynch, C. J., Schaer, M., & Menon, V. (2017). The Default Mode Network in Autism. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, 2(6), 476–486. <https://doi.org/10.1016/j.bpsc.2017.04.004>
- Parsons, L., Cordier, R., Munro, N., & Joosten, A. (2018). The feasibility and appropriateness of a peer-to-peer, play-based intervention for improving pragmatic language in children with autism spectrum disorder. *International Journal of Speech-Language Pathology*, 21(4), 412–424. <https://doi.org/10.1080/17549507.2018.1492630>
- Parsons, L., Cordier, R., Munro, N., & Joosten, A. (2020). Peer’s pragmatic language outcomes following a peer-mediated intervention for children with autism: A randomised controlled trial. *Research in Developmental Disabilities*, 99, 103591. <https://doi.org/10.1016/j.ridd.2020.103591>

- Parsons, L., Cordier, R., Munro, N., & Joosten, A. (2019). A randomized controlled trial of a Play-Based, Peer-Mediated pragmatic language intervention for children with autism. *Frontiers in Psychology, 10*, 1960. <https://doi.org/10.3389/fpsyg.2019.01960>
- Paul, R. (2008). Interventions to improve communication in autism. *Child and Adolescent Psychiatric Clinics of North America, 17*(4), 835–856. <https://doi.org/10.1016/j.chc.2008.06.011>
- Pereira, T., Ramalho, A. M., Valente, A. R. S., Couto, P. S., & Lousada, M. (2022). The Effects of the Pragmatic Intervention Programme in Children with Autism Spectrum Disorder and Developmental Language Disorder. *Brain Sciences, 12*(12), 1640. <https://doi.org/10.3390/brainsci12121640>
- Petinou, K., & Minaidou, D. (2017). Neurobiological Bases of Autism Spectrum Disorders and Implications for Early Intervention: A Brief Overview. *Folia Phoniatrica et Logopaedica, 69*(1-2), 38–42. <https://doi.org/10.1159/000479181>
- Pexman, P. M., Rostad, K. R., McMorris, C. A., Climie, E. A., Stowkowy, J., & Glenwright, M. R. (2011). Processing of Ironic Language in Children with High-Functioning Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 41*, 1097–1112. <https://doi.org/10.1007/s10803-010-1131-7>
- Pfeifer, J. H., & Berkman, E. T. (2018). The Development of Self and Identity in Adolescence: Neural Evidence and Implications for a Value-Based Choice Perspective on Motivated Behavior. *Child Development Perspectives, 12*(3), 158–164. <https://doi.org/10.1111/cdep.12279>
- Phelps-Terasaki, D., & Phelps-Gunn, T. (2007). *Test of pragmatic language* (2nd ed.). Pro-Ed.
- Pizzolorusso, F., Paparella, M. T., Pizzolorusso, I., Masino, F., & Guglielmi, G. (2023). Magnetic Resonance Imaging in Autism Spectrum Disorders: clinical and neuroradiological phenotypes. *Acta Biomedica, 94*(2), e2023027. <https://doi.org/10.23750/abm.v94i2.13434>
- Premack, D., and Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral Brain Sciences, 1*, 515–526. <https://doi.org/10.1017/s0140525x00076512>
- Qian, L., Ding, N., Fang, H., Xiao, T., Sun, B., Gao, H., & Ke, X. (2025). Predicting pragmatic language abilities from brain structural MRI in preschool children with ASD by NBS-Predict. *European Child & Adolescent Psychiatry*. <https://doi.org/10.1007/s00787-025-02775-w>
- Razavi, F., Pourmohamadreza-Tajrishi, M., Haghgo, H., Bakhshi, E., Tavakoli, S., & Miri, M. A. (2019). Relationship between executive functions and pragmatic language in children with autism spectrum disorders. *Iranian Rehabilitation Journal, 17*(3), 225–234. <https://doi.org/10.32598/irj.17.3.225>
- Reindal, L., Nærland, T., Weidle, B., Lydersen, S., Andreassen, O. A., & Sund, A. M. (2023). Structural and Pragmatic Language Impairments in Children Evaluated for Autism Spectrum Disorder (ASD). *Journal of Autism and Developmental Disorders, 53*(2), 701–719. <https://doi.org/10.1007/s10803-020-04853-1>
- Rødgaard, E., Jensen, K., Miskowiak, K. W., & Mottron, L. (2022). Representativeness of autistic samples in studies recruiting through social media. *Autism Research, 15*(8), 1447–1456. <https://doi.org/10.1002/aur.2777>
- Ruiz, M., Groessing, A., Guran, A., Koçan, A. U., Mikus, N., Nater, U. M., Kouwer, K., Posserud, M., Salomon-Gimmon, M., Todorova, B., Wagner, I. C., Gold, C., Silani, G., & Specht, K. (2023). Music for autism: a protocol for an international randomized crossover trial on music therapy for children with autism. *Frontiers in Psychiatry, 14*, 1256771. <https://doi.org/10.3389/fpsyg.2023.1256771>
- Salomo, D., Lieven, E., & Tomasello, M. (2013). Children's ability to answer different types of questions. *Journal of Child Language, 40*(2), 469–491. <https://doi.org/10.1017/S0305000912000050>
- Sasson, N. J., Faso, D. J., Nugent, J., Lovell, S., Kennedy, D. P., & Grossman, R. B. (2017). Neurotypical peers are less willing to interact with those with autism based on thin slice judgments. *Scientific Reports, 7*. <https://doi.org/10.1038/srep40700>
- Schielen, S. J. C., Pilmeyer, J., Aldenkamp, A. P., & Zinger, S. (2024). The diagnosis of ASD with MRI: a systematic review and meta-analysis. *Translational Psychiatry, 14*(1), 318. <https://doi.org/10.1038/s41398-024-03024-5>
- Scott, H. K., Jain, A., & Cogburn, M. (2023, July 10). *Behavior modification*. In *StatPearls* [Internet]. StatPearls Publishing. Treasure Island, FL. <https://www.ncbi.nlm.nih.gov/books/NBK459285/>
- Searle, J. R. (1969). *Speech acts: An essay in the philosophy of language*. Cambridge University Press
- Sharda, M., Foster, N. E., Tryfon, A., Doyle-Thomas, K. A., Ouimet, T., Anagnostou, E., Evans, A. C., Zwaigenbaum, L., Lerch, J. P., Lewis, J. D., & Hyde, K. L. (2016). Language Ability Predicts Cortical Structure and Covariance in Boys with Autism Spectrum Disorder. *Cerebral Cortex, 27*(3), 1849–1862. <https://doi.org/10.1093/cercor/bhw024>
- Sharda, M., Tuerk, C., Chowdhury, R., Jamey, K., Foster, N., Custo-Blanch, M., Tan, M., Nadig, A., & Hyde, K. (2018). Music improves social communication and auditory–motor connectivity in children with autism. *Translational Psychiatry, 8*(1). <https://doi.org/10.1038/s41398-018-0287-3>
- Short, T. L. (2007). *Peirce's theory of signs*. Cambridge University Press.
- Simeoli, R., Rega, A., Cerasuolo, M., Nappo, R., & Marocco, D. (2024). Using Machine Learning for Motion Analysis to Early Detect Autism Spectrum Disorder: A Systematic Review. *Review Journal of Autism and Developmental Disorders*. <https://doi.org/10.1007/s40489-024-00435-4>

- Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child and Adolescent Psychiatry*, 47(8), 921–929. <https://doi.org/10.1097/CHI.0b013e318179964f>
- Soussignan, R., Dollion, N., Schaal, B., Durand, K., Reissland, N., & Baudouin, J. Y. (2018). Mimicking emotions: how 3-12-month-old infants use the facial expressions and eyes of a model. *Cognition & Emotion*, 32(4), 827–842. <https://doi.org/10.1080/02699931.2017.1359015>
- Sandiford, G. A., Mainess, K. J., & Daher, N. S. (2013). Improving pragmatics in nonverbal children with autism using melodic based communication therapy. *Autism-Open Access*, 3(3). <https://doi.org/10.4172/2165-7890.1000116>
- Stern, Y. S., Maltman, N., & Roberts, M. Y. (2017). The Influence of Maternal Pragmatics on the Language Skills of Children with Autism. *Journal of Developmental and Behavioral Pediatrics*, 38(5), 339–344. <https://doi.org/10.1097/DBP.0000000000000445>
- Stogiannos, N., Carlier, S., Harvey-Lloyd, J. M., Brammer, A., Nugent, B., Cleaver, K., McNulty, J. P., dos Reis, C. S., & Malamateniou, C. (2022). A systematic review of person-centred adjustments to facilitate magnetic resonance imaging for autistic patients without the use of sedation or anaesthesia. *Autism*, 26(4), 782–797. <https://doi.org/10.1177/13623613211065542>
- Stogiannos, N., Pavlopoulou, G., Papadopoulos, C., Walsh, G., Potts, B., Moqbel, S., Gkaravella, A., McNulty, J., Simcock, C., Gaigg, S., Bowler, D., Marais, K., Cleaver, K., Lloyd, J. H., Reis, C. S. D., & Malamateniou, C. (2023). Strategies to improve the magnetic resonance imaging experience for autistic individuals: a cross-sectional study exploring parents and carers' experiences. *BMC Health Services Research*, 23(1). <https://doi.org/10.1186/s12913-023-10333-w>
- Tager-Flusberg, H. (1992). Autistic children's talk about psychological states: Deficits in the early acquisition of a theory of mind. *Child Development*, 63, 161–172. <https://doi.org/10.2307/1130910>
- Tesink, C. M. J. Y., Buitelaar, J. K., Petersson, K. M., van der Gaag, R. J., Kan, C. C., Tendolkar, I., & Hagoort, P. (2009). Neural correlates of pragmatic language comprehension in autism spectrum disorders. *Brain*, 132(7), 1941–1952. <https://doi.org/10.1093/brain/awp103>
- Thomeer, M. L., Smith, R. A., Lopata, C., Volker, M. A., Lipinski, A. M., Rodgers, J. D., McDonald, C. A., & Lee, G. K. (2015). Randomized Controlled Trial of Mind Reading and In Vivo Rehearsal for High-Functioning Children with ASD. *Journal of Autism and Developmental Disorders*, 45(7), 2115–2127. <https://doi.org/10.1007/s10803-015-2374-0>
- Vogindroukas, I., Stankova, M., Chelas, E. N., & Proedrou, A. (2022). Language and Speech Characteristics in Autism. *Neuropsychiatric Disease and Treatment*, 18, 2367–2377. <https://doi.org/10.2147/NDT.S331987>
- Wang, A. T., Lee, S. S., Sigman, M., & Dapretto, M. (2006). Neural basis of irony comprehension in children with autism: the role of prosody and context. *Brain: A Journal of Neurology*, 129(4), 932–943. <https://doi.org/10.1093/brain/awl032>
- Wang, A. T., Lee, S. S., Sigman, M., & Dapretto, M. (2007). Reading affect in the face and voice: neural correlates of interpreting communicative intent in children and adolescents with autism spectrum disorders. *Archives of General Psychiatry*, 64(6), 698–708. <https://doi.org/10.1001/archpsyc.64.6.698>
- Weismer, S. E., Kaushanskaya, M., Larson, C., Mathée, J., & Bolt, D. (2018). Executive Function Skills in School-Age Children with Autism Spectrum Disorder: Association With Language Abilities. *Journal of Speech, Language, and Hearing Research*, 61(11), 2641–2658. https://doi.org/10.1044/2018_JSLHR-L-RSAUT-18-0026
- Wellnitz, S. a. C., Kästel, I., Vllasaliu, L., Cholemkery, H., Freitag, C. M., & Bast, N. (2021). The Revised Children's Communication Checklist-2 (CCC-R): Factor Structure and Psychometric Evaluation. *Autism Research*, 14(4), 759–772. <https://doi.org/10.1002/aur.2467>
- Wing, L., Gould, J., & Gillberg, C. (2011). Autism spectrum disorders in the DSM-V: better or worse than the DSM-IV? *Research in Developmental Disabilities*, 32(2), 768–773. <https://doi.org/10.1016/j.ridd.2010.11.003>
- Williams, N. R., Hurt-Thaut, C., Brian, J., Tremblay, L., Pranjic, M., Teich, J., Tan, M., Kowaleski, J., & Thaut, M. (2024). Improved motor skills in autistic children after three weeks of neurologic music therapy via telehealth: a pilot study. *Frontiers in Psychology*, 15, 1355942. <https://doi.org/10.3389/fpsyg.2024.1355942>
- Wong, K. H. Y., Lee, K. Y. S., Tse, S. C. Y., Yu, W. S., Ng, I. H., Tong, M. C. F., & Law, T. (2022). Comparing Early Pragmatics in Typically Developing Children and Children with Neurodevelopmental Disorders. *Journal of Autism and Developmental Disorders*, 52(9), 3825–3839. <https://doi.org/10.1007/s10803-021-05261-9>
- Yankovitz, B. E., Kasirer, A., & Mashal, N. (2023). The Relationship between Semantic Joke and Idiom Comprehension in Adolescents with Autism Spectrum Disorder. *Brain Sciences*, 13(6), 935. <https://doi.org/10.3390/brainsci13060935>
- Yen, C., Lin, C. L., & Chiang, M. C. (2023). Exploring the Frontiers of Neuroimaging: A Review of Recent Advances in Understanding Brain Functioning and Disorders. *Life*, 13(7), 1472. <https://doi.org/10.3390/life13071472>
- Zhang, B., Liang, S., Chen, J., Chen, L., Chen, W., Tu, S., Hu, L., Jin, H., & Chu, L. (2022). Effectiveness of peer-mediated intervention on social skills for children with autism spectrum disorder: a randomized controlled trial. *Translational Pediatrics*, 11(5), 663–675. <https://doi.org/10.21037/tp-22-110>