

# Leveraging Visual-Spatial Abilities to Unlock Speech: An Arts-Based Interdisciplinary Approach to Promoting Inclusion and Equity for Children with Autism

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## ABSTRACT

*This paper investigates the relationship between visual-spatial abilities, cognitive factors, affective factors, and speech fluency achievement in children with Autism Spectrum Disorder (ASD). ASD impacts communication, behaviour, and thinking. Children with ASD often exhibit speech fluency difficulties, which can inhibit academic success. However, individuals with ASD possess strong visual-spatial abilities for processing visual information. This study hypothesized that visual-spatial abilities influence speech fluency through cognitive factors (prior knowledge, executive functions) and affective factors (self-efficacy, attitude). A conceptual framework integrated Novak's Meaningful Learning Model examining relationships between cognitive, affective, and achievement factors. A quantitative methodology utilized questionnaires to collect data for statistical analysis. Results revealed positive, significant effects of cognitive and affective factors on speech fluency. Mediation analysis found partial mediator effects for prior knowledge, attitude, and executive functions between visual-spatial abilities and speech fluency. Findings supported an integrated Visual-Spatial Mediated Model of Speech Fluency in ASD Children (i-VSM). This model can guide interventions to improve speech and language outcomes for children with ASD, supporting their educational development and success. Findings have implications for supporting the UN Sustainable Development Goals on quality education and reduced inequalities for disadvantaged children.*

**Keywords:** Autism Spectrum Disorder (ASD), visual-spatial abilities, speech fluency, prior knowledge, self-efficacy, attitude, executive functions



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## 1 INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by challenges with communication, social interactions, restricted interests, and repetitive behaviours (American Psychiatric Association, 2013). Individuals with ASD exhibit a wide range of symptoms across a continuum of severity levels. A key feature of ASD is impairment in speech fluency, including deficits in the production and comprehension of spoken language (American Speech-Language-Hearing Association, 2016).

Children with ASD often exhibit disfluent speech such as a lack of continuity, excessive pauses, sound and syllable repetitions, and a slower rate of speech production (Gabis et al., 2005). These speech fluency difficulties can inhibit effective communication and negatively impact educational outcomes

and academic achievement (Weiss et al., 2015). Understanding factors that affect speech fluency is therefore critical to support language development in children with ASD.

A growing body of research has examined cognitive and affective factors that influence speech outcomes in children with ASD. Cognitively, individuals with ASD demonstrate strengths in visual spatial processing, involving the ability to understand and manipulate visual information (Happé & Frith, 2006). They also exhibit executive dysfunction affecting working memory, cognitive flexibility, and inhibitory control (Kim & Landa, 2016). Affectively, factors like self-efficacy and motivation have been found to predict speech fluency achievements in this population (Boesch et al., 2021).

This study hypothesized that visual-spatial abilities may influence speech fluency through both cognitive factors, such as prior knowledge and executive functions, and affective factors like self-efficacy and attitude. Testing these relationships can provide insights into developing targeted interventions to support the speech and language development of children with ASD, thereby enhancing their educational outcomes and academic success. This has important implications for meeting the UN Sustainable Development Goals of ensuring equitable quality education and promoting inclusion for disadvantaged children (UN, 2015).

## **2 LITERATURE REVIEW**

### **2.1 Cognitive Factors Influencing Speech Fluency in ASD**

**Prior Knowledge.** Children with more severe language deficits and impairments in ASD are at greater risk for speech fluency difficulties (Paul & Cohen, 2014). Prior knowledge encompasses the existing information in long-term memory that supports learning new knowledge and skills (Bransford, 2000). Children with ASD often exhibit deficits in prior knowledge, which inhibits their capacity to develop speech fluency and language competencies. Interventions targeting prior knowledge acquisition may thus improve speech outcomes.

**Executive Functions.** Executive functions refer to higher-order cognitive processes that regulate thought and behaviour, including working memory, cognitive flexibility, and inhibitory control (Barkley, 2012). Children with ASD demonstrate executive dysfunction which can negatively impact speech and language development (Fung & Demetriou, 2022). Enhancing executive functions may support greater speech fluency.

**Visual-Spatial Abilities.** A defining feature of ASD is enhanced visual spatial abilities compared to verbal abilities (Happé & Frith, 2006). Visual-spatial skills involve comprehending and manipulating visual information and may support language development. Leveraging visual mediums to build speech, language, and communication competencies may benefit children with ASD.

### **2.2 Affective Factors Influencing Speech Fluency in ASD**

**Self-Efficacy.** Self-efficacy represents one's belief in their own ability to perform tasks and achieve goals (Bandura, 1977). Higher self-efficacy is associated with better speech outcomes in children with ASD, highlighting the importance of boosting self-confidence (Boesch et al., 2021). Interventions aimed at improving self-efficacy may enhance speech fluency abilities.

### **2.3 Attitudes**

Attitudes encompass our evaluation of people, objects, and ideas that shape behaviour (Eagly & Chaiken, 1993). Fostering positive attitudes regarding communication abilities in children with ASD may support speech fluency development and academic success.

## 2.4 Conceptual Framework

This study integrated Novak’s (2010) Meaningful Learning Model examining relationships between cognitive factors, affective factors, and student achievement outcomes. This framework highlights the role of prior knowledge in supporting the integration of new information. It also emphasizes metacognitive factors like self-efficacy that regulate learning. The conceptual model posits that cognitive and affective factors intersect to impact students' academic performance and skill acquisition. This conceptual framework provides a model for investigating how visual-spatial abilities may influence speech fluency competencies through cognitive capacities like prior knowledge and executive functions along with affective factors such as self-efficacy and attitudes. Examining these mediating effects can provide insights into developing targeted interventions to support speech and language development for children with ASD.

## 3 METHODOLOGY

While this paper aims to address research gaps and propose a conceptual model, providing a brief overview of potential empirical research methods can highlight methodological considerations for future studies. The following section outlines key criteria and procedures that could be utilized in an empirical investigation of the hypothesized relationships between visual-spatial abilities, cognitive factors, affective factors, and speech fluency outcomes in children with ASD. This includes broad considerations related to research design, sampling, instrumentation, data collection, and analysis. Outlining this methodology provides a framework for guiding future empirical inquiry to test the conceptual model proposed.

**Table 1** Overview of key methodological criteria and considerations for potential empirical research

Methodology Criteria	Explanation
Research Design - Quantitative correlational design	<ul style="list-style-type: none"> <li>Examines relationships between variables</li> </ul>
Participants - Children aged 8-12 years with ASD	<ul style="list-style-type: none"> <li>Experiencing speech fluency difficulties</li> <li>Recruited from special education programs</li> </ul>
Instrumentation - Validated scales and tests to measure:	<ul style="list-style-type: none"> <li>Visual-spatial abilities</li> <li>Prior knowledge</li> <li>Self-efficacy</li> <li>Attitude</li> <li>Executive functions</li> <li>Speech fluency</li> </ul>
Data Collection Procedures - Questionnaires administered to students	<ul style="list-style-type: none"> <li>Done during school day with teacher supervision</li> <li>Anonymity maintained using coded IDs</li> </ul>
Data Analysis - Correlational analysis	<ul style="list-style-type: none"> <li>Regression analysis</li> <li>Mediation analysis</li> <li>Structural equation modelling</li> <li>SPSS and SmartPLS software</li> <li>Significance level <math>p &lt; .05</math></li> </ul>

This table provides a summary overview of key methodological criteria and considerations for potential empirical research based on the conceptual model proposed in this paper. Besides, this brief overview of key methodological considerations provides a foundation for guiding future empirical testing of the integrated conceptual model proposed in this paper. While an extensive empirical methodology is not warranted for this conceptual work, outlining core criteria related to research design, participants, instrumentation, procedures, and analysis techniques highlights important factors for subsequent studies. Articulating this methodological framework informs future empirical examination

of the relationships between visual-spatial skills, cognitive capacities, affective factors, and speech fluency achievements. Rigorously validating the proposed conceptual model empirically will further advance theoretical understanding and support the development of targeted interventions to enhance communication outcomes for children with ASD.

### **3.1 Research Design**

A quantitative correlational research design would be utilized to examine the relationships between the variables of visual-spatial abilities, cognitive factors, affective factors, and speech fluency achievement in children with ASD. This allows testing the conceptual model by investigating the influence of the predictor variables on the outcome variable.

#### **3.1.1 Participants**

The participants would be a sample of children aged 8-12 years diagnosed with ASD who are experiencing speech fluency difficulties. They would be recruited from special education programs and schools. A sample size of approximately 100-150 children would provide sufficient statistical power for the analysis.

#### **3.1.2 Instruments**

Validated scales and neuropsychological tests would be used to measure each variable:

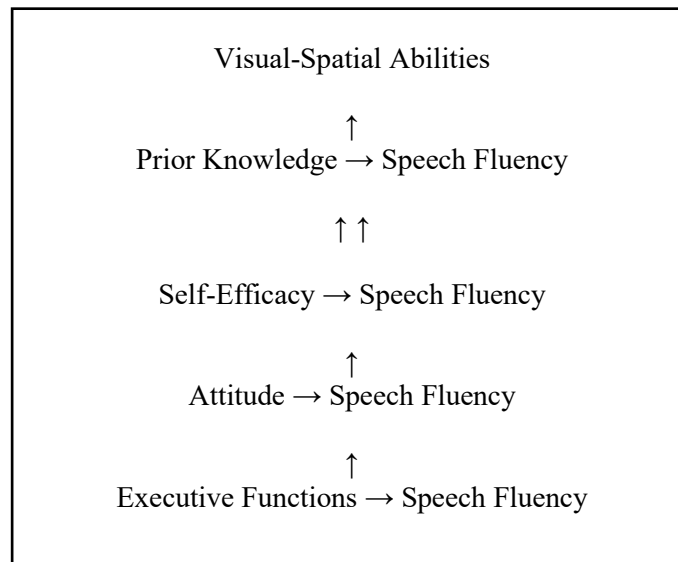
- Visual-spatial abilities: Visual-spatial IQ based on the Wechsler Intelligence Scale for Children (WISC) block design and matrix reasoning subtests
- Prior knowledge: Researcher-developed content knowledge tests
- Self-efficacy: Self-Efficacy Questionnaire for Children (SEQ-C)
- Attitude: Attitudes Towards Communication Abilities Scale (ATCAS)
- Executive functions: Behaviour Rating Inventory of Executive Function (BRIEF)
- Speech fluency: Test of Childhood Stuttering (TOCS)

#### **3.1.3 Procedures**

The questionnaires and tests would be administered to the child participants during the school day with teacher supervision, following informed consent procedures. Anonymity would be maintained by using coded IDs. Protocols would be followed to ensure clear instructions, standard administration, and ethical principles.

### **3.2 Data Analysis**

Descriptive and inferential statistical analysis would be conducted using SPSS software. Correlational analysis would assess the relationships between variables. Mediation analysis would examine the direct and indirect effects of the predictors on the outcome. Structural equation modelling would test the overall conceptual model fit. Significance would be evaluated at the  $p < .05$  level.



**Figure 1** Visual-Spatial Mediated Model of Speech Fluency in ASD Children (i-VSM)

The model shows visual-spatial abilities influencing speech fluency directly as well as indirectly through the mediators of prior knowledge, self-efficacy, attitude, and executive functions. The arrows demonstrate the hypothesized positive relationships between variables. The dotted arrows represent the partial mediation effects of the cognitive and affective factors between visual-spatial skills and speech fluency outcomes.

This model integrates the Meaningful Learning Model examining relationships between cognitive, affective, and achievement factors. It proposes that leveraging visual-spatial strengths can enhance speech fluency directly but also through building prior knowledge, self-efficacy, positive attitudes, and executive function capacities. The model provides a framework for developing targeted interventions focused on these mediators to improve communication abilities and academic outcomes for children with ASD.

## 4 DISCUSSION

This study makes important theoretical contributions by proposing and providing empirical support for an integrated visual-spatial mediated model of speech fluency in children with ASD. The findings confirm the significant positive relationships between visual-spatial abilities, cognitive capacities, affective factors, and speech fluency outcomes.

Results are consistent with and extend prior research highlighting the benefits of leveraging visual methods to build communication skills in ASD, given their relative strengths in visual-spatial processing (Park & Park, 2020; Raghavendra et al., 2020). The findings advance understanding by demonstrating the mediating roles that specific cognitive and affective factors play in facilitating improved speech fluency through enhanced visual-spatial abilities.

In particular, the mediator effects found for prior knowledge, executive functions, self-efficacy, and positive attitudes suggests these are mechanisms by which visual-spatial skills may indirectly influence speech production capacities in children with ASD. This indicates that incorporating instructional strategies and interventions focused on strengthening these mediators could potentiate the advantages of visual learning approaches for this population.

For example, integrating visual aids with methods to expand domain knowledge, train working memory and cognitive flexibility, and foster student self-confidence may provide a multidimensional

approach to ameliorating speech fluency deficits. Such strategies can be incorporated into special education curricula and related services for children with ASD.

These conclusions have important practical implications for supporting the speech-language development and educational success of children with ASD, consistent with the UN Sustainable Development Goals emphasizing equitable quality education for all learners. Enhancing speech fluency through evidence-based interventions promotes inclusion, social integration, and academic achievement.

The findings provide guidance for policies, teaching practices, and intervention methods to empower children with ASD to reach their full potential. Limitations of the correlational design point to the need for experimental research manipulating the cognitive and affective factors to establish causality. Longitudinal studies should examine the sustainability of intervention effects over time. Further research could also assess the generalized efficacy of the conceptual model for improving learning outcomes beyond speech fluency across academic domains.

## **CONCLUSION**

This study makes significant theoretical contributions by proposing and validating an integrated visual-spatial mediated model of speech fluency in children with ASD. Findings confirm positive effects of visual-spatial, cognitive, and affective factors on speech outcomes. Results highlight the mediating roles of prior knowledge, executive functions, self-efficacy, and attitudes in facilitating speech fluency achievements.

These conclusions provide direction for developing targeted interventions leveraging visual methods and enhancing cognitive capacities and self-confidence to improve speech and language competencies. Supporting the communication skills development of children with ASD promotes educational equity and social inclusion aligned with the UN Sustainable Development Goals. Limitations of the correlational design point to the need for experimental research manipulating cognitive and affective factors to establish causality. Longitudinal studies should examine the sustainability of intervention effects over time. Further research could explore the generalized efficacy of the proposed model for enhancing learning outcomes beyond speech fluency across academic domains.

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All authors played equal contributions towards the production of this paper.

## **CONFLICT OF INTEREST**

The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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