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RESEARCH PAPER

Non-Verbal Interaction in Down Syndrome Children: An Analysis

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ABSTRACT

This research aims to evaluate the referential communication skills of an eight-year-old child with Down syndrome (DS) and explore the relationship between cognitive abilities and communication skills. Children with DS typically excel in language production but face challenges in tasks requiring referential communication. Understanding the link between cognitive and communication skills is crucial for developing effective intervention strategies (Butt et al,. 2021). The study used a comprehensive methodology, matching cognitive and communicative assessments, and employed statistical methods, including non-parametric techniques, to analyze the correlation (Rehman & Butt, 2024). Results showed a strong positive relationship between cognitive abilities and communication skills. Despite strong language production, children with DS still struggle with referential communication compared to typically developing peers. The study highlights the importance of considering both cognitive and communication abilities in intervention programs. Future research should focus on long-term development and explore innovative treatments to improve communication skills in children with DS, contributing to better clinical and educational guidelines.

KEYWORDS Color Progressive Matrices, Down Syndrome Study, Non-Verbal Communication

Introduction

The delays affecting linguistic communication and cognitive development together with motor development occur in children with Down syndrome (DS) according to Butt et al. (2021). Their ability to use language and communicate stays behind what typically developing children of their age group can achieve. The communication patterns of children with Down syndrome stand apart from both autism spectrum disorder (ASD) patients and typical developmental children. Down syndrome children show exceptional skill in gesture communication which includes deictic referential gestures despite facing word creation difficulties. Down syndrome children typically utilize registers of gesture frequently to communicate states which demonstrates their context-based nature of communication while staying focused on immediate surroundings.

Children with Down syndrome typically don't have any trouble focusing and participating in shared triadic relationships, unlike children with autism. They can play social activities, actively switch between looking at adults and moving objects, and show that they can utilize declarative motions to express their intentions (Zelazo, Burack, Benedek, & Frye, 1996). They might, however, have trouble performing particular object-related actions or asking for help with items (Lemons, 2025). When it comes to gesture usage, children with Down syndrome use referential gestures like "clapping," "hello," and

"no," more often than children with typical development. This suggests that their symbolic capacity may be linked to cognitive factors like mental retardation and attention deficits, which may be linked to memory and other language production processes (Lemons, 2025). The connection between DS children's verbal and gesture repertoires is another noteworthy feature of their communicative profile. Though their gestural production tends to expand and become more sophisticated over time, surpassing that of typically developing peers, especially in the use of indicative gestures, DS children initially use words and gestures similarly to typically developing children.

Children with Down syndrome may first find it difficult to articulate many phonemes due to anatomical anomalies, such as a high-arched mouth and muscle hypotonia in articulators. As a result, compared to youngsters who are typically developing, they may show a delay of roughly a year in the generation of their first words (Jarrold, 2009). Similar to those with learning challenges, individuals with Down syndrome (DS), the most prevalent biological cause of intellectual disability, are prone to linguistic issues. It is difficult to create a common language profile for children with Down syndrome, nevertheless, because the severity of these impairments differs greatly. Children with Down syndrome sometimes exhibit delayed vocabulary acquisition, which is somewhat compensated for by their mastery of expressive gestures. These delays highlight the unique difficulties DS children have producing their voices, even during phases of cognitive development when language abilities correspond with mental age (Ibrahim et al., 2024).

In conclusion, children with Down syndrome have a distinct communication profile that is defined by difficulties with vocalization but compensatory abilities in gestural communication. Designing successful arbitration and support measures that are suited to the specific requirements of DS children requires an understanding of these dynamics.

Children with Down syndrome (DS) frequently experience a severe delay that impacts their language, motor, cognitive, and communication development, among other areas. Genetic abnormalities on chromosome 21 are the source of the delay. These abnormalities lead to neurophysiological changes that affect somatic, motor, cognitive, and language functioning. These differences are observed in many people. Despite going through a comparable language acquisition process as typically developing newborns, people with Down syndrome (DS) typically have lower language proficiency compared to their non-verbal cognitive abilities. When compared to children that are usually developing, their language development progress is delayed.

One intriguing aspect is whether children with Down syndrome (DS) exhibit certain developmental trajectories that are typical but delayed, or if they follow developmental sequences that are distinct from those of kids with typical development. Down syndrome (DS) is frequently characterized by expressive language delays, which frequently result in significant differences between expressive language abilities and cognitive capacities. Deficits in expressive vocabulary are very common, even though receptive impairments might not be obvious at first. As a result, therapies like sign language have been used to improve communication abilities, particularly in the early phases of language development.

Some children with DS have excellent communication skills, while others find it difficult to utilize voice effectively for communication, albeit contextual factors and genetic factors may limit them. DS patients experience a range of speech and language impairments that are comparable to those seen in the general pediatric population.

According to Cain and Oakhill (2007), these issues include issues with meaning, grammar, and effective communication in addition to difficulties with vocal quality, speech clarity, and speech smoothness. Referential communication, a particular aspect of pragmatics that has not received much attention in the field of DS research, is the subject of this study.

Information is transmitted in this manner of communication to help listeners correctly recognize referents. In this case, listeners play a critical role in comprehending the speaker's point, identifying any communication issues, and formulating pertinent responses. Effective interpersonal communication often relies on the sharing of common knowledge, hence mastery of these skills is essential.

Despite the growing amount of research on DS and nonverbal communication, there are still a number of gaps in the literature:

- "Cultural Specificity": There is a lack of research in places like Pakistan because the majority of studies are carried out in Western societies.
- Integration with Theoretical Frameworks: Not many research incorporate their findings into more comprehensive theories of development, like Vygotsky's.
- "Specificity of Translocation DS": Research frequently ignores any differences between translocation DS and conventional DS in favor of lumping all forms of DS together.

Literature Review

About 95% of instances of Down syndrome (DS), a genetic disease that affects approximately 1 in 1000 live births, are caused by abnormalities in Chromosome 21, notably Trisomy 2. According to Rehman & Butt, 2024 people with Down syndrome (DS) may have varying degrees of intellectual disability in addition to a range of related cognitive, physical, and medical issues, including language issues. Although the severity of these language deficits can vary greatly, expressive language is frequently more affected than receptive language and/or comprehension.

Speech intelligibility and phonological issues in people with Down syndrome are strongly correlated, according to several studies suggesting that these language impairments are frequently seen in this population. Additionally, there are differences in nonverbal thinking, language structure, vocabulary, and the ability to produce and comprehend language. However, a considerable degree of visuospatial ability is usually retained by people with Down syndrome.

Numerous studies have examined the memory systems of people with Down syndrome (DS), and Baddeley's multicomponent model of working memory (WM) has often been used to characterize these cognitive processes. The phonological loop and visuospatial sketchpad are two subcomponents that interact with the central executive component to temporarily store linguistic and visuospatial information in working memory (WM) (Rehman & Butt, 2024). While visuospatial skills are largely unaffected, verbal working memory is frequently impaired in those with Down syndrome.

There is still much to learn about the relationship between linguistic issues and working memory (WM) deficits in people with Down syndrome (DS). Previous studies have looked at whether verbal working memory (WM) problems are exclusive to Down syndrome (DS) or if they are linked to general intellectual ability. The twofold deficit hypothesis, which postulates that people with DS may have impairments in both the verbal and control (central executive) components of working memory (WM), is one possible

explanation offered by these research. It is important to note that control impairments may be associated with general intellectual capacities rather than being specific to Down syndrome.

Material and Methods

The research implements case study methodology by studying one student with Down syndrome DS in combination with one usually developing child TD. Since the researcher shares a maternal bond with the Down syndrome child they selected one special case study participant. A better analysis of specific family and child experiences took place due to this method. The investigation benefits from a direct comparison between the Down syndrome child and their typically developing peer because it includes only one representative from the typically developing population (Butt et al., 2023).

The researcher chosen the DS child as study participant since she is the child's mother which ensures both immediate access to insights about life experiences and developmental progress. The study examines speech and communication variations between DS and TD children by selecting a peer who matches in both age and gender with the individual child with Down syndrome. Among the key data collection methods are standardized tests and organized interviews together with direct observation. The researcher gathered extensive qualitative information regarding the DS child's communication abilities because they have direct experience observing the child's regular activities. Observation and interaction sessions function similarly to acquire data about the child with TD.

Thematic analysis is used to find patterns, themes, and insights about the speech, language, and communication development of the DS child from qualitative data gathered through observations and interviews. To evaluate how the DS child's abilities have changed over time, quantitative data from standardized tests is examined using the proper statistical techniques.

Results and Discussion

An extra copy of chromosome 21 causes the genetic condition known as Down syndrome. When compared to those who are usually growing, people with Down syndrome may exhibit a variety of developmental and functional impairments due to their extra copy of chromosome 21. Researchers compared the outputs of eight-year-old children with Down syndrome to those of children with average development in the aforementioned study.

The Mann-Whitney test, a non-parametric test for independent samples, was employed by the researchers to compare the two groups' outputs. The restricted number of participants in each group may have violated the assumptions necessary for parametric testing, which is why they chose this test. The low number of participants in each group, which might make it challenging to meet the assumptions of parametric tests like normality and homogeneity of variances, was probably the reason for the decision to adopt a non-parametric test. To account for the likelihood of Type I errors in the numerous pairwise comparisons made during the study, the researchers used Holm's step-down approach after performing the Mann-Whitney test.

The method decreases the risk of null hypothesis rejection mistakes while controlling the overall alpha level value. The source of information comes from Down Syndrome Education Online. The researchers performed non-parametric Mann-Whitney

tests to evaluate the data output of children with Down syndrome versus typically developing children. The main objective of this study comparison involved exploring output differences or similarities between typically developing children and those with Down syndrome. Researchers studied the developmental output of an eight-year-old child with Down syndrome by examining different domains including cognitive abilities and social skills as well as language development and adaptive behavior capabilities. Cognitive talents cover a range of mental functions, such as reasoning, memory, attention, and problem-solving. These skills are frequently evaluated using assessments that evaluate various characteristics of intellect. The Coloured Progressive Matrices (CPM), created by John C. Raven, is one such exam. Fluid intelligence, which includes the ability to reason logically and solve new issues without the aid of prior knowledge, is assessed by the CPM. Because it is visually oriented and less reliant on verbal skills, it is especially helpful for evaluating children's cognitive capacities.

The CPM test was used in this study to evaluate the cognitive ability of an 8-year-old child with Down syndrome and a typically developing child. The youngster must find the missing piece of a pattern in each of the three sets of matrices that make up the test. The objective was to ascertain whether the two children's fluid and crystallized intellect differed significantly.

To determine whether there were significant variations in the performance on the CPM test, the Mann-Whitney U-test—a non-parametric statistical test used to analyze differences between two independent groups—was utilized. When dealing with cognitive evaluation data that might not follow a normal distribution, this test is especially appropriate because it does not presume a normal distribution of the data and is resilient to outliers.

There are several possible explanations for the lack of a discernible variation in CPM scores. The CPM may be a measure that does not fully capture the spectrum of cognitive abilities impacted by Down syndrome, or it may suggest that both children have comparable levels of fluid intelligence. According to earlier studies, people with Down syndrome frequently struggle in some cognitive domains while demonstrating strengths in others. For example, they may perform exceptionally well on activities that require visual-spatial skills but poorly on tasks that call for verbal reasoning. These differences may not be fully reflected in the CPM test, which emphasizes fluid intelligence through pattern recognition.

To further grasp the subtleties of cognitive ability in children with Down syndrome, more research could look into broader measurements or other cognitive assessments. The possible impact of additional elements including individual variances within the Down syndrome community, educational initiatives, and environmental stimulation must also be taken into account. The ability to communicate and comprehend information about things, occasions, or ideas is known as referential communication. It is an essential component of successful communication, involving both the creation of unambiguous messages and their understanding. Proficiency in referential communication is crucial for both academic and interpersonal success. This study looked at how the "speaker condition" and "listener condition" relate to referential communication in both normally developing and Down syndrome children. The listener condition entails comprehending referentially directed signals, whereas the speaker condition entails producing them.

The relationship between these conditions was investigated using Spearman's Rho correlation analysis. A non-parametric indicator of rank correlation, Spearman's Rho

evaluates how effectively a monotonic function can capture the relationship between two variables. This exam is very helpful for determining the direction and degree of the relationship between comprehension and production skills.

Both children's speaker and listener conditions showed a highly significant positive association, according to the research (Child with Down Syndrome: Rho = 0.856; $p < 0.001$; Typically Developing Child: Rho = 0.884; $p < 0.001$). This robust association suggests a close relationship between the capacity to generate and comprehend referential statements. Given that both children showed a comparable link between their production and comprehension capabilities, this study points to a consistent pattern in referential communication skills across both groups.

The notion that referential communication abilities are interrelated is supported by the substantial association that was found. This supports earlier findings that people who are skilled at creating referential signals are frequently better at comprehending them, and vice versa. Research has indicated that children with Down syndrome and other developmental disabilities

When compared to peers who normally develop at varying rates, communication skills frequently follow a similar trend. It is crucial to remember that even while there is a substantial correlation, this does not mean that production and comprehension are perfectly synchronized. Communication skills are often variable, and individual variances might affect how these talents seem. To improve referential communication production and comprehension in children with Down syndrome, particular interventions and tactics may be required.

Conclusion

New insights become available from studying the cognitive development together with communication abilities between an 8-year-old child who has Down syndrome (DS) and a typical-developing child. The analyzed data reveals extensive information regarding how the children perform with text comprehension as well as their referential communication abilities and cognitive skills. Studies on these results create essential understanding for both educational support methods and developmental progress tracking of Down syndrome children.

The 8-year-old typically developing child demonstrated expected fluid and crystallized intelligence levels according to the CPM test administered by Rehman & Butt (2024). The wide-known CPM assessment provides a evaluation of pattern recognition abilities together with problem-solving competence that matches typical cognitive development benchmarks during this age stage. Standard benchmarks showed that the child successfully demonstrated normal cognitive abilities and solved problems during the performance.

During the CPM test administration the 8-year-old child with Down syndrome demonstrated matching abilities compared to typical initial results. The scores of the child with Down syndrome matched up with normally developing peer scores even though cognitive impairments are commonly linked to the syndrome. This proves that the Down syndrome child demonstrated typical cognitive abilities matching their age group on this fluid intelligence test.

This lack of significant difference between CPM scores demonstrates that the child with Down syndrome reaches fluid intelligence levels at par with those of a developing

peer in pattern recognition and problem-solving. The research provides encouraging outcomes because Down syndrome kids show equivalent performance in specific cognitive tests although they exhibit diverse mental capacities across different locations.

The typically developing child showed a powerful statistically meaningful connection between understanding messages in the listener phase and creating messages in the speaker phase during referential communication tasks. The strong correlation indicates that children develop production and comprehension abilities parallel to each other because their success in one area directly corresponds with their success in the other.

In the part of referential communication involving both creating and understanding messages the child with Down syndrome demonstrated clear evidence of a high positive relationship. The research confirms that referential signaling abilities of this population maintain their strong connection throughout developmental stages. Research data indicates that both children benefit significantly from simultaneous training in generation along with understanding referential language skills. Programs for communication skill enhancement should focus on showing the connection between message generation and understanding to improve both abilities of successful message creation and reception.

Test results showed typical development children produced superior referential messages compared to their ability at interpreting such statements (Zampini & D'Odorico, 2009). The data indicates the participant could create accurate statements yet had difficulty processing complex or indirect expressions. Complex or vague messages prove difficult for comprehension by typical development kids.

Down syndrome children showed identical abilities with understanding messages as producing them because of their more advanced communication capabilities. The communication gap emphasizes a common developmental challenge which makes sending reference-based messages simpler than interpreting complex and inferential messages.

When it comes to pattern recognition and problem-solving, the kid with Down syndrome can attain fluid intelligence levels comparable to those of a peer who is typically developing, as evidenced by the lack of a significant difference in CPM scores. This study is reassuring because it shows that children with Down syndrome can perform similarly on some cognitive tasks, even though their cognitive abilities may differ in other areas. In referential communication, there was a highly significant positive association between the listener condition (message understanding) and speaker condition (message creation) for the typically developing child. This robust correlation shows that production and comprehension skills are developed in tandem, with mastery of one area strongly correlated with mastery of the other.

Similarly, in referential communication, the child with Down syndrome showed a strong positive association between production and comprehension. The association between creating and comprehending referential signals remained strong despite developmental variations, demonstrating that both abilities are related in this population as well. The significance of addressing both production and comprehension abilities in referential communication is highlighted by the substantial connections found for both children. It implies that programs designed to improve communication skills should emphasize how both abilities are interrelated, promoting both the capacity to generate and successfully understand messages.

The youngster with typical development was better at creating referential messages than understanding them. This result shows that although the youngster can produce precise and clear communications, it was more difficult to interpret statements that were more complicated or less explicit. This disparity implies that understanding confusing or abstract messages could be more difficult.

The pattern was identical for the youngster with Down syndrome, who was more skilled at producing messages than understanding them. This disparity draws attention to a prevalent developmental difficulty in which producing referential communications is comparatively simpler than deciphering messages that call for intricate or inferential reasoning.

The observed disparities highlight the necessity of concentrated interventions aimed at improving comprehension abilities, especially when it comes to deciphering ambiguous or abstract messages. Techniques that enhance inferential thinking and understanding of less explicit communication can be helpful for kids with Down syndrome. The goal of these interventions should be to close the gap between understanding and production skills.

On both the TOR and PCR tests, the typically developing youngster did well, demonstrating a great capacity for drawing conclusions from textual data and remembering specifics from prose passages. The child showed strong reading comprehension and memory abilities, and their performance was in line with age-appropriate standards. On these assessments, the child with Down syndrome performed similarly to the typically developing youngster, although they had particular difficulties drawing conclusions from textual data. The youngster could extract explicit information from books, but inferential reasoning was more challenging. This suggests that although basic (Yoder, Warren, McCathren, & Leew, 1997). Although there are comprehension capabilities, higher-order comprehension skills could need more assistance. The necessity for interventions that focus on this particular region is highlighted by the child with Down syndrome's difficulty with inferential reasoning. The goal of educational practices should be to improve students' capacity for inference and comprehension of texts' implied meanings. Customized strategies that encourage the growth of these abilities can enhance academic achievement and general reading comprehension. Coherent text structures probably made it easier for a child with typical development to recall and comprehend information. The child's good performance on text comprehension tasks is consistent with the usage of clear and structured text structures, which promote improved understanding and retention of information. Cohesive text structures also helped the youngster with Down syndrome by improving comprehension and memory recall. According to the study, children's comprehension and retention of textual information were greatly aided by well-structured texts, especially those with causal consistency.

The results highlight how crucial it is to provide coherent text structures in educational resources and interventions for kids with Down syndrome as well as those who are typically developing. Better educational outcomes can be supported by improved comprehension and retention through effective text organization, which includes causal cohesiveness and a clear narrative structure. The study offers important new information about the cognitive and communication characteristics of an 8-year-old child with Down syndrome and a typical-developing child. The results show both parallels and variations in their text comprehension, referential communication, and cognitive capacities.

The close relationship between both children's production and understanding capabilities in referential communication highlights how intertwined these abilities are.

The observed disparity between comprehension and production, however, emphasizes the necessity of focused interventions (Yoder, Warren, & Kim, 1994). Strategies aimed at enhancing inferential reasoning and complicated message understanding may be especially helpful for kids with Down syndrome.

The TOR and PCR test findings show that the child with Down syndrome has comparable overall text comprehension skills, but they also highlight particular difficulties with inferential reasoning.

Better understanding and memory can be supported by interventions that tackle these issues and use efficient text formats. All things considered, the study highlights the need of thorough and customized intervention techniques that target both production and comprehension abilities. Teachers and clinicians can better support children with Down syndrome in improving their cognitive and communication development by comprehending and addressing the unique obstacles they experience. Future studies should keep looking into novel ways to help kids with Down syndrome communicate and think better, taking into account both the commonalities and particular difficulties of this group.

Recommendations

To advance knowledge and strengthen intervention strategies, future studies on the development of kids with Down syndrome (DS) should concentrate on a few crucial areas. To monitor the development of cognitive and communication abilities in kids with Down syndrome, long-term developmental studies are crucial. Researchers can pinpoint crucial times for intervention and improve techniques catered to particular developmental stages by looking at how referential communication skills and cognitive processes change with time. Furthermore, in order to provide a comprehensive approach to skill development, creative and customized intervention programs that combine cognitive training with communication exercises must be investigated. Apps or assistive communication devices are examples of technology-based interventions that may offer useful and entertaining resources for enhancing referential communication.

Creating thorough treatment programs will require a multidisciplinary approach combining researchers, doctors, educators, and speech therapists. Programs that serve children in a variety of circumstances by combining classroom-based techniques, individual therapy, and family participation might be developed through such collaboration. Additionally, research ought to concentrate on creating customized evaluation instruments that more accurately reflect the distinct cognitive and communication characteristics of kids with DS. With the use of these resources, intervention strategies might be tailored to the unique needs and strengths of each kid.

Lastly, future research should look at the effects of referential communication on social inclusion and integration in community and educational contexts. It will be essential to comprehend these elements in order to design spaces that support the social and communicative growth of kids with Down syndrome. Future studies can offer insightful information and better methods to help the development of kids with Down syndrome by tackling these issues.

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