

Research Paper

Investigating the Relationship Among Communicative Gestures and Words in Tamil-speaking Children With Down Syndrome

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ABSTRACT

Objectives: Gestural usage is one of the earliest signs of intentional communication abilities. In children with down syndrome (DS), one of the most severely compromised areas of functioning is language. In the linguistic profile of children with DS, gesture use and receptive vocabulary are relative strengths. The present study examines the relative use of types of gestures and words in children with DS. Also, this study compares that with a group of expressive language, ability-matched typically developing (TD) children. Additionally, the present research verifies the relationship between total gestures and word production by children with DS and expressive language ability-matched TD children.

Methods: In this prospective study, 30 Tamil-speaking children (15 children in the DS group and 15 children in the TD group) and their parents participated. The parents were asked to play with their children normally, as they do at home, using the set of toys given, and this session was recorded in video. Deictic gestures and words, as well as representational gestures and words, were analyzed with a specific coding scheme.

Results: The DS group used more deictic gestures (Mean±SD, 35±14.10) compared to deictic words (Mean±SD, 2.73±1.79), with a significant difference ($P<0.05$, $Z=-3.40$, $P=0.00064$). Also, children with DS used more representational words (Mean±SD, 46.13±22.63) than representational gestures (Mean±SD, 12.53±8.20), with a significant difference ($Z=-3.29$, $P=0.001$). Meanwhile, this was found to be a moderately positive correlation between overall gesture and word production in the DS group ($r_s=0.574$, $P=0.02$) and TD group ($r_s=0.558$, $P=0.03$). This study revealed no significant difference between children in the DS and TD groups regarding the use of deictic gestures and words. Additionally, there was a significant difference in the use of representative gestures ($P=0.0018$) and words ($P=0.02$) between DS and TD groups. Children in the DS group used more representational gestures compared to children in the TD group.

Discussion: Children in the DS group exhibited an association between gesture and word production during parent-child interaction, which is similar to children in the TD group. This relationship persists despite specific issues with DS children's expressive language traits. Children in the DS group used more representational gestures compared to children in the TD group to compensate for their deficits in speech and language skills.

Keywords:

Gestures, Words, Down syndrome (DS), Parent-child interaction

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Highlights

- There is a link between gestures and word production in children with down syndrome (DS), a relationship that persists despite particular difficulties with certain expressive language characteristics.
- Regarding the use of deictic words and gestures, there was no significant difference observed in the DS and typically developing (TD) groups.
- Children in the DS group used more representational gestures than children in the TD group.

Plain Language Summary

Gestures emerge before language development and have a strong relationship with it. The objective of the present study was to investigate and compare the use of gestures and words in DS and TD groups of children. This study's results indicated a link between gesture and word production in children with DS and TD. Children in the DS group used greater representational gestures than the TD group to compensate for their deficits in speech and language skills.

Introduction

One of the earliest signs of intentional communication abilities is the use of gestures [1, 2]. Gestures are categorized as deictic and representational gestures. In the first category, deictic gestures are used to denote an object of a child's interest and to draw the attention of others to it. Infants typically begin to make deictic gestures between the ages of 7 and 9 months, which include reaching, pointing, showing and giving [3]. In the second category, representational gestures serve as markers for context and denote specific semantic content (e.g. bringing the empty fist to the ear for the telephone). Representational gestures typically develop at the age of 12 months [4, 5]. Typically developing (TD) children speak their first word around the age of twelve months, and the first word-phrase combinations are formed around the age of 18 months [6]. TD children communicate through gestures before they utter their first words [7]. The gestures that TD children use to indicate or request objects precede and predict the development of equivalent words in speech [8]. With the development of their first words, children use words and gestures together to expand upon or reinforce the meaning of a word [3, 9]. Although, in TD children, there are many descriptions of the inter-relatedness between gestures and words, it is quite important to understand the relationship between gestures and words in children with neurodevelopmental disorders.

Down syndrome (DS) is a neurodevelopmental disorder with a genetic basis that is caused by a partial or complete duplication of the 21st chromosome [10]. DS has

been linked to abnormalities in several organ systems as well as a unique phenotype that includes behavioral and physical traits [11]. However, one of the most severely compromised areas of functioning in DS is language, which may also be the major obstacle to independent living and meaningful community engagement [12, 13].

A complex neuropsychological profile, including specific language skill patterns with relative strengths and deficits, is seen in DS [14]. However, they frequently exhibit severe language impairments when compared to TD peers who were matched by their sensorimotor development [15] and are less likely to accompany pre-linguistic communicative gestures with vocalizations [16]. The transition from gestures to words is delayed more severely in DS [17]. They produce their first words at around 21 months of age [18], and their expressive language skills lag behind receptive language and non-verbal abilities [12, 19]. In the language profile of DS, gesture use as well as receptive vocabulary appear to be relative strengths [20, 21].

Some studies compared the gestures used by DS and TD. Singer Harris et al. [22] found that children in the DS group exhibited much greater gestural repertoires when compared to children in the TD group who were matched on comprehension and production vocabulary size. Caselli et al. [23] reported that young children in the DS group used a greater number of gestures compared to children in the TD group who were matched on word comprehension. The above-mentioned two studies used information from parental questionnaires to examine the gestures used by children with DS. Stefanini et al. [24] used spoken naming accuracy and spontaneous gestures

use in a picture naming task to examine lexical production in DS and observed that they made a considerably larger proportion of representational gestures without speech than TD control groups. Since individuals with DS were typically less intelligible during the picture-naming test, they reasoned that the higher gesture use found in these children is most likely the result of speech impairment. Bello et al. [25] emphasized that the number of representational gestures produced by DS was higher in the comprehension task than TD controls.

Iverson et al. [21] reported that the relationship between gestures and words in DS (chronological age=3.9 years; mental age=1.8 years) was nearly similar to that noticed in TD individuals who were matched for language production abilities during spontaneous mother-child interaction. In addition, individuals with DS exhibited a delay in the production of deictic words and in the use of gesture-word combinations compared to TD children. Also, the repertoires of representational gestures in individuals with DS were significantly smaller than those of TD individuals. Individuals with DS weren't found to have a gestural advantage in this study.

Lorang et al. [26] reported that during the interaction between mother and children, individuals with DS (chronological age=42.8 months) used more gestures compared to chronologically age-matched TD individuals, but after accounting for expressive language skills, this variation was not as significant.

Earlier research studies that investigated the usage of gestures and words in individuals with DS were based on the Western population. Therefore, the results of studies conducted in other countries cannot be applied to the Indian context, and hence it is vital to investigate the gestures and words used by children with DS in a region according to its culture. There is a lack of comprehensive published research on the usage of gestures and words among Indian individuals with DS, particularly those from Tamil-speaking families residing in Tamil Nadu. Therefore, the current study was undertaken to investigate the usage of gestures and words in Tamil children with DS during parent-child dyadic interaction.

Accordingly, the present study examines the relative use of types of gestures and words in Tamil-speaking children with DS. Also, this study compares that with a group of expressive language ability-matched TD children and aims to understand the relationship between total gestures and words produced by DS and TD groups of children.

Materials and Methods

Study participants

This study involved two groups of children. First, in the DS group, 15 individuals with DS (4 boys and 11 girls) ranging in age from 6 to 11 years (Mean \pm SD, 8.73 \pm 1.92) were included. Second, in the TD group, 15 TD individuals (4 boys and 11 girls) ranging in age from 1.6 to 3.6 years (Mean \pm SD, 2.61 \pm 0.73) who were matched for the expressive language age of DS were included. All children used Tamil as their primary language for communication. The parents of the children provided informed consent before enrolling in this study. This study was conducted as a part of larger, ongoing cross-sectional research and was approved by the institutional ethical clearance committee.

Children in the DS group were recruited based on the following criterion: Children should have cytogenetic documentation of Trisomy 21 and adequate visual and auditory skills. The developmental age of children in the DS group ranged between 3 to 6 years which was determined using the developmental screening test [27]. The language skills were evaluated using an assessment of language development [28]. The expressive language age of children in the DS group ranged between 1.6 to 3.6 years.

TD group of children were matched for the expressive language age and gender of children in the DS group. The World Health Organization (WHO) 10-question disability screening checklist [29] was administered to all children in this group and those with no communication, motor, or cognitive/neurological deficits were included. Also, an assessment of language development was administered to all the children and those with age-adequate language levels were included.

A total of 90% of the parental participants were mothers. All parent-child dyads were Indian and their native as well as primary language of communication was Tamil. The age of parents ranged from 28 to 40 years. All parents belonged to the middle socio-economic class in India according to the revised Kuppuswamy's socio-economic status scale [30].

Study procedure

A standard set of toys including dolls (boy and girl), a ball, a tea set, a brush, a comb, a car, a bike, a telephone, and books were given to all participants during the interaction. The toy set had items that all children

were familiar with and used in their daily lives and that were suitable for a range of age-appropriate activities. The parents were instructed to play with their children normally for 10 min, as they do at home, using the set of toys given. All the parent-child interactions were video recorded using a video camera of a mobile phone with a resolution of twenty megapixels by the primary investigator at the clinic. Eudico linguistic annotator (ELAN) [31] software, version 6.5 for analysis of speech, language and gesture was used for transcribing and coding the gestures and words. The primary investigator was involved in transcribing and coding the gestures and words by using ELAN software. The taxonomy of the current gesture and word classification system was derived based on literature [21, 32-35]. For a gesture or word to be classified as communicative, there has to be clear evidence of an attempt to draw the listener's attention [34]. Gestures that were produced by the children in this study were categorized into deictic and representational gestures.

Deictic gestures are context-dependent since they indicate an object or event in the immediate surroundings. Four subtypes of deictic gestures were coded as follows: Reaching (R) entails extending the arm alongside the palm facing upward or opening and shutting the hand repeatedly toward an object, person, or location; pointing (P) is commonly characterized as index finger extension and isolation; giving (G) is the act of offering a toy to another person; showing (S) consists of holding up or extending a toy towards another person.

Representational gestures represent specific referents; therefore, their underlying semantic content does not alter greatly with context. Two types of representational gestures were coded: Iconic gestures that are used to represent the characteristics or behaviors of something (e.g. waving an arm in the air to convey an airplane flying); conventional gestures with culturally determined form and meaning (e.g. waving hand for "hi," shaking head for "no").

The words produced by all children were divided into two categories similar to gestures: Deictic words are possessive and personal pronouns (e.g. "i," "yours"), and locative and demonstrative expressions (e.g. "that," "there"). deictic words meaning is decided by their context of use; representational words are affirmative and negative expressions (such as "yes," "no," or "all gone"), as well as conventional interjections and greetings like "hi!" or "bye-bye."

Reliability

For 20% of the samples in each group, the coding reliability was evaluated by a second-trained speech-language pathologist. The percentage of agreement between the coders was 83% for identifying overall deictic gestures and words as well as representational gestures and words in the DS and TD groups.

Data analysis

The frequency of occurrence of each type of gesture and words were calculated. The relationship among the total gestures and words that the children in the DS and TD groups produced was confirmed using the Spearman rank correlation coefficient. Wilcoxon signed-rank test (non-parametric) was employed to analyze the data because of the small sample size and high level of individual variability [36].

Results

The results of this study are described in the following sections.

Types of gesture and word production in DS group

Table 1 represents the Mean \pm SD values of the types of gestures and words produced by children in the DS and TD groups. A detailed analysis of two types of gestures and words used by children in the DS group during spontaneous parent-child dyadic interaction was conducted. Children in the DS group used greater deictic gestures (Mean \pm SD, 35 \pm 14.10) than deictic words (Mean \pm SD, 2.7 \pm 1.79), with a significant difference ($P<0.05$, $Z=-3.40$, $P=0.00064$). Also, children with DS used more representational words (Mean \pm SD, 46.13 \pm 22.63) than representational gestures (Mean \pm SD, 12.53 \pm 8.20), with a significant difference ($Z=-3.29$, $P=0.001$).

Comparison of gestures and words production among DS and TD groups of children

Regarding the two categories of gestures, for deictic gestures, there was no significant difference between the DS and TD groups. For representational gestures, there was a significant difference between the two groups, in which the mean frequency of representational gestures was higher for the DS group than the TD group.

Regarding the two types of words, for deictic words, there was no significant difference between DS and TD groups. For representational words, there was a signifi-

Table 1. Comparison of types of gestures and words in children with DS and typically developed

Variables	Mean±SD		Z	P
	Children With DS	Typically Developed Children		
Deictic gestures	35±14.1	27.4±2.44	-1.30	0.19
Representational gestures	12.53±8.2	5.73±3.01	-3.109	0.0018*
Deictic words	2.73±1.79	6.26±8.73	-0.88	0.37
Representational words	46.13±22.63	70.13±48.58	-2.27	0.02*

*P<0.05.

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cant difference between the two groups, in which the mean frequency of representational words was higher for the TD group than the DS group.

Relationship among gestures and words in DS group and in expressive language age-matched TD group

The results of the Spearman rank correlation coefficient revealed that in children with DS ($r_s=0.574$, $P=0.02$) and in expressive language age-matched TD children ($r_s=0.558$, $P=0.03$), there was a significant moderate positive correlation between overall gestures and words.

Discussion

The main objective of this prospective study was to compare the use of gestures and words in a sample of Tamil-speaking DS and TD groups of children during spontaneous parent-child interaction; accordingly, the possible differences in the relationship among the gestures and words could be investigated. To the best of our knowledge, this is the first study done in a sample of Tamil-speaking Indian children with DS to investigate the above-stated objectives during spontaneous parent-child interaction. The study's results revealed a number of noteworthy findings, which are discussed in the section below.

The first finding of this study was that the DS group used higher deictic gestures compared to deictic words. This finding is in coherence with an earlier study done by Iverson et al. [21] in which the DS group did not use any deictic words and they reported that the link between deictic words and their referents, was extremely abstract and transitory, and due to this, children in the DS group might need longer period to learn this relationship before the emergence of deictic words. Furthermore, deictic gestures are primarily used to convey information about objects in the immediate environment, whereas

words are frequently used to convey information about distant referents, or objects that are not in the immediate physical or temporal vicinity of their users. This is a key distinction between deictic gestures and words. An individual must have a mental image of both the referent and the symbol that links the referent and the term to refer to a word [37]. Also, in this study, when comparing representational gestures and words within the group of children with DS, more representational words were used than representational gestures. This could be because the cognitive demands of representational gestures exceed those of spoken words [38].

The second outcome of this study was that a positive link was found between gesture and word production in DS and TD groups during parent-child interaction. Though children in the DS group have expressive language deficits, a relationship between gesture and word production persists in expressing their intention during interaction. These results are consistent with earlier investigations done in children with DS [21]. Iverson and Goldin-Meadow [8] reported that in TD children, gestures emerge before language development and have a strong relationship with them. At the lexical level, words that were first detected in children's gestural repertoires later showed up in their spoken lexicons. Chan and Lacono [39] emphasized the significance of gestures for children with DS at the beginning of intentional communication and before to the appearance of word production. Therefore, our findings have so made a further literary contribution to the relationship between gesture and word production in DS.

The third finding indicated that children in the DS group used greater representational gestures and fewer representational words than expressive language age-matched TD group. This is in line with previous findings [22-25]. The possible explanation for the high repertoire of representational gestures was that since children with DS in this study were using fewer representational

words and also, they have deficits in the intelligibility of speech, they were using more representational gestures to compensate for speech and language difficulty. Studies have also mentioned that children with DS frequently depend on gestures for considerably longer than children with TD as a method to supplement words spoken as they develop their language because they frequently have decreased speech intelligibility [40] and language impairments that last beyond the early years [41]. However, gestures are easier for children with DS to learn and produce than spoken words [24], which may help them compensate for speech and language difficulties. As suggested by Bello et al. [25] because of their phone-articulatory difficulties, individuals with DS continue to exhibit a minor link among semantic representation along with lexical items across both lexical groups which in turn contribute to the variation in the distribution of representational gestures. Previous research studies mentioned that individuals with DS gestured more compared to TD individuals and referred to this as a gesture advantage in individuals with DS [23, 24]. Furthermore, this specific finding of this study contrasts with what has been reported in two earlier studies [21, 26] with a methodology and comparison group similar to this study. There are a few reasons why this disparity could exist between this finding and those mentioned in the previous studies. One of the most important differences was related to the age group of children in the DS group. In this study, school-age children ranging from 6 to 11 years were included. Whereas the chronological age of children in the DS group in the Iverson et al. [21] study ranged from 37 to 56 months and in Lorang et al. [26] ranged from 23 to 63 months. Hence, children with DS in this study had higher chronological age compared to the other two studies. Also, children with DS in this study had greater chronological age compared to TD children who were matched for expressive language ability. Because of their higher chronological age, children with DS have a longer social experience which contributes to their greater ability to use communicative gestures [42, 22]. As a result of this, a form of specialization in nonverbal communication occurs [23]. Another important difference was related to the culture and language variation. This study was done on Tamil-speaking Indian children with DS, whereas other Western studies [21, 23, 24] were done on Italian-speaking children with DS. Additionally, Sapir [43] acknowledged that gesture patterns varied among cultures and that in communicative contexts, manual gestures continually interact with words. Capirci et al. [44] suggest that a high level of gestural culture may influence the frequency of representational gestures used by children. All these factors combined could have resulted in

greater use of representational gestures by the DS group in our study. However, there was no significant variation among the DS and TD groups in terms of the usage of deictic gestures and deictic words. Furthermore, only a few in the DS group were using deictic words whereas all children with DS were using deictic gestures. This similar trend was observed in the TD children group. The possible reason for this trend might be that parents and children interacted in a free choice of play with the toys provided, which was highly unstructured. Also, this contributed to the variation in the chances of elicitation of deictic words and deictic gestures from parent to parent. Therefore, there is a need to develop a task paradigm comprising both free and structured play to study the gestures and word types used by children holistically. In this study, the DS group used greater deictic gestures compared to deictic words. Therefore, in speech and language intervention for children with DS, deictic gestures can be shaped into verbal production by using child child-directed approach which would facilitate gesture and word mapping.

Finally, these findings need to be confirmed by conducting future research studies with a large sample size of Tamil-speaking children with DS. In this study, a cross-sectional design was used. To adequately document the dynamic process of variation across age, numerous longitudinal studies are necessary [45].

Conclusion

In the current study, it was determined that during parent-child interaction, similar to TD children, there is a link between gesture and word production in the DS group, a relationship believed to exist in spite of certain issues with the expressive language traits of this group. The present study contributes to the existing literature that shows that compared to the TD group, children in the DS group used greater representational gestures to compensate for the deficits in speech and language skills. Furthermore, the outcome of the present study emphasized the importance of profiling the types of communicative gestures and words used by children with DS to gain more insight into the size of the vocabulary used, which in turn can assist in the design of assessments and interventions.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Sree Balaji Medical College and Hospital (BIHER), Chennai, India (Code: 002/SBMCH/IHEC/2023/1944).

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interpretation of the results, and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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