Journal of Modern Rehabilitation

Research Article

Language Skills in Preschool Children with Down Syndrome and Non-verbal Mental Age-matched Controls

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Citation: Aminian M, Karbalaei Sadegh M, Salmani M, Jafari Naeemi A. Language Skills in Preschool Children with Down Syndrome. Journal of Modern Rehabilitation. 2023; 17(2):134-141. https://doi.org/10.18502/jmr.v17i2.12411

https://doi.org/10.18502/jmr.v17i2.12411

Article info:
Received: 9 Aug 2021
Accepted: 30 Oct 2021
Available Online: 01 Apr 2023

Keywords:
Down syndrome; Language; Preschool children

ABSTRACT

Introduction: Down syndrome (DS) as a chromosomal abnormality has different symptoms including cognitive problems and language delay. Studies showed a heterogeneous profile of language skills in this group of children. This study aimed to provide further information about the most vulnerable area of language -grammatical skills- regarding the unanalyzable utterances, clauses, phrases, grammatical morphemes, and mean length of utterances (MLU) in children with DS and compare them with those of non-verbal age-matched controls.

Materials and Methods: The grammatical structures of 12 children with DS (non-verbal age=39 months) were compared to those of 50 non-verbal mental age-matched controls (non-verbal age=41 months). Clause, phrase, and grammatical morphemes were investigated through spontaneous language sample analysis according to Persian-language assessment remediation and screening procedure (P-LARSP).

Results: Children with DS had higher percentages of unanalysable text units compared with typically matched peers (P≤0.001). The MLU, number of phrases and clauses structures, and inflectional morphemes were significantly lower in children with DS compared with typical children (P<0.001).

Conclusion: Children with DS showed a noticeable gap in grammatical structures compared with typical children. The possibility of specific language problems in children with DS should be considered by future studies.

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1. Introduction

Intellectual disability is one of the most common disorders [1] in childhood that causes different levels of developmental disabilities depending on the type of syndrome and its etiology. Among the various syndromes, down syndrome (DS) is the most common chromosomal disorder in children. The international prevalence of DS is estimated at one in 1000 live births [2], and the national prevalence of DS is 0.9 per 1000 births (95% CI: 0.7-1.2) [3]. Cognitive problems, especially memory [4], intellectual disability [1], behavioral disorders [5], and delayed language abilities [6] have been reported in children with DS. The extent and severity of language disorders in children with DS have been under investigation by different studies [7-10].

These studies indicated that language acquisition, especially the grammatical aspect, is a challenge for children with DS [11]. Berglund et al. (2001) compared the spoken language skills in children with DS with those of typical children. Children with DS at the age of 3 and 4 had performance similar to typical children at the age of 1;04 and 1;08 respectively which means children with DS lag behind typical children by about two years in spoken language skills. Marginal grammatical differences still existed when both groups had similar lexicon sizes [9]. Chapman et al. (1998) analyzed and compared conversational and narrative language samples from children and adolescents with DS with language samples from nonverbal mental age-matched controls (aged 2 to 6 years). They reported children with DS presented a specific language impairment because of the differences in several different words and total words (in the first 50 utterances) and mean length of utterance (MLU), compared to the control group [12]. Finestack et al. (2013) evaluated language profiles of children and adolescents with DS and children with Fragile X syndrome to assess the diagnostic value of language profiles to reliably differentiate these two groups. Administration of standardized language measures and analysis of conversational language samples showed each group its unique language profiles which were characterized by differences in children's grammatical ability. Such differentiation was not possible based on children's performance on vocabulary measures [13].

The challenges in language acquisition for children with DS have been confirmed in languages other than English such as Italian [14] and Persian [15, 16]. Ebrahimian et al. (2003) examined the language performance of 18 children with DS. They found a significant gap between children's performance in expressive language and language comprehension [16]. In another study, Raghibdoost and Malekshahi (2009) evaluated comprehension of simple and complex syntax in ten participants with DS at a mental age of 7-8 years and ten typically developing children using a researcher-made activity. Their results showed children with DS had poorer performance in comprehension of syntactic structures compared with matched controls [15]. Mozafar Zangane and Ferdosi (2014) [17] evaluated the total words, conjunctions, and MLU (as indices of morphosyntactic skills) in 43 children with Down syndrome with the age range of 10 to 20 years and 40 nonverbal mental age 8 to 12 years of age-matched control by a storytelling procedure. Their participants with DS showed significantly poorer performance in all indices compared with matched controls.

In summary, language studies in different languages including Persian confirmed the existence of language problems in children with DS and the vulnerability of the morphosyntactic field in this syndrome. However, few concerns are still in Persian literature that needed to be considered by this study and future studies: a) Draghi and Zampini found different developmental patterns in morphosyntactic skills of Italian children with DS during the emergence of multiword utterances; Persian, like Italian, is an inflective language, and we do not know the developmental patterns of morphosyntactic skills in Persian children with DS; b) Most of the Persian studies chose to have a narrow perspective on morphosyntactic skills (looking at MLU) while morphosyntactic skills have a wide range from affixes to complex clauses and MLU is just a general index; c) Shifting in the intervention policy and undertaking evidence-based practice by speech and language pathologists (SLPs) mean the best documentation must be provided for clinicians to have reliable and confident assessment and intervention; d) While studies in English have reached saturation and meta-analysis and developmental studies have been extracted [18-20], in Persian, there is not even basic knowledge about the linguistic characteristics of children with DS; e) Measures in English spoken language including vocabulary, syntax, and speech intelligibility showed adequate psychometric values to be used for children with DS [21], but the language measures that might help Iranian SLPs to run intervention studies or use as diagnostic indices have not been investigated. The present study aimed to provide documents for these concerns with the hope that its results might be the starting point for studies that can answer all these doubts. The present study has investigated the following aims:

The percentage of analyzable (intelligible, complete, and grammatical utterances) and unanalyzable (unintelligible, deviant, symbolic noise such as sirens, incomplete, ambiguous, stereotyped, repetition, and structurally abnormal utterances) utterances in children with DS and matched control;

A rough estimate of children's responsiveness regarding children's verbal responses, nonverbal responses, and zero responses;

The portion of different types of analyzable utterances;

Evaluation of clauses, phrases, and grammatical morphemes in children with DS compared with those of the non-verbal intellectual age-matched control group.

2. Materials and Methods

Study design and participants

This study had a cross-sectional design. All participants were recruited through convenient sampling in Semnan.

Children with down syndrome

From 24 children with DS who were present at the schools with special needs in Semnan, only twelve (four boys and eight girls; Mean±SD 39.50±3.32 age of nonverbal) were eligible to participate in the study and recruited by convenient sampling. To be part of this study, all 12 children had the physical and behavioral phenotype of DS and were diagnosed by a pediatrician. Children with DS had no record of neurological disorders in their medical profile; however, all of them received treatments for kidney problems, heart and lung diseases, and otitis media at different periods of their lives. They did not have hearing loss or visual problems according to the school screening and were monolingual (Persian users). All children had normal parents and the average age of the mother at the time of pregnancy was 30 years. Children's nonverbal age was regarded as the exclusion criterion, thus children with non-verbal age below three or above four years were excluded from the study (studies indicated the main changes in Persian grammar acquisition by children happen between 3 to 5 years old).

Control-matched group

Five kindergartens were randomly selected in Semnan city. Among 89 signed consent forms returned from families, fifty typical children (Mean±SD 41.26±3.50 age; 20 boys & 30 girls) were selected who were matched with children with DS in terms of nonverbal mental age, gender, and socioeconomic status. In an interview with mothers, they confirmed that their children had no history of any specific syndrome or disorder that could cause mental retardation or speech or language impairment (such as hearing loss, seizures, cerebral palsy, and epilepsy) and they speak only in Persian. The parents of the typical controls were normal and the mean age of the mothers at the time of pregnancy was 30 years. Healthcare providers also confirmed the health of the control group based on the age and stages questionnaire. The family physician, kindergartens principals, and teachers based on their routine evaluations were also the source of health confirmation.

Ethical considerations

One part of this study was approved by Semnan University of Medical Sciences (Ethics Code: IR.SEMUMS.REC.1395.26) and another part was approved for PhD thesis in Islamic Azad University, Sciences and Research Branch in Tehran. For both groups, the SLPs took informed consent, they assured the families that this study did not have any harm to their children, their names and information would be confidential and anonymous during the whole study even in publishing data, and if they decided to stop their cooperation during any stage of study or even withdraw their information, there would not be any financial or social consequences for them. The whole process of data gathering happened when the families and children were ready to cooperate.

Test materials

The cognitive skills of children with DS were evaluated using the Persian version of Leiter that offered a completely nonverbal measure of intelligence that was ideal for use with those who were cognitively delayed, non-English speaking, hearing impaired, speech impaired, or on the autism spectrum. This tool was administered individually with game-like tasks assessing cognitive, attentional, and neuropsychological abilities in 20-45 minutes. The Leiter could be administered in the people age range of 3 to 75+ years old. The background information (from family history to the child's development) was collected using Children's Language Pack [22].

Assessing language skills was done through spontaneous language sample analysis. The formal framework to analyze language samples was the Persian version of the language assessment, remediation, & screening procedure known as P-LARSP which provides a one-page language profile for each child [23, 24]. In this method, section A removed all unanalyzable utterances (unintel-

ligible, deviant, symbolic noise such as sirens, incomplete, ambiguous, stereotyped, repetition, and structurally abnormal utterances) from the language analysis (for more details on unanalyzable text units see Salmani et al. 2021 [25]). The remaining units were further analyzed as analyzable text units in the next sections of P-LARSP.

Section B categorized the child's analyzable responses into different columns according to the number of syntactical elements that remained in the child's utterances (as elliptical 1, 2, 3+, full major, and minor). Section C had the same columns as section B and was dedicated to the child's analyzable spontaneous utterances. In sections B & C, the SLP recorded all nonverbal responses and zero responses (where the SLP expected a response from a child but received none, recorded as '∅'). The child's responsiveness in communication could be roughly estimated by looking at the child's verbal responses, nonverbal responses, and zero responses.

In the middle of the profile, analyzable text units are then categorized in stages I through V, depending on the number of syntactic structures. Stage I had a completely different categorization from the other four stages. In stage one, one-word utterances in both the minor and major rows received more analysis, while utterances with more than two syntactic elements were categorized in stages II through V in the columns of clauses, phrases, and inflectional morphemes. The last line of the P-LARSP profile provides some general syntax-checking features such as average utterance length1.

Study procedure

A psychologist with sufficient experience from the General Department of Education of Semnan Province performed the Leiter IQ test. The SLP had a face-to-face interview with children's mothers at the kindergartens to collect demographic information.

Two SLPs collected language samples during a 30-minute interaction with each child using free play context. All sessions were recorded. Another SLP then transcribed all the sessions and segmented them according to the principles in the P-LARSP to identify analyzable and non-analyzable text units. Using the time-based language sample cutting method, the middle ten minutes of the sessions were selected to allocate morphosyntactic structures. To evaluate the reliability, 10% of the language samples were transcribed, segmented, and analyzed by a blind SLP. A 95% consensus agreement was obtained between SLPs.

1. See this link for further information: https://www.google.com/search?q=larsp+chart&rlz

Statistical analysis

The obtained data were analyzed with SPSS software, version 24.0 for Windows (SPSS Corp, Chicago, IL). At first, Mean±SD as the descriptive indicators were extracted for the outcome measures (percentages of analyzable vs unanalyzable, number of clauses, phrase and inflectional morphemes, and MLU). The Shapiro-Wilk test was applied to check the normal distribution assumption. Then, independent samples t-test and Mann-Whitney U were administered to compare the two groups. A $P<0.05$ was considered significant.

3. Results

Normal distribution

Using the Shapiro-Wilk test indicated that the $P>0.05$ meaning that the data had a normal distribution. Thus, parametric tests were performed to compare the groups.

Language findings

Un-analyzable text units

At the first stage of the language analysis, un-analyzable units were calculated using the P-LARSP. Accordingly, 40% of the utterances of children with DS could not be analyzed, while this figure was about 10% for non-verbal age-matched controls (Table 1).

Both groups used nonverbal responses during interactions and both groups left some of the communication partner's stimulants without responses. The average number of zero responses in children with DS was more than that of matched controls; however, the larger SD in children with DS might be the reason that the difference between groups was not significant.

Analyzable text units

In sections B and C, the analyzable text units were categorized into 1, 2, and 3+ellipsis, full, and minor according to the number of syntactic elements remaining in the child's utterance (Table 2).

Clause, phrase, and inflectional morphemes

Based on the principles of P-LARSP, the analyzable utterances were categorized into stages I to V to define the morphosyntactic structures (Table 3). The significant differences between the two groups started from the major part of the stage I and continued until stage V. For those variables that children with DS scored zero, the Mann-Whitney U was implemented to compare groups.

Table 1. General information about language sample analysis according to P-LARSP

Variables	Mean±SD		P
	Typical Children (n=50)	Children With Down Syndrome	
Total morphemes	386.62±105.71	69.25±34.44	<0.001
Percentage of analyzable unit	89.13±6.31	58.92±20.20	<0.001
Percentage of unanalyzable unit	10.87±6.31	41.08±20.20	<0.001
Total number of nonverbal responses	5.40±6.11	6.92±7.20	0.45
Zero response	5.16±8.37	9.33±12.37	0.16
Mean length of utterances	4.17±0.90	1.33±0.40	<0.001

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Table 2. Different types of analyzable utterances

Types of Analyzable Utterances		Mean±SD		P
		Children With Down Syndrome	Control Group	
Elliptical	1	31.83±16.80	26.26±9.30	0.288
	2	4.00±4.93	23.28±6.40	<0.001
	3+	0.17±0.39	19.36±11.49	<0.001
Full		0.08±0.29	8.18±5.06	<0.001
Minor		16.75±11.77	13.14±8.29	0.218

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Table 3. Morphosyntactic structures at different grammatical stages

Morphosyntactic Structures	Mean±SD		P
	Typical Children (n=50)	Children with Down Syndrome (n=12)	
Stage I: minor	13.98±7.74	17.67±9.50	0.16
Stage I: major	15.50±8.29	29.25±15.17	0.01
Stage II: clause	10.52±5.35	2.58±2.35	<0.001
Stage II: phrase	39.16±16.39	1.92±2.31	<0.001
Stage III: clause	21.14±7.20	1.67±2.10	<0.001
Stage III: phrase	16.18±7.83	1.17±2.66	<0.001
Stage IV: clause	15.34±7.72	0.50±1.17	<0.001
Stage IV: phrase	6.70±4.71	0.25±0.45	<0.001
Stage V: clause	9.20±7.47	0.00±0.00	<0.001
Stage V: phrase	1.42±2.15	0.00±0.00	<0.001
Inflectional morpheme	132.70±44.71	3.67±3.94	<0.001

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4. Discussion

The present study showed that preschool children with DS were as responsive as the non-verbal matched controls in interactions; however, their language skills were not compatible with those of their non-verbal matched controls in a similar context. Such a finding may support the hypothesis that children with DS have specific language impairments that cannot be explained by their intellectual disability. Further evidence to support this hypothesis could be found in the analysis taken place through P-LARSP. Over 40% of the utterances that children with DS produced were not analyzable because of unintelligibility, deviation, ambiguity, incompleteness, etc. In sections B and C, where the analyzable utterances were distributed according to the number of their morphosyntactic structures, over 90% of the analyzable units in children with DS were elliptical 1 and minor, while in the control group, the utterances had an acceptable distribution among different categories. Hence, the gap that existed between the two groups from the previous stage (section A) was more visible in this stage (sections B and C) and then reached its peak in the next section where the morphosyntactic structures were defined.

The MLU as a general index of grammatical development highlighted the grammatical gap between children with DS and the non-verbal matched controls. Using Brown's benchmark to interpret the MLU indicated that children with DS were at stage I (MLU=1.0-2.0; age=12-26 months) and the non-verbal matched controls were at stage V (MLU=3.75-4.5; age=41-46 months). This finding was in complete agreement with the findings reported in English studies and Persian studies [9, 17, 26, 27]. Berglund et al. found similarities between the spoken language skills of 3-4 years old children with DS and one-year-old typical children in spoken language measures. This study also found that according to the MLU, children with DS had grammatical skills similar to typical children aged 12-26 months [9]. Accordingly, our findings provided further evidence of the significant morphosyntactic delay that children with DS showed compared with non-verbal matched controls and highlighted the need for reconsidering educational and interventional plans for this group of children.

The categorization of analyzable utterances among different grammatical stages and different columns of morphosyntactic structures (clause, phrase, and inflectional morphemes) showed that the concentration of grammatical functions of children with DS was in stage I. Then, a sharp drop from stage I to stage II gradually reaching zero in stage V was observed in tangible grammatical changes in children with DS. The trend for non-verbal matched controls was a steady downward one that never reached to zero. In contrast with Draghi and Zampini (2019) who found different morphosyntactic patterns [14], we found only one pattern repeated in all language profiles of children with DS. The difference might be in the children's language age, their participants were in the emergence of multiword combinations while ours were in the one-word stage. The morphosyntactic pattern in the present study shown by children with DS should be further investigated by future studies in comparison with other groups of children with language disorders with different etiologies. We did not assess the reliability and validity of grammatical measures; however, it seems that the MLU, percentage of one-word utterances, and number of complex utterances in stage V are ideal spoken language measures to be used in clinical settings for assessment and intervention purposes. Future Persian studies may investigate the discriminant accuracy of these grammatical measures too.

Limitations

The present study was performed using the analysis of language samples resulting from interactions between the examiner and children. Future studies with different communication partners and contexts of interaction may reach to different results. We did not use a standardized language tool to see children's language age. Future studies that implement standardized tools can find the level of children's language functions.

5. Conclusion

In summary, we assumed by controlling the level of nonverbal cognitive function, the language function of children with DS and their non-verbal age-matched controls would be the same. But the findings were against our assumption. Persian children with DS had noticeable grammatical delays compared to matched controls since they produced significantly limited numbers of complex utterances, inflectional morphemes, and complex phrase structures and had a considerably higher percentage of unanalyzable utterances. Our finding supports the presence of specific language impairment which has been discussed in previous studies [6, 17].

Ethical Considerations

Compliance with ethical guidelines

One part of this study was approved by Semnan University of Medical Sciences (Ethics Code: IR.SEMUMS.

REC.1395.26) and another part was approved for PhD thesis in Islamic Azad University, Sciences and Research Branch in Tehran.

Funding

A part of this study was supported financially by Semnan University of Medical Sciences (Grant Number =1049)

Authors' contributions

Conceptualization: Monireh Aminian, Masoomeh Salmani; Data collection: Monireh Aminian and Ali Jafari Naeemi; Writing the first draft: Monireh Aminian, Mahnaz Karbalaei Sadegh and Ali Jafari Naeemi; Data analysis: Mahnaz Karbalaei Sadegh and Ali Jafari Naeemi; Language: Masoomeh Salmani and Ali Jafari Naeemi; Final approval: Masoomeh Salmani.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

The authors wish to thank the participants children and their mothers, Ministry of Education: Islamic Azad University, Semnan Branch, and the Student Research & Technology Committee that made this study possible.

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