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Assessment of phonological skills in the context of intellectual disabilities: comparative study between children with Down syndrome and children with intellectual disabilities

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Abstract
This scientific investigation delves into the pivotal role of phonemes in language acquisition among children aged 8 to 11 with Down syndrome and intellectual disabilities. The study uncovers significant disparities between these groups, emphasizing the need for tailored educational strategies. Findings reveal fluctuations in rhyme, syllable, and phoneme recognition, underscoring the complexity of linguistic development. Noteworthy is the positive correlation between higher intelligence and enhanced phonological performance in both groups. The study suggests the importance of early interventions for children with Down syndrome and advocates for personalized educational programs.
Keywords: intellectual disability, Down syndrome, phonological skills, linguistic development

Introduction
Intellectual disability and Down syndrome represent two complex entities in the field of health and human development, capturing the attention of researchers and professionals in health, special education, and psychology. Despite being distinct in their essence, these conditions exhibit significant interconnections, highlighting opportunities for investigation and intervention. This comparative analysis explores the differences and similarities between intellectual disability and Down syndrome, providing insights into phonological abilities that develop at different ages.

Intellectual disability and Down syndrome constitute two significant facets within the intricate landscape of human development.

Intellectual disability is a condition characterized by significant limitations in intellectual functioning and adaptive behavior, often resulting in diminished capacity to learn and function in everyday life (APA, 2013). The cognitive development of a child with intellectual disability involves specific characteristics that progress at a slower pace and in a manner different from that of a typical child (Bratu, 2014). These individuals encounter difficulties in understanding and utilizing abstract concepts, as well as challenges in performing operations such as analysis, synthesis, comparison, classification, generalization, and abstraction (Agheana, 2017).

Down syndrome, also known as trisomy 21, is a genetic condition characterized by the presence of an extra copy of chromosome 21, exhibiting distinct physical features and often associated with intellectual impairments (Arumugam & al, 2015). It represents the most common genetic cause of intellectual disabilities, affecting approximately 1 in 400-1500 newborns (Kazemi, 2016). The exact mechanisms through which the chromosomal anomaly induces intellectual delay are still

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under investigation, with evidence suggesting that specific systems such as the hippocampus, prefrontal cortex, and cerebellum are disproportionately affected (Nadel, 2003).

Both intellectual disability and Down syndrome can significantly impact development and learning. Individuals with intellectual disability may encounter difficulties in acquiring everyday life skills, while Down syndrome brings a unique set of challenges, including distinctive facial features and reduced muscle tone. In the educational context, it is crucial to adapt teaching approaches to address individual needs and facilitate an inclusive learning environment. In this regard, phonological awareness represents a fundamental element and a key component of metalinguistic awareness, essential for a child's literacy development (Nicholson, 1997). Phonological awareness develops alongside neuropsychological maturation and serves as a specific element of writing, particularly evident in the pre-literacy phase and continuing throughout the process of learning written language (Hategan, 2013)

It involves the ability to manipulate and recognize language sounds and is a strong predictor of success in reading (Chard & Dickson, 1999). Research has identified a universal sequence of phonological awareness development, influenced by language characteristics (Anthony & Francis, 2005). This has practical implications, as phonological awareness can be assessed and taught, with specific guidelines for children with special educational needs (Chard & Dickson, 1999; Calota & Vasile, 2021)

Research on phonological awareness in individuals with intellectual disabilities has shown that, although these individuals may follow a different path in acquiring these skills, there is a positive relationship between phonological awareness and reading acquisition (Sun & Kemp, 2006). However, they often exhibit weaknesses in certain aspects of phonological awareness, such as rhyme detection and phoneme segmentation (Dessemontet & al, 2017). Phonological awareness training interventions have proven effective in improving phonological working memory in these individuals (Soltani & Roslan, 2013). Additionally, phonological awareness and knowledge of letter sounds have been identified as important predictors of progress in reading for children with mild and moderate intellectual disabilities (Dessemontet & Chambrier, 2015).

Research on phonological awareness in individuals with Down syndrome has yielded mixed results. Fletcher & Buckley (2002) found a positive correlation between phonological awareness and reading and spelling competence in children with Down syndrome, suggesting that they possess measurable levels of phonological awareness. Prahl & al (2021) reported positive outcomes from phonological awareness interventions, emphasizing the importance of repeated practice and peer involvement. However, Kennedy & Flynn (2003) noted that these improvements did not always generalize to other aspects of phonological awareness. Van Bysterveldt, Gillon, & Moran (2006) also highlighted the role of phonological awareness in reading acquisition for children with Down syndrome, suggesting that phonics-based reading instruction may be beneficial.

Method

The proposed research addresses a need for understanding and intervention in the field of special education, focusing on the development of phonological skills in children with Down syndrome and those with intellectual disabilities. The choice of this topic stems from the crucial importance of phonological skills in the learning and adaptation process of children with special needs.

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Our approach has centered around the following research question: Are there significant age-related differences in the development of phonological skills between children with Down syndrome and those with intellectual disabilities?
Children with Down syndrome and intellectual disabilities often face significant challenges in the processes of communication and learning, with phonological skills representing an essential component in language development and reading competencies. To date, there is a notable gap in the specialized literature concerning a detailed analysis of differences in the development of phonological skills between these two distinct categories of children with special needs. Identifying and understanding significant differences in phonological development could provide a solid foundation for the formulation and adaptation of educational and therapeutic strategies tailored to the individual needs of these children.

Participants

Within the exploratory study, 148 randomly selected subjects participated, consisting of students from preparatory classes to the fourth grade in eight special education institutions in Bucharest (Romania). The participants' ages ranged from 8 to 11 years, with an average age of M=9.7 years for those with intellectual disabilities and M=9.1 years for those with Down syndrome.

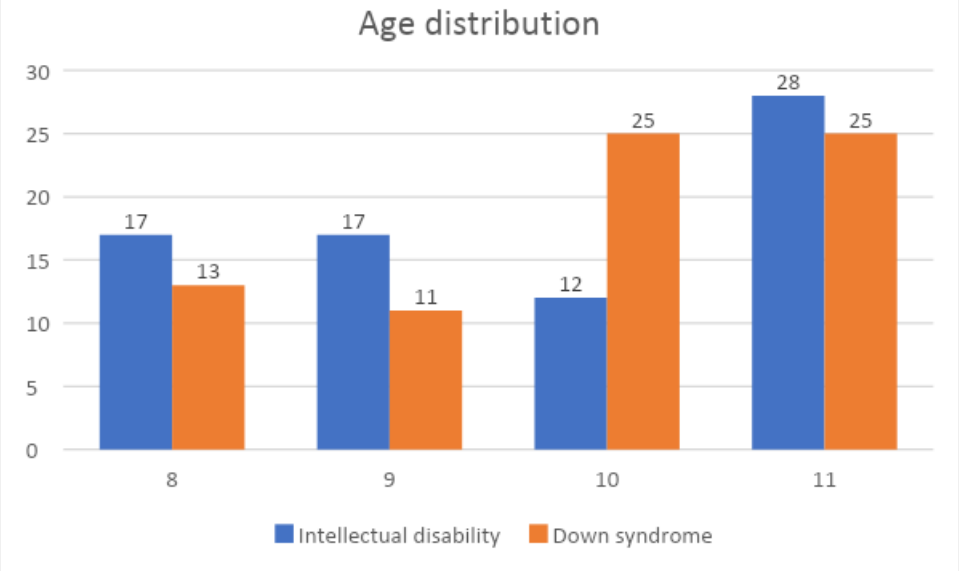

Figure 1. Age distribution for children with intellectual disability and Down syndrome

The age distribution is depicted in the above graph as follows: subjects with Down syndrome, at 8 years old, 13 subjects; at 9 years old, 11 subjects; at 10 years old, 25 subjects; and at 11 years old, 25 subjects. Subjects with intellectual disabilities, at 8 years old, 17 subjects; at 9 years old, 17 subjects; at 10 years old, 12 subjects; and at 11 years old, 28 subjects.

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Table 1 – Distribution by intelligence levels for children with intellectual disability and Down syndrome

Batch distribution by intelligence levels	Down syndrome		Intellectual disability	
Intellectual level	number of subjects	percent	number of subjects	percent
Mild mental disability QI=50-69	22	30	25	34
Moderate mental disability QI=36-49	30	40	32	43
Severe mental disability QI=20-35	22	30	17	23
Total	74	100%	74	100%

The distribution of the sample according to intelligence levels reveals notable differences between groups of children with Down syndrome and those with intellectual disabilities. Among children with Down syndrome, a balanced distribution is observed across categories of mild, moderate, and severe intellectual disabilities. Approximately 30% fell into the mild disability category (IQ=50-69), 40% in the moderate disability category (IQ=36-49), and 30% in the severe disability category (IQ=20-35). Conversely, children with intellectual disabilities exhibit a more extended distribution in the moderate disability category, representing 43% of the total. The categories of mild and severe disabilities have closer percentages, with 34% for mild and 23% for severe. In both presented groups, children with Down syndrome and those with intellectual disabilities, a diverse distribution across intelligence levels is evident. Moderate intellectual disability is the predominant category in both groups, accounting for 40% of children with Down syndrome and 43% of those with intellectual disabilities.

Applied test

PAST Phonological Awareness Screening Test **(**David A. Kilpatrick, Ph.D. © 2003, 2010, 2019)

Objective: Detection of language disorders at the syllable, phoneme, and word levels.

The test comprises three main items: rhyme recognition and awareness, syllable recognition and awareness, and phoneme recognition and awareness. Each item consists of three indicators, each with 10 subpoints, resulting in a maximum score of 90 points. Test administration takes into account the phonological characteristics of the Romanian language, with difficulties encountered by the subject being noted in the comments section, and no time limit for completion being imposed.

Phonological awareness is grounded in mental representations, stemming from the process of phonological understanding, and holds particular significance in reading comprehension. The activation at this level of memory, attention, and hearing underscores the complexity of this decoding system. With each new unit of information, combinations of cognitive processes are brought into play. Difficulties in phonology, i.e., the ability to recognize and manipulate sounds, impact the learning of reading and, concurrently, the comprehension of the written message. In the assessment of phonological awareness, the PAST test evaluates crucial areas and phonological components, such as rhyme (in verses, in isolated words, with a target word), syllable synthesis (syllabification, merging of syllables, and target syllables), and phoneme synthesis (in a word, in onomatopoeia, in a target sound).

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Findings and discutions

According to the analysis conducted on rhyme recognition and awareness, the mean values of the two groups are observed. Thus, at the age of 8, children with intellectual disabilities and children with Down syndrome start from a similar value. Over the course of development, i.e., at ages 9, 10, and 11, the group of children with intellectual disabilities follows a slightly ascending curve (M=15.12, M=15.25, M=16.57), in contrast to the group of children with Down syndrome, whose curve is descending (M=9.00, M=13.04, M=14.72).

Table 2 – Distribution of means. Rhyme recognition and awareness by age

	Rhyme recognition and awareness			
	8 years	9 years	years	11 years
Down syndrome	14,77	9,00	13,04	14,72
Intellectual disability	14,41	15,12	15,25	16,57

Significant variations are observed in rhyme recognition abilities based on age. For instance, in children with Down syndrome, the percentage of rhyme recognition appears to decrease at the age of 9, only to exhibit a slight increase at 10 and 11 years. Conversely, in children with intellectual disabilities, a notable increase is noted at the age of 11.

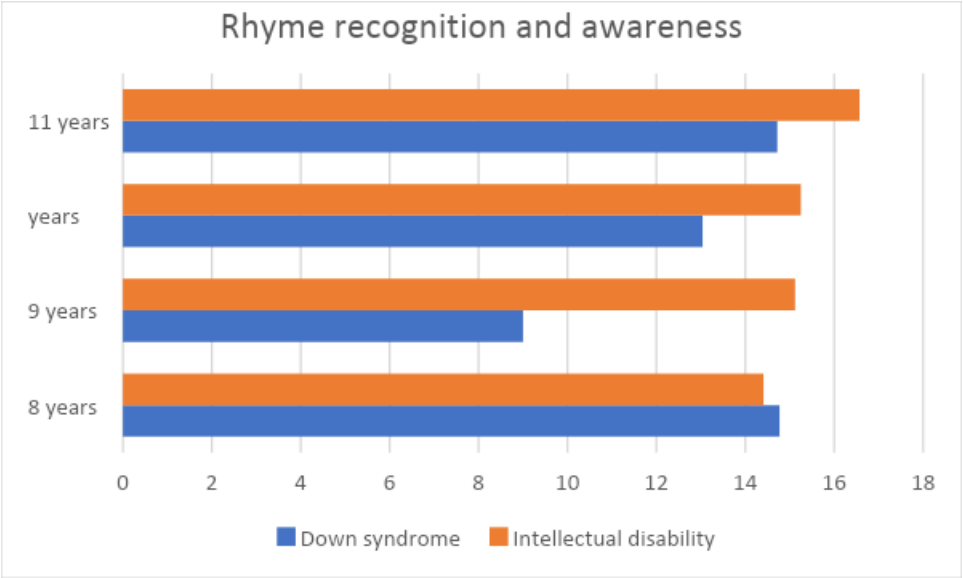

Figure 2. Rhyme recognition and awareness for children with intellectual disability and Down syndrome

Children with Down syndrome appear to exhibit fluctuations in rhyme recognition abilities, and these variations may be significant during the transition period from 8 to 11 years. Specific influences of the syndrome on the development of these linguistic abilities are possible. In contrast, children with intellectual disabilities seem to have a more stable development of rhyme recognition abilities, with a significant increase during the period from 9 to 11 years. This suggests a continuous and more consistent evolution in terms of this ability.

Analyzing the distribution based on intelligence levels regarding rhyme recognition and awareness, we observe that at the level of mild intellectual disability (IQ=50-69), children with Down syndrome and intellectual disabilities exhibit notably better performances, with a percentage of 30% and 25%, respectively. This aspect may indicate an increased sensitivity to the rhythmic aspects of language in this category of children. However, at moderate (IQ=36-49) and severe

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(IQ=20-35) levels, we observe a slight decline in performances, indicating possible challenges associated with the severity of intellectual disabilities.

As in rhyme recognition and awareness, at the age of 8, the groups of children with Down syndrome and intellectual disabilities start from similar values in the evaluation of the syllable recognition and awareness item. Similar to rhyme recognition, there are significant fluctuations in syllable recognition abilities based on age for both groups.

Table 3 – Distribution of Means. Rhyme syllable recognition and awareness by age

	Syllable recognition and awareness			
	8 years	9 years	10 years	11 years
Down syndrome	11,23	7,91	10,92	11,72
Intellectual disability	11,35	12,71	12	14,18

Thus, in syllable recognition and awareness as well, children with Down syndrome have the lowest recorded values.

In the evolution of syllable recognition abilities in children with Down syndrome and intellectual disabilities, we observe contrasting trends across the ages of 9, 10, and 11 years. The group of children with intellectual disabilities exhibits a slightly ascending curve, with means of 15.12 at 9 years, 15.25 at 10 years, and 16.57 at 11 years. Conversely, the group of children with Down syndrome highlights a descending curve, with means of 9.00 at 9 years, 13.04 at 10 years, and 14.72 at 11 years.

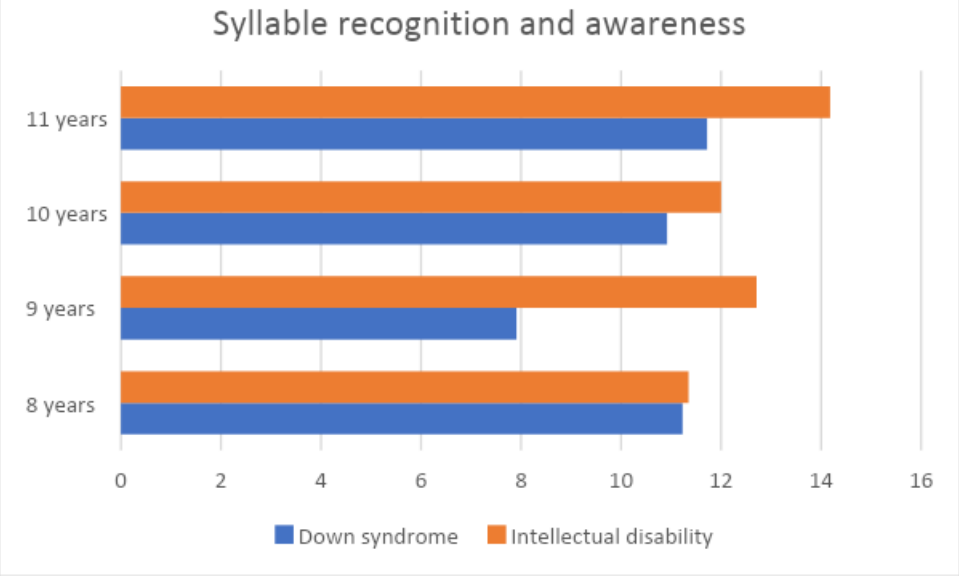

Figure 3. Syllable recognition and awareness for children with intellectual disability and Down syndrome

For children with Down syndrome, we observe a significant decrease at the age of 9, followed by a gradual increase. In the case of children with intellectual disabilities, there is a significant increase at the age of 9, with a continuation of this positive trend up to the age of 11. The performances of children with intellectual disabilities seem to demonstrate a more stable evolution and a more consistent growth compared to children with Down syndrome, who undergo more pronounced fluctuations.

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Regarding syllable recognition and awareness, the distribution based on intelligence levels indicates significant fluctuations. At the level of mild intellectual disability, children with intellectual disabilities exhibit a significant increase at 12.71%, while those with Down syndrome maintain a stable percentage at 11.35%. At moderate levels, scores stabilize, suggesting an adaptation to the specific requirements of this linguistic ability. At severe levels, children with Down syndrome show a significant increase, while those with intellectual disabilities show a decrease. These differences underscore the complexity of the syllable awareness process in the context of intellectual disabilities.

The phonological analysis continues with Phoneme Recognition and Awareness, where the same trajectory observed earlier in the other two tests is evident.

Table 4. Distribution of Means. Rhyme phoneme recognition and awareness by age

	Phoneme recognition and awareness			
	8 years	9 years	10 years	11 years
Down syndrome	3,92	1,64	2,04	3,16
Intellectual disability	8,47	9,65	6,67	8,36

Simultaneously, we observe a negative trend in children with intellectual disabilities and Down syndrome at the age of 9. Across all three phonological skill items assessed, subjects in Group A obtained the lowest scores at the age of 9 (Rhyme Recognition - M=9.00, Rhyme Syllable - M=7.91, Rhyme Phoneme - M=1.64).

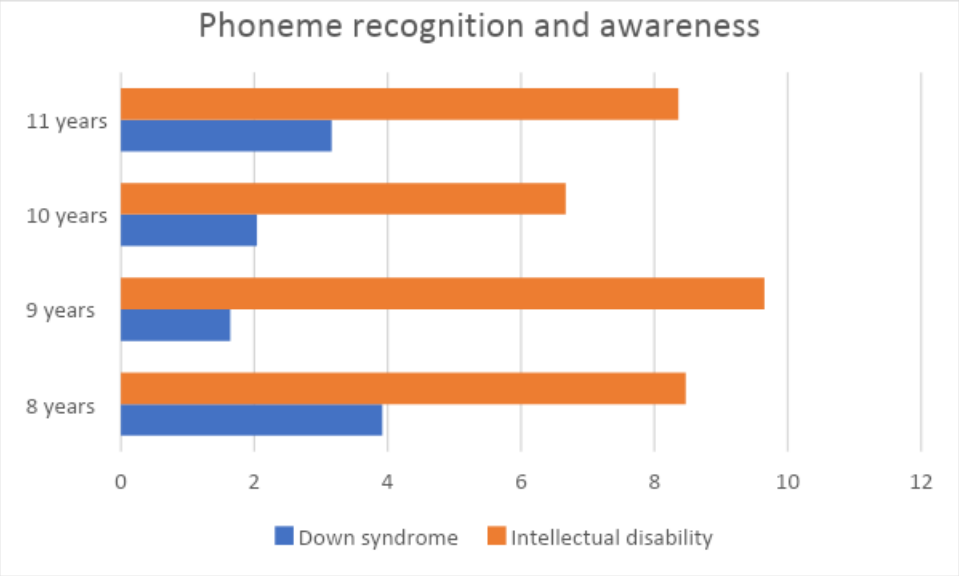

Figure 4. Phoneme recognition and awareness for children with intellectual disability and Down syndrome

There are significant differences between children with Down syndrome and those with intellectual disabilities regarding phoneme recognition. Children with intellectual disabilities generally have higher percentages. Children with Down syndrome experience a significant decrease in phoneme recognition at the age of 9, followed by a gradual increase. In contrast, children with intellectual disabilities maintain consistent recognition at 9 and 10 years, with a slight increase at 11 years after a temporary decline at 10 years.

Phoneme recognition and awareness bring notable trends in the distribution across intelligence levels. At mild and moderate levels, children with Down syndrome and intellectual

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disabilities exhibit similar performances. However, at severe levels, we observe a significant increase in performance for children with Down syndrome and a decrease for those with intellectual disabilities. This discrepancy may reflect the influence of cognitive specificities on phonetic abilities in this category of children.

The Phonological Awareness Screening Test (PAST) represents an essential means of assessing phonological abilities in children with intellectual disabilities and Down syndrome. The total scores, reflected in the data presented for the ages of 8, 9, 10, and 11 years, provide insight into the evolution of these abilities over time.

Table 5. Distribution of total scores on the Phonological Awareness Screening Test (PAST) by age.

	Phonological Awareness Screening Test (PAST)			
	8 years	9 years	years	11 years
Down syndrome	27,6	26,8	26,7	27,2
Intellectual disability	35,2	36	35,9	39,1

Total scores on the Phonological Awareness Screening Test (PAST) highlight significant differences between the two groups of children. Children with intellectual disabilities have higher scores compared to those with Down syndrome at all analyzed ages.

In the developmental stage at the age of 8, they achieve a total score of 35.2. At the age of 9, the total score increases to 36, remaining relatively stable at 35.9 at the age of 10. A notable aspect is observed at the age of 11, where a significant increase is noted, reaching a total score of 39.1. In contrast, children with Down syndrome exhibit a total score of 27.6 at the age of 8. At the age of 9, the total score is 26.8, remaining constant at 26.7 at the age of 10. Finally, at the age of 11, a slight increase is observed, reaching a total score of 27.2.

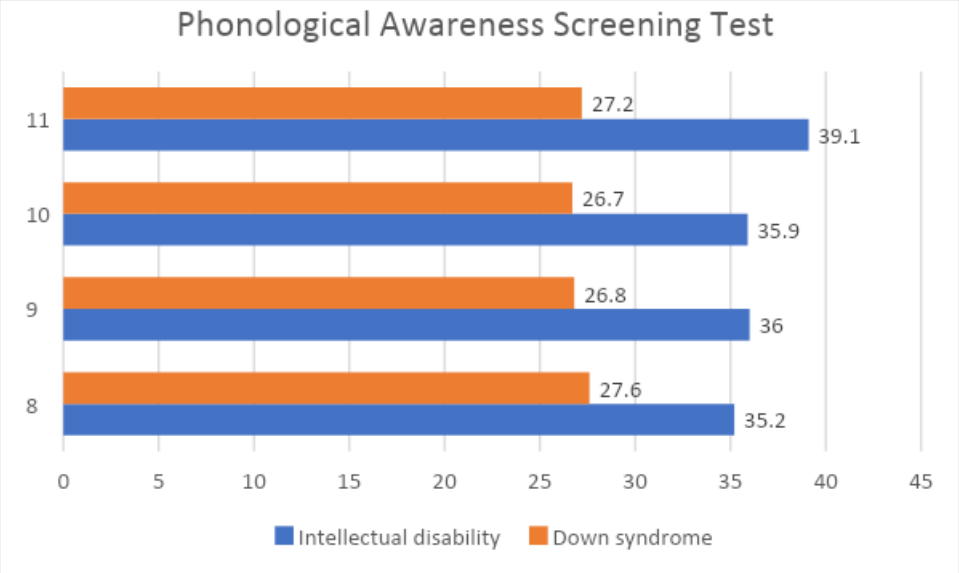

Figure 5. Total scores on the Phonological Awareness Screening Test (PAST)

Children with intellectual disabilities exhibit a relatively consistent evolution of total scores throughout the evaluation period. This stability may suggest a progressive and steady development of phonological abilities as they age. In contrast, children with Down syndrome seem to record smaller fluctuations in total scores. Nevertheless, a slight increase is observed at the age of 11,

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indicating a potential positive evolution in this group. Total scores on the Phonological Awareness Screening Test (PAST) vary significantly with age in both groups. Children with intellectual disabilities show a progressive increase, while children with Down syndrome experience a slight increase or maintain consistent scores.

Analyzing the total scores on the Phonological Awareness Screening Test (PAST) based on intelligence levels, a general trend is observed. At mild and moderate levels, children with Down syndrome and intellectual disabilities present relatively close scores, indicating a balanced distribution of phonological competencies in these categories. However, at severe levels, PAST scores significantly increase in children with Down syndrome, while those with intellectual disabilities experience a decline. This aspect may suggest a significant influence of disability severity on phonological skill performances.

To determine if there is a correlation between intelligence quotient, age, and phonological abilities in children with intellectual disabilities, we calculated the Pearson correlation coefficient.

Table 6. Correlation data between IQ, age, and PAST scores for children with intellectual disabilities.

Correlations

		QIid	AGEid	PASTid
QIid	Pearson Correlation	1	,053	,955**
	Sig. (2-tailed)		,656	,000
	N	74	74	74
AGEid	Pearson Correlation	,053	1	,115
	Sig. (2-tailed)	,656		,330
	N	74	74	74
PASTid	Pearson Correlation	,955**	,115	1
	Sig. (2-tailed)	,000	,330	
	N	74	74	74

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation data analysis between IQ (intelligence quotient), age, and PAST scores in children with intellectual disabilities reveals that the Pearson correlation coefficient between IQ and age is 0.053, indicating a very weak correlation. This suggests that there is no significant relationship between intelligence level and the age of the children in the studied sample. The Pearson correlation coefficient between IQ and PAST scores is 0.955, presenting a significant and positive correlation. This indicates a strong association between the intelligence level of children with intellectual disabilities and their performance in the PAST test. In other words, children with higher IQs tend to achieve higher scores on the PAST test. The significance values (Sig.) associated with these correlations are highly relevant. The correlation between IQ and PAST scores is significant at a very high level of confidence (Sig. = 0.000), while the correlations with age do not reach significant levels (Sig. > 0.05).

In conclusion, these results suggest a significant association between intelligence measured by IQ and performance on the PAST test among children with intellectual disabilities, while age seems

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to have a lesser influence. We applied the same procedure to analyze the results for children with Down syndrome.

Table 7. Correlation data between IQ, age, and PAST scores for children with Down syndrome.

Correlations

		QIds	AGEds	PASTds
QIds	Pearson Correlation	1	-,015	,900**
	Sig. (2-tailed)		,896	,000
	N	74	74	74
AGEds	Pearson Correlation	-,015	1	,092
	Sig. (2-tailed)	,896		,435
	N	74	74	74
PASTds	Pearson Correlation	,900**	,092	1
	Sig. (2-tailed)	,000	,435	
	N	74	74	74

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation coefficient between IQ and age is -0.015, indicating an extremely weak correlation. This result suggests that there is no significant relationship between the intelligence level and age of children with Down syndrome in the studied sample. The Pearson correlation coefficient between IQ and PAST scores is 0.900, presenting a significant and positive correlation at a high level of confidence (Sig. = 0.000). This result suggests a strong association between the intelligence level of children with Down syndrome and their performance in the PAST test. In other words, children with higher IQs tend to achieve higher scores on the PAST test. The Pearson correlation coefficient between age and PAST scores is 0.092, indicating a very weak correlation. This result suggests that age does not have a significant influence on the performance of children with Down syndrome in the PAST test. It is important to note that the correlation between IQ and PAST scores is significant at a very high level of confidence (Sig. = 0.000), underscoring the importance of this relationship. On the other hand, correlations with age do not reach significant levels (Sig. > 0.05). These results indicate a strong association between the intelligence level measured by IQ and performance on the PAST test among children with Down syndrome. However, age does not seem to significantly influence their performance in this specific test.

Conclusions

Phonemes, as basic units of language, play a crucial role in the process of language learning and communication. The analysis of these abilities in children with Down syndrome and those with intellectual disabilities between the ages of 8 and 11 reveals significant trends and differences between the two groups of children. The evolution of linguistic abilities in children with Down syndrome and intellectual disabilities constitutes a complex and varied domain. The significant differences between the two groups underscore the importance of adapting educational strategies to the specific needs of each child. Recognition and awareness of rhyme, syllables, and phonemes

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represent essential pillars in the development of language and communication, and identifying trends in these abilities can guide educational interventions.

Analyzing data regarding rhyme recognition and awareness in children with Down syndrome and intellectual disabilities, we observe significant variations in the evolution of this ability based on age and specific medical conditions. In children with Down syndrome, there is a decline at the age of 9, followed by a gradual increase at 10 and 11 years. In contrast, children with intellectual disabilities exhibit a more stable progression, with a significant increase at the age of 11. These findings suggest that early educational interventions can play an essential role in supporting the development of rhyme recognition skills in children with Down syndrome.

Regarding syllable recognition and awareness, significant differences emerge between the two groups of children. Children with Down syndrome undergo a series of fluctuations, experiencing a decline at the age of 9 and slight increases at 10 and 11 years. Conversely, children with intellectual disabilities seem to exhibit a more stable development, with a significant increase at the age of 11. These results underscore the complexity of the syllable learning process and highlight the necessity for educational strategies to be tailored to the specific needs of each group.

Data on phoneme recognition and awareness bring forth interesting aspects of the linguistic skills development in children with Down syndrome and intellectual disabilities. Children with Down syndrome exhibit a significant decline at the age of 9, followed by an increase at 10 and 11 years. At the same time, children with intellectual disabilities generally demonstrate high performance, with a slight decrease at 10 years and an increase at 11 years. These findings underscore the variations in the development of phonetic skills and suggest that educational programs should incorporate personalized approaches for each category of children.

The analysis of total scores on the Phonological Awareness Screening Test (PAST) provides a crucial perspective on the development of phonological awareness skills in children with intellectual disabilities and Down syndrome. The significant divergences between these groups indicate the complexity of the linguistic skills development process. For children with intellectual disabilities, total scores on the PAST reflect a constant and progressive evolution, suggesting a positive adaptation to the learning process of phonological skills. Conversely, children with Down syndrome exhibit smaller fluctuations, but slight increases at the age of 11 indicate a potential positive evolution. Analyzing the distribution based on intelligence levels in linguistic abilities reveals significant trends and specific variations for each evaluated aspect. At mild and moderate levels, children with Down syndrome and intellectual disabilities often demonstrate similar performances, implying certain convergences in the development of linguistic abilities in these categories. However, at severe levels, significant differences emerge, with children with Down syndrome frequently exhibiting better performances.

In the group of children with intellectual disabilities, we identified a significant and positive correlation between IQ and scores on the Phonological Awareness Screening Test (PAST). This finding indicates that children with higher levels of intelligence tend to achieve higher scores in phonological evaluation. In contrast, we did not observe a significant correlation between age and PAST scores, suggesting that, in the case of these children, age does not significantly influence measured phonological abilities. In the group of children with Down syndrome, we also identified a significant and positive correlation between IQ and PAST scores. This finding suggests that similar to the intellectual disability group, intelligence level is positively associated with performance in phonological evaluation. Additionally, we found that age did not have a significant influence on PAST scores in children with Down syndrome.

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In children with intellectual disabilities, including those with Down syndrome, the specific impact of intelligence level on phonological abilities can be complex. For instance, children with mild intellectual disabilities may fare better in language learning processes, but this does not exclude the influence of other disability-specific factors. In the case of children with Down syndrome, syndrome-specific characteristics, such as features of the oro-facial apparatus, may influence how they develop linguistic skills, including phonological awareness. When comparing the two groups, we did not identify significant differences in the correlations between IQ, age, and PAST scores. This finding indicates that, concerning the development of phonological abilities measured by the PAST test, children with Down syndrome and those with intellectual disabilities exhibit similar patterns of association between intelligence and performance.

For children with Down syndrome, the results indicate the necessity for early interventions and tailored support to manage significant declines in linguistic abilities at certain ages. Goetz (2008) and Tyler (2015) have demonstrated that early reading interventions can significantly enhance language skills, including reading, in children with intellectual disabilities and Down syndrome. Simultaneously, children with intellectual disabilities seem to benefit from increased resilience, suggesting that educational programs should leverage this resilience in their learning processes.

The relevance of these findings extends to educational interventions and the environment in which these children operate. The development of personalized educational programs adapted to the specificities of each group, could play a crucial role in enhancing phonological skills in these children and, consequently, supporting their learning processes. Further studies could delve deeper into the relationship between environmental factors, educational interventions, and the development of phonological awareness skills in this particular context.

In conclusion, the development of linguistic skills in these children is a dynamic process influenced by a range of complex factors. Future research should explore in more detail the interactions between developmental level and children's characteristics, the surrounding environment, educational interventions, and the evolution of linguistic skills, aiming to develop more effective and personalized strategies in the education of these children.

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