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Speech and Language Processing Abilities in Saudi Children With Speech Sound Disorders and Language Disorders

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Abstract

From a clinical practice perspective, the number of children with speech disorders is the largest, and there are also many children with both language disorders and speech disorders. However, there are currently few research papers on how these two communication disorder subcategories co-occur in Saudi, and our knowledge is quite limited. This paper chooses to start with speech processing ability to explore the relationship between speech disorders and language disorders and possible connections. A total of 34 children with speech disorders aged between 5 and 6 years participated in this study. They came from two preschools and were recruited to participate in the study after being diagnosed with speech disorders. The results showed that the two groups of children had similar abilities in this aspect, which was the most superficial commonality between the two groups. The corrected scores of non-word repetition showed that the performed similarly to the two normal control groups, but the scores of the speech-language disorder group were still lower than the mean scores of the control groups.

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INTRODUCTION

In the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), published by the American Psychiatric Association in 2013, there are four subcategories under communication disorders: (1) language disorder; (2) speech sound disorder; (3) childhood-onset fluent disorder (stuttering); and (4) social (pragmatic) communication disorder (Eissa, 2018a; Eissa & Omaima, 2019; Vitulano et al., 2024). From the perspective of diagnostic criteria, these four categories of disorders cover different levels of communication performance, from speech accuracy (speech sound disorder) to fluency (childhood-onset fluent disorder), and from the reception and use of vocabulary and sentence structure (language disorder) to oral and non-verbal communication in social interaction (social (pragmatic) communication disorder). However, DSM-5 also points out that children with language disorders, especially those with expression defects, may also suffer from speech disorders. In addition, language disorders are closely related to neurodevelopmental disorders such as specific learning disabilities (literacy and calculation), attention deficit/hyperactivity disorder, autism spectrum disorder and developmental coordination disorder, and are also related to social (pragmatic) communication disorders (Das et al., 2024; Eissa, 2018b; El Banna & Eissa Saad, 2019). In other words, language disorders are the most widely involved in communication disorders and have a certain core position.

PROBLEM STATEMENT

From a clinical practice perspective, the number of children with speech disorders is the largest, and there are also many children with both language disorders and speech disorders. However, there are currently few research papers on how these two communication disorder subcategories co-occur in Saudi, and our knowledge is quite limited. This paper chooses to start with speech processing ability to explore the relationship between speech disorders and language disorders and possible connections.

LITERATURE REVIEW

CHILDREN'S SPEECH DISORDERS

According to the diagnostic criteria of DSM-5, children with speech disorders do not have obvious neurophysiological causes such as intellectual disability or cleft lip and palate, have normal hearing, normal non-verbal intelligence, no obvious neurological symptoms, and do not show behavioral symptoms of autism, but their speech is usually difficult to understand (McCabe et al., 2024). In general, the speech characteristics of children with speech disorders are similar to those of younger normal children, the development process of phoneme pronunciation accuracy is roughly the same as that of normal children, and vowels have higher accuracy than consonants (Stoel-Gammon & Herrington, 1990). However, children with speech disorders also make some errors that are rare in normal children (Dodd et al., 2002), and there are also cases of pronunciation disorder, that is, some words have several different pronunciations in the same test (Dodd & McCormack 1995). Dodd & McCormack (1995) further standardized these pronunciation variation phenomena as the basis for the classification of speech disorder subtypes.

Some children with speech sound disorders have problems with pronunciation accuracy only, but still have adequate vocabulary, can produce grammatically complex sentences, and have good oral comprehension. A significant number of children in this category also show deficits in other language areas, such as insufficient vocabulary and inability to understand complex sentences (Shriberg et al., 2017).

NON-WORD REPETITION AND VOCABULARY LEARNING

In fact, there has long been a consensus in the literature on the relationship between speech development and vocabulary growth. Vocabulary learning involves paired processing of speech and

word meaning, and clear speech memory is an important condition for recognizing vocabulary. For young children, the speech memory of words is initially based on syllables, without fine segmentation. At around 3 years old, the speech information units of vocabulary begin to be refined and transformed into segmental units that are more effective in the process of vocabulary recognition and retrieval (Walley, 1993). Stoel-Gammon (1989) examined two 2-year-old children with delayed language development and found that there was a positive correlation between their vocabulary and the types of speech they mastered, that is, children who could correctly pronounce multiple phonemes had a larger vocabulary. Mirak & Rescorla (1998) used a similar method to test 37 children with language expression disorders and obtained the same results. Schwartz & Leonard (1982) pointed out that when learning vocabulary, young children often avoid words with unfamiliar phonetic forms, and this avoidance strategy has also been found in children with speech disorders.

The first to widely use non-word repetition tasks to detect children's phonological working memory was the British scholar Gathercole's team. Their research showed that the non-word repetition performance of normal children and children with speech disorders was positively correlated with language ability development (Gathercole & Baddeley, 1989). Listening to and repeating unfamiliar sounds is similar to some aspects of children's vocabulary learning in terms of process, so children's phonological working memory will directly affect the effectiveness of vocabulary learning, and their research did find that there was a high correlation between non-word repetition and vocabulary comprehension in 4- to 5-year-old children. In another longitudinal study (1992), Gathercole's team found that children's phonological memory at the age of four or five can effectively predict their later performance in learning vocabulary in elementary school. This predictive causal relationship also appeared in children with developmental language disorders (Gathercole & Baddeley, 1990). Later, many studies also agreed with the predictive role of phonological working memory deficits in children with language disorders (Bishop et al., 1996; Botting & Conti-Ramsden, 2001; Ellis et al. 2000; Gathercole et al., 1994; Gray, 2003; Conti-Ramsden et al., 2001). Based on these findings, poor performance in non-word repetition is also regarded as a risk marker for developmental language disorders. In recent years, some genetic studies on language disorders have also used non-word repetition as a key behavioral indicator (Peter et al., 2011).

There are two different explanations in the literature for children's difficulties in non-word repetition. One is based on the significant positive correlation between the accuracy of non-word repetition and other short-term memory tests (such as number or word memory), and then infers that the difficulty lies in the insufficient working memory capacity to process semantic information. Another view is that the difficulty comes from the children's insufficient phonological ability, because repeating non-words involves many processes of processing speech. From the recognition of speech acoustic signals and the segmentation of speech units at the receiving end to the planning and execution of speech muscle movements during production, the lack of ability in any link will have a negative impact on the non-word repetition task (Edwards & Lahey, 1998). Kirchner & Klatzky (1985) found that the speech repetition ability of children with language disorders is worse than that of normal children of the same age, and Bowey (1996) reported the association between speech sensitivity and speech memory of 5-year-old children. These research results all support the potential speech processing factors in non-word repetition tasks, that is, children's performance in repeating non-words may be closely related to their speech abilities.

THE PRESENT STUDY

This study explored the difficulties of children with speech disorders in speech processing ability, compared the performance of two groups of children with speech and language disorders and those with only speech disorders in three test tasks, and verified the relationship between speech processing ability and vocabulary learning ability reported in the literature. Based on the research results in the literature, the prediction of this study is that the children with speech disorders will have poor performance in repeating non-words, and this will affect the learning of new words.

RESEARCH QUESTION

Will children with speech disorders have poor performance in repeating non-words, and will this affect the learning of new words?

METHODS

PARTICIPANTS

A total of 34 children with speech disorders aged between 5 and 6 years participated in this study. They came from two preschools and were recruited to participate in the study after being diagnosed with speech disorders. After diagnosis, these children were not affected by hearing impairment, neurological damage or language and intelligence retardation. Language ability was evaluated using the "Preschool Language Scale 4" (Zimmerman et al., 2002). The cutoff point was set at the 10th percentile. Those with scores above the cutoff point belonged to the speech disorder group, with a total of 25 children; there were 15 children with scores below the cutoff point, who had more extensive language disorder characteristics and met the diagnostic criteria for language disorders, and belonged to the speech-language disorder group. Two typically developing control groups were also tested: an age-matched group, age range is 5 years 11 months to 6 years, and a younger group, age range is 4 years 11 months to 5 years 1 month. The four groups of subjects were tested for vocabulary ability using the Peabody Picture Vocabulary Test, and the average sentence length of the first 100 sentences was obtained from the 30-minute free-language sample.

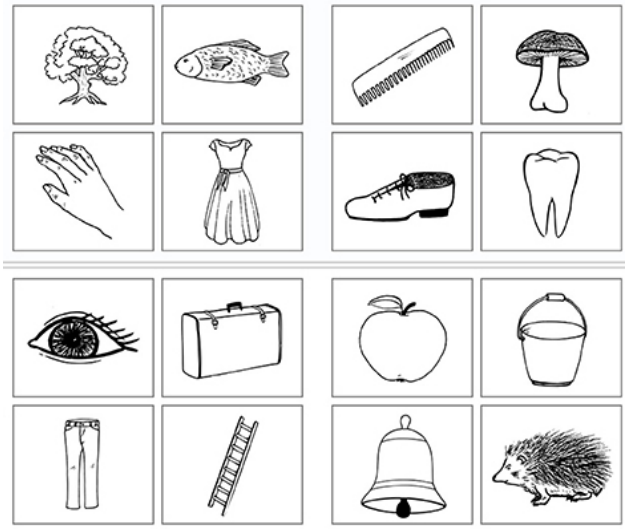
TEST TASKS

This study has three main tests: picture naming task, non-word repetition task, and quantifier elicitation and learning task, which respectively test the children's speech, phonological working memory, and vocabulary learning abilities. The details of each task are described below.

1. PICTURE NAMING

The task materials consisted of 16 pictures printed on 10 cm × 21 cm cards. At the beginning of the task, the experimenter showed the 16 pictures to the subjects one by one, and asked the subjects to say the name of the object in the picture and repeat it once. If the subject did not recognize the object in the picture, the experimenter provided the pronunciation of the target word and asked the subject to imitate it twice. The pronunciations collected were recorded and two analyses were performed. A content validity index was calculated at the item level (I-CVI = 0.90). The scale has test-retest reliability of .67 (see Figure 1).

Figure 1. *Picture Naming*



2. NON-WORD REPETITION

The aim of this test is to test the phonological working memory of the children. The entire test includes 3 practice questions and 16 formal test questions, each of which consists of 3 disyllabic non-words. There are no repeated syllables in each test. At the beginning of the task, the experimenter told the children to repeat some new words and to "say them exactly the same." The test started with 3 practice questions, repeating a disyllabic non-word each time, and entering the formal test after completing 3 non-words. A content validity index was calculated at the item level (I-CVI = 0.90). The scale has test-retest reliability of .62.

RESULTS

1. PICTURE NAMING TASK

Table 1 shows the statistical analysis. This showed that there were significant differences among the four groups [F (3,45) = 10.12, p < .05]. After post hoc comparison, only the difference between the two disorder groups was not significant (speech disorder group mean = 8.52, SD = 5.09; speech-language disorder group mean = 8.64, SD = 5.31). The results showed that the pronunciation accuracy of the speech disorder group and speech-language disorder group was at the same level.

Table 1. *Repeated-measures ANOVA by group*

Picture naming task	SS	df	MS	F	P	ηp2
Group	12.37	0.00	12.37	10.12	0.00	0.08
Error	99.73	87.00	1.10			

2. NON-WORD REPETITION TASK

Table 2 shows the scoring results of the non-word repetition task. Among the 4 groups, the speech-language disorder group had the lowest score (mean = 7.78), the speech disorder group was slightly higher (mean = 8.45), but still lower than the age-matched group (mean = 13.56) and the young group (mean = 12.26). One-way analysis of variance showed that there were significant differences between the groups [F (3, 45) = 8.19, p < .05]. Post hoc t-tests showed that children in both disorder groups performed worse than the age-matched group.

Table 2. *Scoring of non-word repetition task*

Group	Average (maximum = 16 points)	Standard Deviation	Correct rate (%)
The age-matched group	13.56	2.12	84.75
The young group	12.26	3.13	76.62
Speech disorder group	8.45	5.26	52.81
Speech-language disorder group	7.78	6.53	48.62

DISCUSSION

The picture naming task was used to test the pronunciation accuracy of the speech disorder group and the speech-language disorder group. The results showed that the two groups of children had similar abilities in this aspect, which was the most superficial commonality between the two groups.

Speech disorders may involve dysfunction of the oral motor system and the speech phonological system, and there is no need for there to be any correlation or conflict between these two causes. In the analysis of articulatory variation, both the speech-language disorder group and the the speech disorder group had fairly stable alternative pronunciations, and the two scores of the non-word repetition task indeed demonstrated that their pronunciation errors affected their repetition performance (Finestack et al., 2024). The corrected scores of non-word repetition showed

that the performed similarly to the two normal control groups, but the scores of the speech-language disorder group were still lower than the mean scores of the control groups (Gordon et al., 2024; Montgomery et al., 2024). The non-word repetition ability of the the speech-language disorder group is consistent with the results of studies on children with developmental language disorders in the literature (Bishop et al., 1996; Botting & Conti-Ramsden, 2001; Ellis et al., 2000; Gathercole et al., 1994; Gray, 2003).

At the level of phonological ability, when learning new words, children need to record the speech signal first, and perform segmentation and decoding (Edwards & Lahey 1998), and then enter the vocabulary comparison and analysis. The phonological system of children in the speech-language disorder group has not yet matured, and the efficiency of phonetic analysis and decoding is low. They perform poorly in the phonetic processing link of new word learning, resulting in difficulties in matching the phonetic form of new words with the meaning of words, resulting in grammatical and matching errors. It is also possible that some children use avoidance strategies and use universal quantifiers to answer the number of objects because they cannot master the phonetic form of new quantifiers. If these inferences are correct, then the phonetic problems faced by children in the speech-language disorder group are the source of their difficulties in non-word repetition and new word learning.

On the other hand, the speech disorder group had a smaller vocabulary and their pronunciation accuracy was also below the age expectation, just like the speech-language disorder group, but the root of their pronunciation problems should be in the oral motor system.

CONCLUSION

This study required the subjects to perform two tasks to explore the different performances of Saudi children with speech and language disorders in non-word repetition and vocabulary learning, and observed the association between phonological working memory, speech analysis, and vocabulary learning. In addition, the non-word repetition of both disorder groups was underestimated due to pronunciation errors. After correcting the scores, only the non-word repetition of the speech-language disorder group was worse than that of the age-matched control group, and there was more pronunciation variation. These results show that the main differences between children with speech disorders and children with speech-grammatical disorders are the variability of incorrect pronunciation and the ability to repetition non-words.

LIMITATIONS AND FUTURE RESEARCH DIRECTION

Although the sample size of the subjects tested in this study is small, an important research direction has been explored, that is, it is necessary to strengthen the research on the speech processing ability of children with speech disorders, understand the differences between the two subcategories of speech disorders and language disorders from multiple perspectives, and improve the clinical efficacy of treatment for children with speech disorders.

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