

RESEARCH ARTICLE



Developing acoustic analysis skills among students with developmental apraxia of speech (DAS)

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Abstract

Objectives: This study aimed at examining the effectiveness of a cognitive training program on promoting phonemic awareness skills on acoustic analysis skill among students with developmental apraxia of speech (DAS) in Saudi Arabia. **Methods/Statistical analysis:** the semi-experimental approach was used in this study. The training program was applied on (12) male and female students from the fourth and fifth grades from schools at Abha Educational District. Data were collected through the Developmental apraxia of speech (DAS) Scale developed by the researcher along with acoustic Analysis Scale developed in the literature Data were analysed using the SPSS software package. **Findings:** The results of the study showed significant improvements in acoustic analysis skills of the students who received the training program compared to students who were taught using the conventional methods. The results also revealed no connection between the age of students and their interaction with the developed training program. The final mean scores of the experimental group were better than the control group as scored in the post test, which indicated the effectiveness of the developed training program in improving acoustic analysis skills among the sample of the study. **Application/improvements:** special education teachers can use the designed program to help students with apraxia. Future research can investigate visual analytical skills in developmental apraxia of speech (DAS) in handwriting and other areas.

Keywords: Apraxia; acoustic analysis; phonemic awareness

1 Introduction

Apraxia is a major type of problems among children having learning disability and is categorized within developmental learning difficulties. Educators, and especially those working in the field of special education, agree that it is necessary to help students who suffer from apraxia, but the main problem that faces

them remains in finding the scale or the tool that will help them in detecting students with apraxia. Failure to diagnose the students results usually in describing them as having laziness or negligence. Because of the unavailability of correct diagnoses and adequate special services for those cases, the results are negative most of the times. For example, students may surrender to their learning disability, and therefore, their academic achievement will decrease, and eventually will force them to be absent deliberately to avoid frustrating classroom situations, which also can be accumulative frustrations (1).

1.1 Problem Statement and Questions of the Study

The main objective of the study was to develop a phonemic awareness based training program and examine its effectiveness in promoting acoustic analysis skills among students with verbal apraxia. Specifically, the problem of the study was addressed in the following questions:

1. Are there any statistically significant differences in acoustic analysis skills of students with developmental apraxia of speech (DAS) between the experimental and control groups due to the effect of the training program?
2. Are there any statistically significant differences in acoustic analysis skills of students with developmental apraxia of speech (DAS) between the experimental and control groups due to gender?
3. Are there any statistically significant differences in acoustic analysis skills of students with developmental apraxia of speech (DAS) between the experimental and control groups due to the interaction between group and gender?
4. Are there any statistically significant differences in acoustic analysis skills of students with developmental apraxia of speech (DAS) between the experimental and control groups in the posttest?

1.2 Significance of the Study

The theoretical significance of the study stems from the importance of phonetic awareness and its effect on developing acoustic analysis skills among students with verbal apraxia. The practical significance of the study is represented in its attempt to develop a scale to identify developmental visual physical apraxia disorder. Furthermore, the study employed an Acoustic Analysis Scale with high validity and reliability coefficients that may be used by educational institutions, special education centers, and school counsellors to identify learning difficulties. In addition, the current study provides resource rooms' teachers with a practical training program and a test that may help them in training students with developmental apraxia of speech (DAS) to use phonetic awareness skills. Resource rooms lack such training programs.

1.3 Delimitations of the Study

1. The psychometric properties of the scale used in diagnosing students, with developmental apraxia of speech (DAS), the subjects of the study.
2. The sample of this study was limited to developmental apraxia of speech (DAS) students in the age group (8-12) enrolled in resource rooms at schools in Abha Educational Directorate- KSA in the first semester 2018/2019.
3. The results of this study are determined by the ability of resource rooms' teachers to apply the developed training program and their ability to measure students' responses to the scale tailored to achieve this objective.

1.4 Definition of Operational Terms

Phonemic Awareness

Phonemic awareness was defined as the conscious management with speech voice tune. In other words, phonemic awareness is to have the ability to recognize and acknowledge the location of language acoustic production, how to pronounce them, and the nature of language acoustic formulation to form words, phrases, utterances with the ability to recognize similarities and differences between these sounds as a whole or in words (2). In the current study, phonetic awareness is defined as a set of practical activities contained in the developed training program.

Apraxia

A developmental disorder and difficulties in acquiring behaviours that depend on using hands and fingers. Children with apraxia do not face any stereotyped problems in walking and swimming, but encounter problems in performing tasks requiring the use of delicate muscles such as writing. The specialist explain this by arguing that when this group of students well recognizes what is needed to be done, their brains cannot command the body organs to do the required tasks appropriately (3).

Verbal Apraxia

A condition among children who have severe problems in producing clear speech despite the absence of any damage to muscles. These children have major difficulties in speech sounds production and in ordering sound letters in the same word (4).

Effectiveness

The improvement resulting from the acoustic analysis training program is measured by the differences in the mean scores of the pre-posttests of these skills and in the participants.

2 Literature Survey

Apraxia is one of the main disorders found in people with learning difficulties and is considered as a developmental learning difficulty. The learning process in any classroom includes responding to the various sounds and voices received from the surrounding environment. This requires from students the ability to recognize these sounds and voices, organize them, and then giving the appropriate responses. Students with low acoustic awareness tend to be unable to realize the meaning of sounds and voices, which leads to negative impacts appearing in their understanding, ability and academic achievement to communicate with others. Several scholars associated the acoustic analysis skills with learning difficulties, as they argue that developmental deficits in acoustic analysis skills have great impact on readability. The ability to analyse, remember acoustic stimulus, sequencing them is vital for reading process.

The basic problem faced by educators in this field is the lack of robust tools or scales that may assist in identifying these students. Furthermore, the Arab educational field lacks appropriate training programs that may be helpful for such students. As a consequence, the reported results related to this type of students tend to take negative directions, and eventually affect the students' academic achievement and making them vulnerable to school absence to avoid embarrassing and frustrating class situations; leading to several psychological disorders (5) Most times, students with learning difficulties fail in analysing the vocal structure of speech, whether this was on the word or on the sentence level. The more the student has the ability to analyse words into separate syllabus, the better his/ her readability level.

This has urged the researcher to develop a scale to identify a apraxia, to identify a apraxia in the Arab environment. The development of such a scale was based on using a preliminary checklist for apraxia, a reading identification list, an orthography identification list, and social skills and communication identification list.

2.1 Previous Studies

Many studies have tackled the issue of phonemic awareness and its effect on developing acoustic analysis skills among students with apraxia. One study investigates the relationship between the types of errors resulting from children with speech disorders and the development of language and phonemic awareness skills. The study was conducted on a sample of (40) children, half of whom suffer from speech disorder and the other half do not. Speech and language tests were used to measure the level of children. The results concluded that poor phonetic awareness skills are associated with neglect and unconventional speech errors (6).

Another study explored the awareness and understanding of pre-school teachers of conditions of apraxia and the different means of providing support to children with apraxia. The study applied the semi-structured interviews on (15) pre-school teachers from the Cape Peninsula, South Africa. After conducted the thematic analysis of these interviews, the results of showed high degree of awareness among participants regarding the behavioural and cognitive difficulties related to apraxia. Teachers showed the importance of having professional development in order to provide better assistance to their students (7).

A similar study conducted in the same country to explore another dimension related to students with apraxia, and this time from the point of view of the parent-carer rather than the teacher. The study applied semi-structured interviews on a sample of (15) parents from the Cape Peninsula, South Africa. The results of this investigation revealed that parent-carers have high rates of awareness regarding the problems their children have in relation to apraxia and the needed help and assistant to such children. Parents-carers showed the importance of seeking counselling from the professionals in local schools to help them support their children (8).

Another South African study evaluated different levels of phonological awareness among Sotho speakers in order to determine the relationship between phonological and apraxia and reading. The study was conducted in the city of Shwani in southern Africa on a sample of third graders. Statistical analysis revealed that Sotho speakers are highly skilled in identifying syllables rather than phonics, and that phonological awareness predicts better accurate reading outcomes. The study concluded that phonological awareness does not necessarily develop in the early stages of language through a single syllable (9). One of the studies conducted to explore the effect of educational and career level of parents on the development of phonemic awareness of first and second grade students. The study was conducted on a sample of (70) students from basic schools in Bosnia and Herzegovina. The results revealed that the educational and career level of parents affect the development of phonemic awareness of

students with apraxia in the first and second grades and this development of phonemic awareness is higher for students whose parents have higher jobs and academic qualifications. (10)

In Jordan, one study explored the effectiveness of using story-reading activities and written expression on improving phonemic awareness and awareness of printed materials among kindergarten children in Jordan. The study was based on the semi-experimental method and was applied on (50) students. The results showed a positive impact of the use of written expression and story reading activities in the development of phonemic awareness and awareness of printed materials, and in favour of the experimental group.

The majority of previous studies confirmed the importance of developing acoustic analysis skills as they are strongly related with academic skills learning. The deficits in phonemic awareness skills among students with learning difficulties lead to negative effect on their hearing skills and the need for training programs in developing phonemic awareness were highlighted in these studies. The current study is similar to previous studies in its investigation of phonemic awareness skills as a major problem faced by students with learning difficulties. However, the current study is different from previous studies in this design of the training program as it was developed based on the cognitive psychological theory to promote phonetic awareness. Furthermore, the sample in the current study is different as it consists of students with verbal apraxia. Finally, this study differ in its design and methodology as it uses the semi- experimental design to investigate the impact of the training program on developing acoustic analysis skills.

3 Methods and Procedures

3.1 Population and Sample of the Study

The population of this study consisted of all (580) students enrolled in the resource rooms, and who are diagnosed with learning difficulties , in the public schools at Abha Educational Directorate, from the 4th, 5th and 6th grades. After the administration of apraxia Identification Scale on the whole population of the study, the sample of this study consisted of (12) students suffering from apraxia. This disorder appeared only in the 4th and 5th grades from the population of the study.

The sample of the study was randomly distributed to two experimental groups and two control groups. The first experimental group contained male students and second experimental group contained female students. First control group contained male students and second control group contained female students.

3.2 Design of the Study

The current study used the semi- experimental approach as it aimed to identify the effect of a cognitive training program on developing acoustic awareness skills and their effect on phonemic awareness among developmental apraxia of speech (DAS) students. The study used experimental control groups design based on the use of a pre- posttest and a posttest.

3.3 Instruments of the Study

3.3.1 Acoustic Analysis Skills Test

The acoustic analysis scale measures the ability to analyze components of phonetic patterns and to identify the phonetic pattern resulting from omitting a specific syllabus of the original pattern. The scale then diagnoses deficits in this skill and the resulting consequences on the academic achievement, particularly in reading, spelling, and dictation of students enrolled in the resource rooms at schools. The scale also tests the levels of readiness to read and the related skills such as spelling and dictation among students in their early school years. The scale provides significant diagnostic information that teachers may use in designing intervention and training programs concerning training students to use acoustic analysis skills for different language sounds, discriminating between letters and their corresponding sounds.

3.3.2 Multidimensional Scale to identify apraxia

The researchers developed apraxia identification Scale for students in 4th, 5th and 6th grades who are diagnosed as having learning difficulties. This included different steps:

Phase One: Determining Domains

In this phase, a list of apraxia symptoms the scale seeks to measure at each grade level and for each domain was developed. Furthermore, the main fields covered by the scale were determined based on the domains list by reviewing some related scales designed to identify learning difficulties (e.g. PIST Scale).

Phase Two: Scale Development

After the apraxia domains have been identified, and the fields covered by the scale to measure these difficulties, the researcher developed the scale by asking resource rooms teachers to identify and describe apraxia disorder symptoms. Based on this, the final format of the scale items was developed.

Phase Three: Pilot Study

At the completion of phase two, the scale was administrated to a sample consisting of (37) students randomly selected from the 4th, 5th and 6th grade students. The clarity of test instructions was confirmed and the effectiveness of each item was verified by calculating the difficulty and discrimination coefficients for each paragraph individually. Paragraph reporting discrimination coefficient less than (0.3) were eliminated and paragraph, which reported a difficulty coefficient at (0.2-0.9) were also eliminated.

Phase Four: Validity of the Test

The validity of the test was determined by consulting a group of specialists to take their remarks with respect to the structure and language of items and their ability to achieve the intended objectives. The language of each individual paragraph and belonging to the designated domain were tested.

Phase Five: Reliability of the Test

Reliability of the paragraphs was measured using Test- retest reliability and calculating Cronbach Alpha.

Phase Six: Discrimination of the Paragraphs

To determine the discrimination of the test, discrimination coefficients for each individual paragraph was computed by measuring the correlations between performance on each paragraph with the domain score, which the paragraph belongs to, and the scale total score for each grade levels included in the study.

3.3.3 The Training Program

The purpose of the training program was to develop acoustic analytical skills in students with developmental apraxia of speech (DAS) enrolled in the resource rooms in schools of Abha Educational Directorate – KSA. These skills have a significant effect on improving the learning process. The training program consisted of drills, exercises, and activities developed by the researchers to enable students to acquire skills within the phonological awareness skill dimensions.

This training program was designed in an attempt to meet the needs of apraxia students by training them to use some strategies that can develop their acoustic analytical skills. The program provided an acoustic content suitable for the targeted age group to help them in receiving and retrieving message effectively, especially in communication situations happening within the classroom.

4 Results and Discussion

The following is a display and discussion of the results for this study.

The first question of this study attempted to find the connection between using the cognitive training program and the acoustic analysis skills of students with developmental apraxia of speech. To answer this question, means and standard deviations for experimental and control groups scores on the pre-posttests were computed, and **Table 1** presents the results.

Table 1. Means and standard deviations for scores of the experimental and control groups on the pre-posttests according to group

Group	No.	Pretest		Posttest	
		M	SD	M	SD
Experimental	8	4.38	0.518	12.13	0.835
Control	4	4.50	0.577	8.75	0.500

Table 1 shows differences in the mean score of the experimental groups students in the pre-test and posttest, where it was (12.13) for the posttest and (4.38) for the pre-test. The mean score for the control groups students on the posttest was (8.75) while it (4.50) for the pre-test. To identify the differences in the means scores and their direction, ANCOVA analysis was used and the results are presented in **Table 2**.

Table 2 shows that the differences between the mean scores for the control groups and experimental groups were statistically significant as F was (F=70.153) at the significance level (0.000). In other words, there clear differences in the scores of the experimental groups students in the posttest after receiving the cognitive training program. They also scored better than the control groups’ students, who did not participate in the training program.

The results of the current study showed that there are improvements in words reading among children, who receive the training program compared to children in the control groups. Moreover, these results are consistent with results found in the literature regarding the role of using intervention programs in developing phonemic awareness among students with apraxia.

Table 2. ANCOVA analysis for developmental apraxia of speech (DAS) students on the acoustic analysis test

Source of variance	Total squares	Df	Squares average	F	Sign.
Pretest	1.571	1	1.571	3.487	0.095
Group	31.603	1	31.603	70.153	0.000
Error	4.054	9	0.450		
Total	1488.000	12			

The results may be due to several advantages the training program provides, such as the several training activities that focused on acoustic analysis, audio memory, audio closure, and audio discrimination between the form and the background. This was achieved via the use of different learning media such as audio recordings, different photos, models, and cubes. The training program was able to increase the efficacy of students as it was appropriate to this age level, easy to use and was administrated in a suitable sequence. In addition, the researchers created the optimal learning environment during the training sessions by eliminating distracters, drawing children attention by the variety of educational games, and reinforcing students, which attracted children attention in the different training sessions, and eventually, had positive effects on their participation.

The second question of this study attempted to explore the variable of gender and its effect on the final achievements of students participated in this training program. The third question further investigated the interaction between each group and the gender of each group. To answer these two questions, means and standard deviations for the female and male groups on the pre-posttests were calculated.

Table 3 shows that the mean score for male students in the control groups on the posttest was (8.85), while the mean score for male students in the experimental groups on the posttest was (12.00).

Table 3. Means and standard deviations for the female and male groups on the pre-posttests

Group	Test		Gender		
			Male	Female	Total
Experimental	Pre-test	M	4.25	4.50	4.38
		SD	0.50	580.0	0.520
	Posttest	M	12.00	12.25	12.13
		SD	816.0	0.57	0.835
Control	Pre-test	M	4.50	4.50	4.50
		SD	71.0	710.0	0.580
	Posttest	M	8.50	9.10	8.75
		SD	707.0	0.230	0.500

The mean score for female students in the control groups on the posttest was (9.01) while the mean score for female students in the experimental groups on the posttest was (M= 12.25). To identify the differences between the mean scores and to identify their direction, ANCOVA was used to determine the effect of the group and gender as shown in Table 4.

Table 4. ANCOVA analysis for the effect of group and gender and the interaction between the two variables in students with developmental apraxia of speech (DAS) in acoustic analysis test

Source of variance	Total squares	Df	Squares average	F	Sign.
Pretest	10455	1	10423	20683	0.145
Gender	0.212	1	0.234	0.391	0.552
Group	31.543	1	31.759	58.198	0.000
Gender X group	0.125	1	0.132	0.226	0.649
Error	3.795	7	0.542		
Total	1488.000	12			

Table 4 shows that the differences between the mean scores of female and male students on the acoustic analysis were not statistically significant. F value was (0.391) with a significance level of ($\alpha = 0.391$). This value is bigger than the significance level employed in the current study set at ($\alpha \leq 0.05$), which means there are no differences in the scores of female and male students. As for the interaction between gender and group, the differences were not statistically significant (F=0.226, Sign.

0.649), which means accepting there is no relationship between the interaction between gender and group.

This result is consistent with the result reported by previous studies on the relationship between the gender of students and their interaction with the training programs designed to help students with apraxia. The results of this study indicated no statistically significant differences in the memory test between male and female students with learning difficulties. This result can be due to the fact that training is not influenced by students' gender as it was effective for both genders.

The fourth question of this study attempted to find the statistical differences between the achievement of the experimental and control groups in the post test after applying the training program. To answer this question, means and standard deviations for both study groups (experimental and control) in the pretest and post test were calculated as shown in Table 5.

Table 5. Means and standard deviations for experimental and control for students with developmental apraxia of speech (DAS) on the pretest and posttest according to group

Group	No.	Pretest		post-test	
		M	SD	M	SD
Experimental	8	4.38	0.518	12.63	0.916
Control	4	4.50	0.577	8.50	0.577

Table 5 shows apparent differences in the mean scores of all groups. The mean scores for experimental groups' students and control groups' students were (12.63) and (4.38), respectively. To identify the differences in the mean scores and their direction, ANCOVA analysis was used as shown in Table 6.

Table 6. ANCOV Aanalysis for the group effect in developmental apraxia of speech (DAS) students in the posttest

Source of variance	Total squares	Df	Squares average	F	Sign.
Pretest	0.440	1	0.440	0.616	0.453
Group	45.794	1	45.794	64.049	0.000
Error	6.435	9	0.715		
Total	1571.000	12			

Table 6 shows that the differences between the mean scores of control and experimental groups students were statistically significant. F value was (76.0493) with a significance level ($\alpha=0.000$), which means there were statistically significant differences between the scores of the experimental group and control group, and in favor of the students of the experimental groups who received the training program.

5 Conclusion and Recommendations

Developmental apraxia of speech (DAS) is a major problem faced by students with learning difficulties. Educators also find difficulties in treating this category of students despite the existence of different training programs to solve this problem. This study attempted to investigate the use of one cognitive training program, designed by the researcher, to help students build the acoustic analysis skills in order to improve their phonemic awareness. The findings of the study support that the use of this program helped students in achieving better scores in the acoustic analysis test and improving their phonemic awareness as shown in the previous section. Students' gender did not have any effect on their scores, which was explained due to the same treatment students received regardless of their gender.

In light of the results reported in the current study, it was found that the training program was effective in developing acoustic analytical skills in students with verbal apraxia. Therefore, the following recommendations were suggested:

1. To develop more training programs to promote developmental skills in students with verbal apraxia.
2. Future research examining visual analytical skills in developmental apraxia of speech (DAS) in handwriting is needed.
3. There is a need for studies examining motor- visual skills relapse in students with developmental apraxia of speech (DAS) in physical education.
4. Special education teachers can adopt this training program in teaching students with developmental apraxia of speech.

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