APRAXIA AND SPEECH PRODUCTION: EFFECTS OF VERBAL RELATIONS' STRENGTHENING

Apraxia e produção da fala: efeitos do fortalecimento de relações verbais

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ABSTRACT

This study proposed to report the effect of improvement of reading relations and transfer of stimuli control on speech production of a child diagnosed with speech apraxia. The program "Learning to Read and Write in Small Steps®" was used. The activities were conducted in 22 sessions, in two weekly sessions of 30 minutes each. As result there was improvement in the correct responses percentage on speech production of the participant with different stimuli. The results corroborate the preview studies that speech outcome can be improved by strengthening the reading and writing network while addressing the equivalence relations.

KEYWORDS: Apraxias; Speech; Teaching; Verbal Behavior

INTRODUCTION

Infant speech apraxia is defined as difficulty in voluntarily programming articulatory gestures. Although the individual knows that he wants to speak, he has difficulty producing the appropriate sounds (syllables and words). The topography of infant speech apraxia resembles apraxia that is acquired in adulthood. The difference between these two types of apraxia is related to the etiology and type of impairments[1]. The literature presents several terms that identify this condition. In the present article, we use the term "infant speech apraxia" based on the American Speech-Language-Hearing Association (ASHA)[2].

The prevalence of this communication disorder is 1-2 in every 1000 children. It is more common in males, but more severe manifestations occur in females.[3] Studies on infant speech apraxia began in the 1970s, and speech therapists indicated that children with speech apraxia do not improve or minimally improve with conventional speech therapy. Apraxia has two diagnostic markers. The first marker is related to voluntary speech programming (e.g., a task of repeating dictated words said by another person). The second marker refers to the inconsistency of errors in speech sounds, in which an individual can correctly produce a word in one situation but produce the word with errors in another situation. The literature presents a consensus when describing[3] and characterizing speech apraxia and reporting the importance of therapeutic procedures that utilize the principles of motor learning to acquire control or improve precision and consistency in speech programming and planning, thus achieving word production and its point-by-point correspondence with the conventions defined by the verbal community in repeated trials (programming and planning).

The production of speech that can be comprehended by a listener is one of the principal targets of speech investigation and intervention. However, no consensus has been reached in the literature with regard to what must be evaluated[4].

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With regard to apraxia specifically, the literature has shown different possibilities of intervention, highlighting the complexity of the cases and the slow and difficult therapeutic process. Although apraxia is a disorder in the linguistic-phonological domain, therapeutic processes that emphasize only this perspective are not fully efficacious in clinical speech therapy because essentially articulatory aspects are not sufficiently strengthened. According to the literature, mixed therapeutic perspectives in interventions for apraxia are more effective[5].

In the scope of behavioral analysis, studies on stimulus equivalence can guide research to identify the conditions under which verbal behaviors that are independently established (e.g., listening, speaking, reading, and writing) can be related to each other[6]. Verbalizations by a subject when presented with text (reading designates) and figures (naming designates) are established under independent conditions. The establishment of one of these behaviors does not necessarily result in the establishment of the other; unless the necessary conditions for learning are provided[7,8]. Equivalence relations between stimuli describe the symbolic values that topographically distinct stimuli have in the behavior of individuals with well-established verbal repertoires.

Sidman[9] presented a pioneering study on stimulus equivalence, in which a 17-year-old boy with microcephaly was taught to pair printed words (designated by the letter C) with the respective dictated word (designated by the letter A). The participant was already able to select figures (designated by the letter B) that corresponded to dictated figures (A), and he also already knew how to vocalize responses (designated by the letter D) when presented with figures (B). After teaching conditional AC relations (dictated word-printed word), the emergence of performance in selecting between figures and printed words (BC) and printed words and figures (CB) was observed, in addition to vocalization when presented with printed words (CD). Therefore, Sidman demonstrated that the proposed arrangement was able to promote the emergence of skills that were not directly taught, including reading with comprehension[10].

Other studies have been conducted with this model[11, 12], reaffirming that the teaching of conditional relations with an element in common results in other non-taught relations under different conditions and with different procedures. More recently, Golfeto[13] performed a study on speech production in children with pre-language audition deficiency who used cochlear implants. Relations were taught between auditory (A) and visual (B) stimuli and relations between dictated words (A) and printed words (C), with the goal of verifying whether this teaching method would favor the emergence of responses in symbolic character, thus broadening auditory comprehension and possibly speech. The majority of the participants learned conditional relations that were taught, with the emergence of non-taught relations for a significant number of words. Additionally, performance in naming probes and the periodic imitation of words were considered strategically favorable for demonstrating a gradual increase in the number of correct responses by the participants.

Anastácio Pessan[14] demonstrated how expressive language in deaf children with cochlear implants could improve with similar procedures by teaching six children to emit more comprehensible speech and transfer the functions of speech control from text to figures. Although the children displayed precise reading skills, they presented many distortions in naming. The study consisted of strengthening conditional relations between dictated words and figures (AB) and between dictated words and printed words (AC), tests of the formation of equivalence classes (BC and CB), and teaching conditional relations between printed syllables and dictated syllables, each followed by tests of naming figures (BD) and reading words (CD). The results of this study demonstrated that strengthening the network of relations favored the transfer of control from reading to naming and, therefore, to speech production, with increased point-by-point correspondence with the conventions defined by the verbal community in tasks of naming figures.

A recent study[15] evaluated children with cochlear implants who were exposed to the program "Aprendendo a Ler e a Escrever em Pequenos Passos®" and taught relations between dictated words, printed words, and figures and relations between dictated syllables and printed syllables. The results showed the transfer of control from reading to naming, with an improvement in the production of verbal responses when presented with figures after teaching, thus creating methodological and therapeutic methodologies using this program to teach reading and writing in populations with speech language problems.

Combining the monitoring of speech in systematic reading programs, the fact that visual and auditory stimuli facilitate the correction of speech production, and the model of stimulus equivalence as an operational criterion in the description of behavior, the present study sought to verify the influence of strengthening specific relations that describe reading and procedures to transfer stimulus control over speech production (with point-by-point matching) on speech apraxia.

PRESENTATION OF THE CASE

The participant in this study, DJ, was 12 years old and had a diagnosis of infant speech apraxia. He presented inconsistent speech errors, problems combining speech sounds, increased pauses between words, syllables, and sounds, word simplification, the omission of syllables and sounds, and the production of inadequate articulatory movements. These characteristics had a severe impact on speech production. In addition to speech apraxia, DJ also had a cleft palate that was surgically corrected but continued to have velopharyngeal insufficiency, which was treated with a palatal prosthesis and speech therapy. Speech apraxia may at least partially explain the failure of speech therapy to correct speech disorders related to velopharyngeal insufficiency, explaining the difficulty obtaining improvement in point-by-point matching in speech production. Velopharyngeal insufficiency was corrected with a prosthetic palate, and speech therapy improved the articulatory accuracy and consistency of the correct production of speech sounds, but inconsistent errors that are characteristic of speech apraxia remained unresolved. The palate prosthesis was successfully used daily by DJ, creating a velopharyngeal condition that allowed its proper closure when required during speech. We then opted for an apraxia intervention using the programs "Avaliação da Rede de Leitura e Escrita" and "Aprendendo a Ler e a Escrever em Pequenos Passos®." Using this approach, we sought to improve speech production by strengthening specific relations that describe reading in the present case of apraxia.

At the time of the intervention, DJ was attending the fourth year of elementary school in a public school in a city in the countryside of São Paulo state, Brazil. DJ also underwent therapy twice per week in specialized institutions where he received speech and psychological care. The participant was already literate, had preserved hearing, and understood language. DJ's responsible guardian signed a Statement of Informed Consent to allow the disclosure of intervention data.

This research was part of a larger project that was approved by the Ethical Committee in Research of the Faculdade de Ciências de Bauru/Universidade Estadual Paulista "Julio de Mesquita Filho" (FC/UNESP-Bauru; approval no. 13653/46/01/12).

Experimental design

In the present study, we adopted a single-subject experimental design, in which the participant's performance was his own control using successive measures of performance obtained during the study. The tradition in this type of research has been to present results individually[16]. In the present study, we evaluated the effects of different teaching procedures on the production of speech in figure naming tasks.

Materials and conditions of data collection

We used the programs "Avaliação da Rede de Leitura e Escrita" and "Aprendendo a Ler e a Escrever em Pequenos Passos®" that were controlled by the LECH-GEIC platform. This platform is a web system that enables the authoring and remote and online application of learning programs without the need to download the programs on the computer[17,18].

The "Avaliação da Rede de Leitura e Escrita" program was initially used to characterize the participant's repertoire in different relations that describe reading and writing and evaluate the ability of the program to teach reading. This was used to teach basic repertoires of reading and writing simple words, predominantly consisting of syllables of the consonant-vowel type, with a total of 60 words. The procedure was divided into five units that consisted of the following steps: training selection and naming of figures, teaching conditional relations between dictated and printed words (AC) and writing skills under dictation based on the composition of syllables that were presented on the computer screen (AE screen), and pre- and posttests that were presented before and after each unit, respectively.

In addition to these programs, we used slides created and applied via Microsoft PowerPoint 2010, with the presentation of figures and printed words according to the four steps of the procedure described below.

The sessions were performed in the clinical school that the subject attended. The data described in this study were collected over the course of 22 sessions performed by the subject, with an average duration of 30 min each.

Procedures

The overall design of the study involved the evaluation of the network of reading and writing, exposure to training steps, and selection and naming of figures according to the steps of word and syllable teaching, which were all managed by GEIC software[17]. After teaching, the transfer of the maximum control exerted by the written word to the naming of figures was performed. The teaching procedures are described in detail below.

1. Evaluation of reading and writing network. This step was developed to characterize the subject's performance in three types of tasks: selection, vocalization and writing.

1.1. Selection tasks. Tasks of selecting between dictated words, printed words, and figures were conducted, in which one was presented as the model and three were presented as comparisons using a matching-to-sample procedure. The task was to select the correct comparison stimulus: figure/figure (BB), printed word/printed word (CC), dictated word/figure (AB), dictated word/printed word (AC), figure/printed word (BC), and printed word/figure (CB). Item 1.1 in Figure 1 shows an example of a relation between a dictated word and printed word (AC).

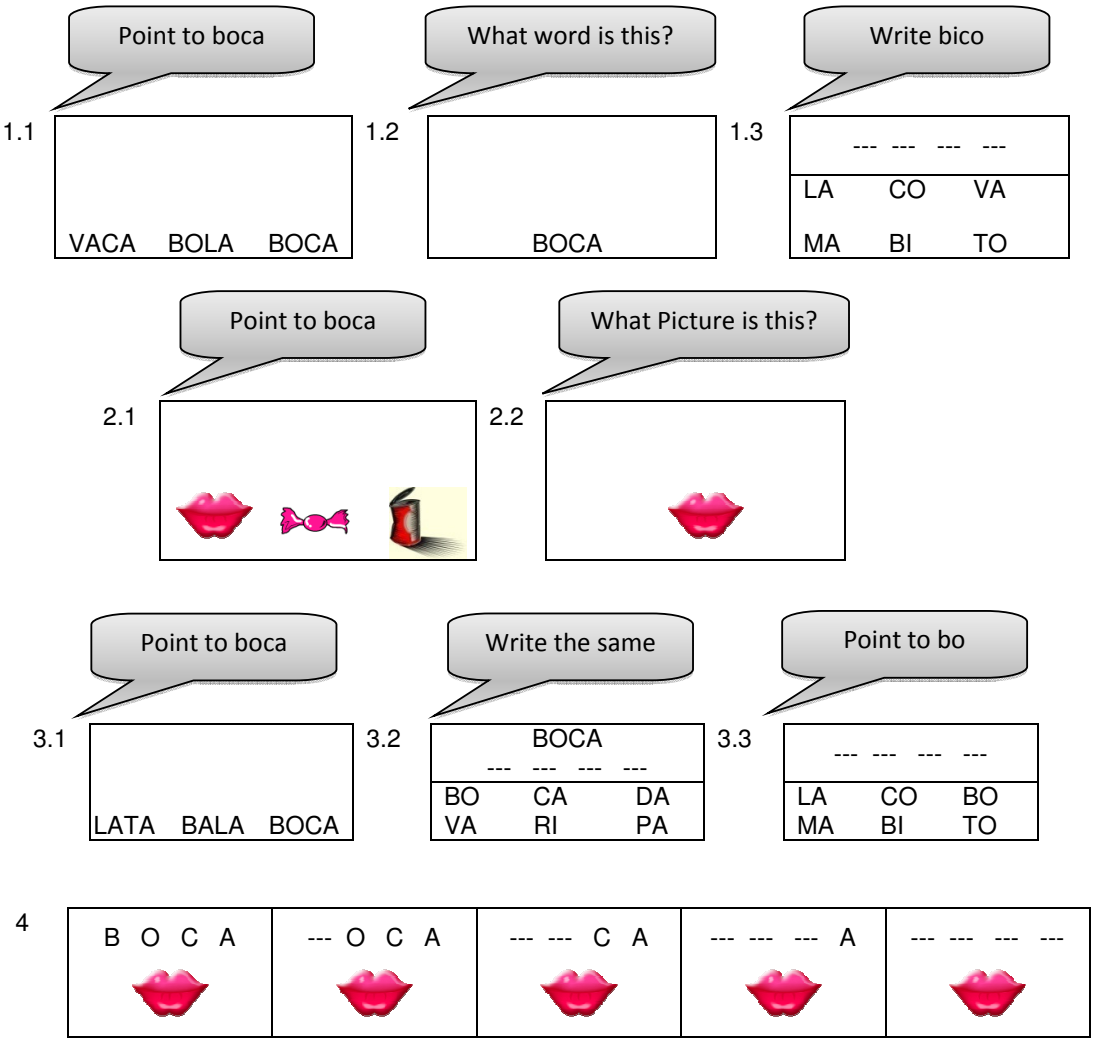

Figure 1 - Examples of the trials used in the study. The numbers represent the corresponding procedures. (1) Evaluation of the network of reading and writing. (2) Training of selection and naming test. (3) Teaching of words and syllables. (4) Transfer of control of the written word to the figure in successive fading out steps.

1.2. Vocalization tasks. After the presentation of a stimulus (figure or text), the subject had to make a corresponding vocal response that consisted of naming or reading. Therefore, we tested the naming of figures (BD) and the reading of words (CD), letters (CD letter), syllables (CD syllable), and vowels (CD vowel; see item 1.2 in Figure 1).

1.3. Writing tasks. We sometimes presented printed words on the computer screen and sometimes dictated words via the speaker. The tasks were divided into dictation according to the composition of letters (AE) or handwriting with pen and paper (AF) and copying according to the composition of letters (EC) and handwriting with pen and paper (CF; see item 1.3 in Figure 1).

2. Training of selection and naming of figures. This step sought to strengthen the relations between dictated words/figures (AB) followed

by tests of naming figures (BD). In the training of selection, a succession of discrete trials presented dictated words as the model and three figures as the comparison. The subject's task was to select with the mouse the figure that corresponded to the referred word (item 2.1 in Figure 1). The subjected only progressed to the stage of naming figures (BD) after achieving 100% correct responses in the selection of pictures (AB). Otherwise, the block of selection tasks was repeated.

In the test of naming figures, a single figure (e.g., the drawing of a beak) was presented to the subject, and he was asked, "What figure is this?" If he did not achieve 100% accuracy, then he was exposed again to the training of selection, which could be repeated five times (see item 2.2 in Figure 1).

3. Teaching of words and syllables. We used tasks of selecting printed words when presented with dictated words (AC) and composing words by selecting dictated syllables (AE syllables). DJ was exposed to five teaching steps. Each step taught three different words, for a total of 15 words. The teaching steps were evaluated by conducting retention tests of what was learned in the previous step (AC and AE), with pre- and posttesting of target words in the respective step.

Generally, words were taught using a multiple-copy teaching procedure, in which steps of selecting a printed word when presented with a dictated word, writing when presented with dictation, and copying by composition were interspersed. If the subject made any errors during the posttest of selecting printed words after being presented with dictated syllables (AC), then all of the teaching steps were repeated.

Syllabic teaching was characterized by steps of syllabic contextualization and teaching the selection of printed syllables based on the model of dictated syllables (AC syllable). The syllabic contextualization step was composed of tasks of pairing dictated words and figures (AB), with writing based on composition from the figure (BE syllable), dictated word (AE syllable), and printed word (EC syllable). This step evaluated the ability to focus on dictation that was composed of syllables (AE syllables). Item 3 in Figure 1 presents the types of trials in this step of the procedure.

4. Transfer of control of the written word to the figure in successive steps of fading out. After strengthening reading, we performed the transfer of stimulus control of the written word to the figure by overlapping a written word that was already taught in the previous step with its corresponding figure, thus making the visual stimulus a composite stimulus (i.e., the figure and text were simultaneously displayed on the computer screen). The subject had to read the word when it was presented. Gradually, every letter that formed the printed word was removed (i.e., faded out) until the visual stimulus was only the figure. This was done so that the control exerted by the printed word was transferred to the figure because the latter did not provide clues about which phoneme must be emitted (see 4 in Figure 1).

This procedure was applied to the 14 words that were trained previously. Because the words had different lengths, the number of fading steps varied by length. Words with four letters had five steps (e.g., "Boca"). Words with five letters had six steps (e.g., "Navio"). Words with six letters had seven steps (e.g., "Peteca").

In each step of the procedure, a vocalization analysis was performed based on transcriptions of the audio recordings of the sessions by counting the phonemes that were emitted by the subject and verifying the matching percentage with the word model according to the conventions in the verbal community.

RESULTS

The results are presented according to the steps of the procedure, with a focus on performance in the naming figure tasks after each of the procedures.

1. Evaluation of the reading and writing network

Figure 2 shows the percentage of correct responses obtained by DJ in the different relations tested during the evaluation of the reading and writing network. In the tasks that involved selection (black bars), his performance was 100% correct responses, with a few mistakes caused by distraction. In writing (light gray bars), his performance was also precise, with the exception of dictation according to the composition of letters (AE), for which he obtained 86.6% correct responses. His principal difficulty was in vocalization (dark gray bars). Although he presented good performance in the recognition of stimuli, the percentage of correct responses was low with regard to speech production based on point-by-point correspondence with the conventions defined by the verbal community, with 57.3% correct responses in naming figures (BD), 75.7% correct responses in word reading (CD word), and poorer performance for syllables (CD syllables) and letters (CD letter). Given these results, he underwent training of the selection and naming of figures.

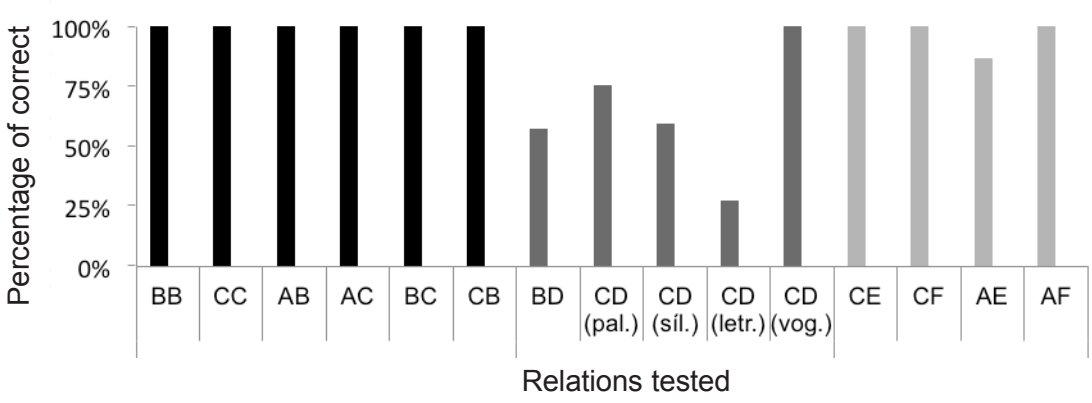

Figure 2 - Percentage of correct responses in the evaluation of the network of reading and writing. Black bars represent the results in the selection tasks. Dark gray bars represent the vocalization tasks. Light gray bars represent the composition tasks.

2. Training of selection and naming figures

In training the selection of figures when presented with dictated words (AB; hatched bars in Figure 3), DJ achieved 100% correct responses in all of the trials with three word sets. In the block of naming figures (BD; white bars), he presented variability in performance, presenting increases from 50% to 75% with the first word set, 50% to 62.5% with the second word set, and 50% to 75% with the third word set.

Because the percent increase in correct responses was slight, we verified whether strengthening the relation between the spoken word and printed word and selection of syllables in the next step would increase the percentage of correct responses for speech production. After an increase in the degree of control of the printed word over reading, we tested whether this control could be extended to the figure in naming tasks.

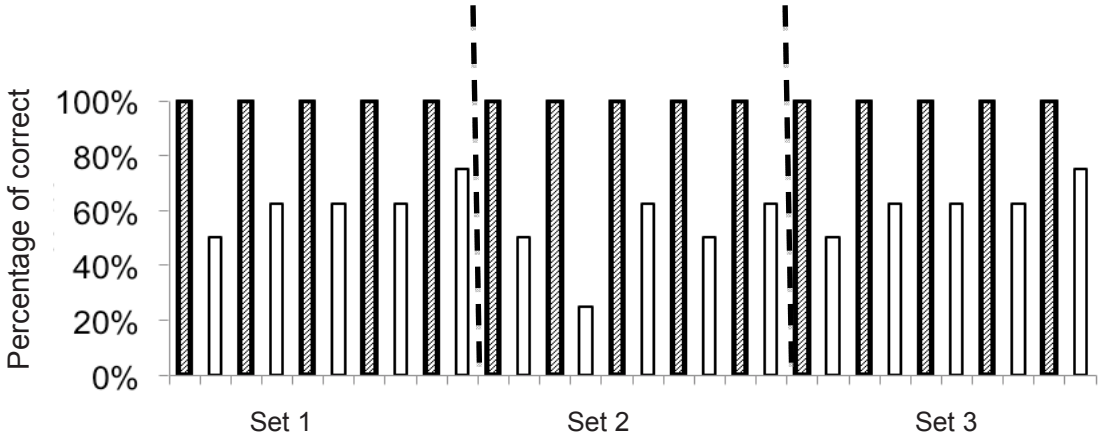

Figure 3 - Percentage of correct responses in the training of selection (hatched bars) and test of naming figures (white bars)

3. Teaching of words and syllables and transfer of control from reading to naming

In reading training, DJ presented 100% correct responses in all of the relations of selecting printed words when presented with dictated words and selecting printed syllables when presented with dictated syllables, for which he required only the minimal number of trials in each teaching step.

Figure 4 shows the subject's performance during the transfer of maximal control by the printed word in tasks of naming figures in successive steps of fading out in two sessions. The horizontal axis indicates the steps of fading out. Each column represents one phase of fading or gradually removing the textual stimulus. Step 1 refers to the complete word that was presented together with the figure. Step 2 refers to removing the first letter of the word that was presented together with the figure, and so on. Because the longest words had six letters, the maximum number of steps was seven. On the vertical axis, the values indicate the mean of the percentage of phonemes that were correctly verbalized by DJ. Figure 4 shows the data from two sessions of the transfer of control using the fading out procedure. Despite the gradual removal of the textual stimuli, the percentage of correct responses was still high, even in the final steps, during which only the figure was presented. These results indicate that the control exerted by the written word was transferred to the figure. Notably, during the second session of the fading out procedure (black bars), the percentage of correct responses increased compared with the first session (i.e., from 5% to 11% between each step; e.g., from 74% to 84% in Step 1 and from 78% to 89% in Step 7).

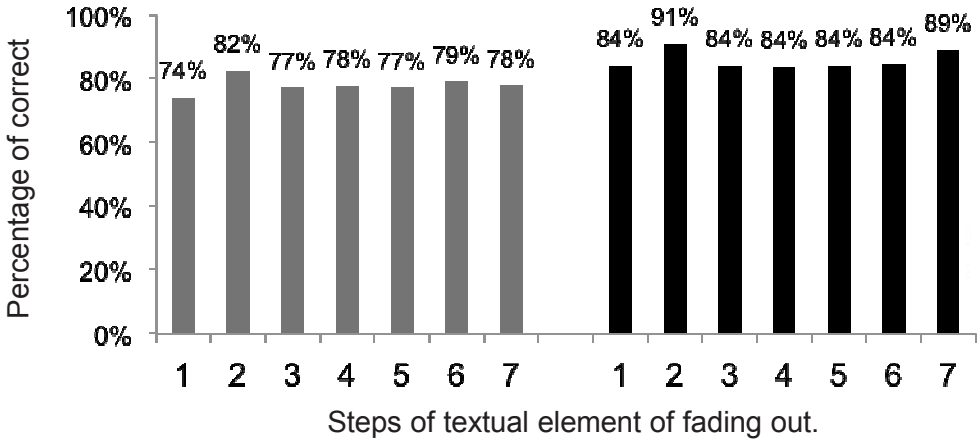

Figure 4 - Percentage of correct responses in naming figures after successive steps of fading out the textual component of the tasks. Words with four letters (e.g., "Bolo") had five steps. Words with five letters (e.g., "Navio") had six steps. Words with six letters (e.g., "Peteca") had seven steps. Session 1 (gray bars); Session 2 (black bars).

Training with fading out the textual component allowed improvement by 14.9% in the participant's vocalization. Comparing the data of the final step of the transfer of control by fading out with regard to performance in reading (CD) in the evaluation of the reading and writing network (Figure 1), improvement of more than 31% correct responses in DJ's vocalizations was observed.

DISCUSSION

The present study revealed that DJ, who was evaluated with regard to the reading and writing network, had a high percentage of correct responses in activities of reading by selection and a lower percentage in activities of vocalization with regard to speech production[3]. These findings suggest that the difficulties presented by DJ derived from a failure to program and produce speech and not from a failure to understand written language. Although the subject had a corrected palatine fissure, the team at the reference center where the subject received care determined that these alterations were not attributable to the palatine fissure, which only caused a more nasal voice. Additionally, the transcription of the subject's vocal responses indicated that omissions, transpositions, and phonemic distortions were nonspecific and

inconsistent, which are characteristics of apraxia and not palatine fissure. These data showed better performance in expressive speech in reading tasks to the detriment of naming the corresponding items, demonstrating the functional independence of these behaviors, which can be seen in other populations[15,19-21]. When presented with printed words, DJ received hints that guided his speech movements that are necessary for the emission of a determined sound, in contrast to what occurred with the figure that indicated only the object that was to be named but did not provide hints for the movement to be performed. For children with speech apraxia, support for speech (monitoring) using point-by-point correspondence is important. Support can be provided for the written word, and hints for the production of the sequence of sounds (words) can be offered by the therapist during training[3]. The present findings corroborate the literature[3], showing an overall improvement of 31% in DJ's vocalization and indicating that support for speech (monitoring) with point-by-point correspondence is important for children with speech apraxia.

In the selection and naming activities, despite the 100% correct responses in the first type of task, difficulties were observed in the final task. The improvement in DJ's performance in naming activities in the final exposures compared with the first replicates data from this type of procedure in other populations with regard to the cyclical relationship between listening and speaking[22]. Listening, pointing to a figure, saying the name of the figure, hearing what is said, and listening again in successive tasks can be a successful model for speaking. Although the increase in the percentage of correct responses was not substantial, it can be considered a significant gain because traditional audition therapies for children with speech apraxia have not shown satisfactory results[1,3].

The last step of the present study prioritized the use of support for written words with a focus on expressive speech using point-by-point correspondence in a procedure of naming compound stimuli (printed word + figure) while fading out the printed word component[11, 12]. Given that stimulus control in this step was transferred to the figure, the gains that were obtained with such interventions were clearly important. In addition to transferring reading performance to naming, the results showed an increase in the percentage of correct responses, a fact that was related to the large number of opportunities of vocalization[20,23] that served as a device of speech generalization[24]. These results replicate those of other studies on improvements in speech after procedures of establishing or strengthening equivalence relations between spoken words and syllables, written words and syllables, and figures,[15,19-21] indicating a potential procedure that can be applied for different diagnostic conditions that target the establishment of language.

CONCLUSION

These results replicate the potential of establishing equivalence relations and its generative capacity to form new verbal behaviors in populations with apraxia. We consider that this study marks the beginning of a promising research field that favors the development of speech in children with apraxia by strengthening equivalence relations between stimuli. The data presented herein are consistent with results of other studies on the gains obtained with guided teaching procedures based on the paradigm of establishing equivalence relations and transferring control between verbal behaviors in the development of speech in different diagnostic conditions, suggesting a therapeutic pathway with great potential for various groups. According to the objectives of this study, we found that different conditions of teaching relations between stimuli positively affected speech production in a child with speech apraxia, thus contributing to the literature on this communication disorder.

RESUMO

Este estudo propõe relatar o efeito do fortalecimento de relações de leitura e da transferência de controle de estímulos sobre a produção da fala de uma criança com apraxia de fala. Utilizou-se o programa Aprendendo a Ler e a Escrever em Pequenos Passos®. As atividades foram realizadas em 22 sessões, com duas sessões semanais, de 30 minutos cada. Como resultados houve aumento na porcentagem de acertos na produção da fala do participante frente a diferentes estímulos. Os resultados corroboram os estudos anteriores sobre o favorecimento da fala por meio de relações de equivalência e dados sobre o benefício do trabalho a partir do fortalecimento da rede de leitura e escrita.

DESCRITORES: Apraxias; Fala; Ensino; Comportamento Verbal

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