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Systematic review of delayed auditory feedback effectiveness for stuttering reduction

Análise sistemática da efetividade do uso da alteração do feedback auditivo para a redução da gagueira

Keywords

Speech, language and hearing sciences
Stuttering
Equipment and supplies
Hearing

ABSTRACT

Purpose: To perform a systematic review of studies related to the effects of delayed auditory feedback on speech fluency in individuals who stutter. **Research strategy:** Concepts of the Cochrane Handbook were followed: formulation of initial question (theme to be reviewed), location and selection of studies (PubMed database) and compatibilization among researchers (aiming to minimize possible citation losses). **Selection criteria:** The following were excluded: citations in languages other than English, citations that did not allow access to full text, repeated citations due to the overlap of keywords, studies developed exclusively with fluent individuals, case reports, reviews of the literature, letters to the editor, and texts that were not directly related to the theme. Hence, texts that were related to treatment with delayed auditory feedback (DAF) and frequency-altered feedback (FAF) were analyzed. **Data analysis:** Data were analyzed according to research indicators and according to study quality markers. **Results:** The results indicated that the use of altered auditory feedback devices for the reduction of stuttering events still do not have robust support for their applicability. Methodological variability does not allow a consistent answer, or a trend about the effectiveness of the device, to be drawn. **Conclusion:** Although the limitations in the studies prevent generalizations about the effectiveness of the device for the reduction of stuttering, these same limitations are important resources for future research planning.

Descritores

Fonoaudiologia
Gagueira
Equipamentos e provisões
Audição

RESUMO

Objetivo: Realizar uma revisão sistemática de pesquisas relacionadas aos efeitos da alteração do *feedback* auditivo sobre a fluência da fala em pessoas com gagueira. **Estratégia de pesquisa:** Foram seguidos os preceitos do *Cochrane Handbook*: formulação da pergunta inicial (tema a ser pesquisado), localização e seleção dos estudos (base de dados PubMed) e compatibilização entre os pesquisadores (visando minimizar possíveis perdas de citações). **Critérios de seleção:** Foram excluídas: citações em línguas que não fossem o Inglês, citações que não permitiram o acesso ao texto completo, citações repetidas por sobreposição das palavras-chave utilizadas, pesquisas realizadas exclusivamente com indivíduos fluentes; estudos de caso; revisões de literatura; cartas ao editor e textos que não se relacionavam diretamente ao tema. Desta forma, foram analisados os textos que efetivamente se relacionavam às pesquisas de tratamento com *delayed auditory feedback* (DAF) e o *frequency-altered feedback* (FAF). **Análise dos dados:** Os dados foram analisados quanto aos indicadores da pesquisa e quanto aos marcadores de qualidade dos estudos. **Resultados:** Os resultados indicaram que o uso dos dispositivos de alteração do *feedback* auditivo na redução do número de eventos de gagueira ainda não tem suporte robusto em sua aplicabilidade. A variabilidade de método não permite uma resposta ou uma tendência de resposta que possa ser considerada consistente sobre a eficácia do dispositivo. **Conclusão:** Embora as limitações apontadas nos estudos impeçam generalizações sobre a eficácia do uso do dispositivo para a redução da gagueira, essas mesmas limitações são recursos importantes para o planejamento de pesquisas futuras.

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INTRODUCTION

For over 50 years different studies have shown that auditory feedback alterations (AFA) may decrease the number of stuttering events[1]. AFA can be defined as a set of conditions that involves electronic changes in the speech signal in which the speaker perceives his own voice in a modified form. The most frequent forms of AFA are delayed auditory feedback (DAF) and frequency-altered feedback (FAF).

DAF occurs when the auditory feedback of the voice is usually delayed in a range between 50 and 100 ms. With this feature, the speaker hears his own voice as a chorus effect. The FAF refers to the frequency variation of the voice, usually between ¼ to 1 octave above or below it. With this feature, the speaker hears his own voice with a pitch that is different from the usual[2].

The rationale behind this is that inhibition of the involuntary neural block occurs at the central level under the effect of a second speech signal. This is believed to be the causative agent of all the observable symptoms of stuttering. The frequency of stuttering can be reduced by approximately 60% when a second speech signal is presented depending on the linguistic and temporal synchrony of the stimuli. This second signal can be understood as a "gestural information" that further promotes fluent speech[3].

A systematic review involves the application of scientific strategies that aims a critical evaluation and synthesis of a large number of studies on a particular topic. The ability to condense and summarize results of several studies, producing different quantitative and qualitative indicators on the researched topic, justifies the importance of conducting such studies[4].

PURPOSE

The aim of this study was to conduct a systematic review of studies related to the effects of changes in auditory feedback, specifically from DAF and FAF, on speech fluency of people who stutterer.

RESEARCH STRATEGY

We followed the precepts of the Cochrane Handbook for the establishment of the research method[5,6]:

1. Formulation of the research question: analysis of texts on the effects of AFAs (DAF and FAF) on speech fluency in adults who stutterer, who have or not undergone previous treatment for stuttering;

2. Location and selection of studies: survey of published studies on the topic, without a temporal delimitation. The articles were selected through a PubMed database using the keywords "altered auditory feedback and stuttering; delay auditory feedback and stuttering; frequency altered feedback and stuttering"; limited to research with human beings and adults who were English speakers;

3. Compatibility among researchers: the search in the database was performed independently by the two authors in order to minimize possible losses of citations.

SELECTION CRITERIA

Each citation retrieved in the database was independently analyzed by the two authors, who judged the relevance of its inclusion or exclusion. We excluded citations in languages other than English. Articles that did not allow access to full text (obtained in the CAPES Journal Portal), or which were repeated by the overlapping keywords were also excluded.

Studies carried out exclusively with fluent speakers, case studies, literature reviews, letters to the editor, and articles that were not directly related to the topic were excluded from the sample of obtained full texts. We analyzed the articles that were effectively related to the study of treatment with DAF and FAF.

All phases of the study were independently conducted by each of the authors. When disagreement occurred, we only included the texts for which the final position was consensual. Masking was not possible given the nature of the study.

DATA ANALYSIS

1. The following were considered indicators of the study: purpose, number and gender of participants; age of participants; variables of device calibration; criteria of assessment and control of treatments; results.

2. Regarding the quality index of studies, texts were analyzed according to: type of masking; control group, quantitative data analysis; statistical analysis confirming significance of results; research design.

RESULTS

Figure 1 displays the route for the final selection of the analyzed articles. The selection process of the present method excluded: citations which the topic was not relevant to the present study (19), literature reviews (8), letters to the editor (4); case studies (3); studies conducted exclusively with fluent speakers (4), studies of patients with neurogenic stuttering (2), and studies with no possible recovering of the full text, primarily for being old and not available (37).

Purpose of studies

Of the 24 texts analyzed[7-30], 45.8% (n=11) had as main purpose the evaluation of device effectiveness in reducing stuttering. In 29.2% (n=7) of the texts, the primary purpose was the effectiveness of the device (at short, medium, and long term) on the speech performance. Other goals comprised 25% (n=6) of studies such as: acoustic changes of sounds (e.g., vowels) and of auditory response (e.g., monaural or binaural use).

Gender and age of participants

Of the 24 analyzed articles, 87.5% (n=21) presented a description of the gender of participants. The average number of people who stutter in the studies was 12.3, with a standard

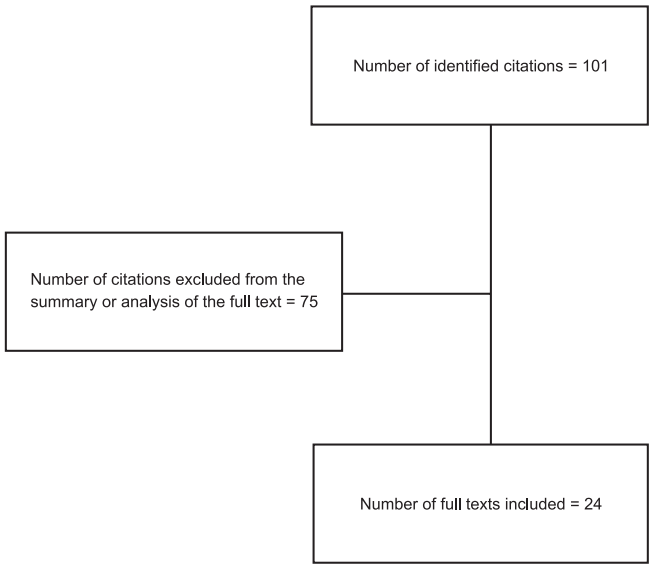

Figure 1. Search route conducted for selection of articles to be analyzed

Table 1. Gender analysis

	Number of people who stutter	Male subjects (%)	Female subjects (%)
Mean	12.3	80.3	17.9
SD	5.7	16.9	16.5

Note: SD = standard deviation

deviation of 5.7 (Table 1). There was, as expected, a larger number of male participants, at a ratio male/female of 4.48 /1.

Only 19 texts specified age or age range of participants. Therefore, it was not possible to calculate the mean age from the available specifications. The mean age range of the studies was from 19 to 47 years.

Tasks and variations in the calibration of devices

There was a balanced distribution of tasks on the 24 analyzed articles. Simple tasks (54.2%, n=13) were those applied in cross-sectional studies and studies that tested a single variable (e.g., reading of a small text – monologue or both – with different variations in the calibration of the device or different devices). Complex tasks (45.8%, n=11) were those who managed more than one variable (e.g., longitudinal studies, studies with judges, competing tasks, etc.).

The researchers contemplated induced fluency tasks (reading, speaking in chorus, etc.) and spontaneous speech (monologue, conversation, etc.) in 50% (n=12) of the analyzed articles. In 20.8% of the studies (n=5) the task comprised reading of short texts; 12.5% (n=3) comprised monologue and conversation; 12.5% (n=3) other speech activities (e.g. telephone, automatic speech, etc.); and 4.2% (n=1) comprised other types of reading tasks (words, sentences, etc.).

Given the diversity of the calibrations presented in the analyzed studies we decided to divide the articles into two groups: articles that presented AFA with the use of DAF and articles that presented AFA with the use of FAF. The articles with devices with the function COMBO (DAF associated with FAF) were scored in both groups. This was because in case the analysis of the COMBO devices had been done separately (i.e., without separating DAF and FAF characteristics) we would have practically independent analyses given the large variation of calibration of devices. Furthermore, a separate analyzes of these devices would cause a large data dispersion.

Of the studies with DAF (n=19), 47.4% (n=9) presented a specific time delay calibration and 52.6% (n=10) presented calibration with variable time delay. Of the studies with DAF that presented a specific delay, 44.4% (n=4) had a delay of 60 ms, 33.3% (n=3) of 50 ms, 11.1% (n=1) of 100 ms and 11.1% (n=1) of 195 ms.

There were no studies with DAF that applied a variable delay calibration with the same variation – i.e., of the 10 studies analyzed, each presented a different variation of the time delay.

In these studies, 10% (n=1) presented the calibration varying between 55 and 105 ms, 10% (n=1) from 93 to 147 ms, 10% (n=1) from 30 to 120 ms, 10 % (n=1) 30 to 60 ms, 10% (n=1) 60 to 90 ms, 10% (n=1) from 90 to 250 ms, 10% (n=1) of 50 to 75 ms, 10% (n=1) from 40 to 100 ms, 10% (n=1) 100 to 200 ms, and 10% (n=1) from 55 to 100 ms.

In relation to the FAF, we observed a differentiation in the calibration frequency according to the technical specifications of devices. Some devices exhibit variation in hertz (Hz), with increments of 500 Hz (positive or negative, varying from -2 kHz to +2 kHz). Other devices present frequency variation in the range of octaves (relative to the fundamental frequency of the patient).

Among the reviewed studies that used FAF (n=20), 55% (n=11) presented a specific frequency calibration and 45% (n=9) presented a variable frequency calibration.

Regarding studies that presented a specific calibration, 36.4% (n=4) presented a variation in frequency of +500 Hz, 18.2% (n=2) an octave below in relation to the fundamental frequency of the patient; 18.2 % (n=2) half octave below, 18.2% (n=2) one fourth of octave above, 9% (n=1) half-octave above. Already in studies that presented variable frequency calibration, 33.3% (n=3) showed variation from one fourth of octave below to one fourth of octave above, 22.2% (n=2) half-octave below to half octave above, 11.1% (n=1) one octave below to one octave above, 11.1% (n=1) -2 kHz to +2 kHz, 11.1% (n=1) -500 Hz to +500 Hz, and 11.1% (n=1) -500 Hz to +1 kHz.

Results of analyzed studies

The following criteria were applied for the analysis of results obtained in the 24 analyzed articles: positive (when the conclusion of the study stated that the device has met with the proposed target), negative (when the conclusion of the study stated that the device has not reached the proposed target) and inconclusive (when the conclusion of the study indicated that the device was effective in one aspect and ineffective in another aspect; or when the device was effective for one group and ineffective for the other group; or when the device was effective

on pre-test and ineffective on follow-up). For these analyses we used the Fisher's exact test with a significance of 0.05.

Table 2. Comparison of the efficiency and type of device used

	Positive x Negative	Negative x Inconclusive	Positive x Inconclusive
DAF	1.000	1.000	1.000
FAF	0.021*	0.462	0.286
DAF+FAF	<0.001*	0.590	0.100

* Statistically significant values (p≤0.05) – Fisher's Exact test
Note: DAF = delayed auditory feedback; FAF = frequency-altered feedback

On the analyzed articles, the exclusive use of DAF showed no conclusive results. There was no difference between positive, negative, and inconclusive results. For the FAF, a difference between positive and negative results was observed. However, no significant differences were found when comparing both positive and negative results with inconclusive ones. There was no difference between positive and negative results for the combination FAF+DAF. Moreover, no differences were observed when comparing both positive and negative results with inconclusive results for this combination.

Quality index of the studies

The articles were analyzed for the type of masking (single/double blind, agreement among judges or not), control group (present or absent), quantitative data analysis (yes or no); statistical analysis confirming the significance of results (yes or no); research design (longitudinal or transverse).

Each of the following indexes was attributed a score of one point: single/double blind or agreement among judges; presence of control group; quantitative data analysis, statistical analysis confirming significance of results; longitudinal research design. The remaining indexes were attributed a score of zero. The qualification of the studies was scored based on the relationship 5/5 for better delineated studies and 0/5 for the studies with greater frailty.

Regarding the evaluated items, 12.5% (n=3) of the studies had a control group, 37.5% (n=9) relied on some type of masking, 95.8% (n=23) had some type of quantitative data analysis, and 79.2 (n=19) applied statistical analysis. Longitudinal design was applied in 28.8% (n=5) of the studies.

As for the overall score, no study reached a full score (i.e. 5/5). A score of 4/5 was achieved by 20.8% (n=5) of articles. The same number of articles (20.8%; n=5) obtained a score of 3/5. The score 2/5 was achieved by 45.8% (n=11) of studies, 8.4% (n=2) of the studies obtained a score of 1/5, and 4.1% (n=1) was scored 0/5.

CONCLUSION

This first systematic review on the topic has as results that from a universe of 101 citations, 23.8% of studies relate to quantitative research, are applied to people who stutter, with or without a control group, with adults of both genders who have or have not undergone previous stuttering treatment. Furthermore, the results state that there are no similar texts in terms of methodology, i.e. there are no studies that completely replicate a particular method – that is profile of participants, specific tasks and calibration of devices.

Although there are studies that are consistent in isolation regarding the research qualification criteria, no analyzed study can be considered fully satisfactory. Few studies include 80% of the requirements for a consistent research. Furthermore, there are still no randomized clinical trials on the topic.

Within the paradigm that systematic review is the basis for clinical practice based on evidence, our findings indicate that the use of AFA devices in reducing the number of stuttering events is not yet robustly supported in its applicability. The variability of the methods does not allow a response or a response trend that can be considered consistent on the effectiveness of these devices.

The exclusive use of DAF has no conclusive results given that the number of positive, negative, and inconclusive results is similar among the analyzed studies. Regarding the use of FAF, no difference is found when comparing the number of positive and negative results. However there is a difference between both the positive and negative results with inconclusive ones. For the combination DAF+FAF there is a significant difference for positive results when compared to negatives but there is no significant difference when comparing both the positive and negative with inconclusive results.

Although these limitations prevent generalizations about the effectiveness of these devices on the reduction of stuttering, these same limitations are important resources for planning future studies, in which the following should be considered: increasing the number of participants, the existence of a control group, masking of the groups, replication of tasks that show to be effective in their purpose, and consistency in calibrating the devices.

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