http://dx.doi.org/10.1590/S2317-64312015000200001397

Effect of the delayed auditory feedback in stuttering

O efeito do feedback auditivo atrasado na gagueira

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ABSTRACT

Purpose: To verify the effect of delayed auditory feedback and altered frequency in the stuttering severity, by means of the *SpeechEasy*® device. **Methods:** Sixteen 17 to 49 year-old men and women who stuttered were selected. Schooling ranged from High School to Undergraduate degree. Subjects were distributed in 2 groups: G1 with 8 people who stuttered and had speech therapy using the *SpeechEasy*® device and G2 with 8 people who stuttered and had therapy without the device. All the subjects underwent conventional speech-language-hearing evaluation, specific stuttering evaluation, basic hearing evaluation and speech training with or without the device. Obtained data was submitted to appropriate statistical analysis. **Results:** There was a significant decrease in the stuttering severity level and in atypical disfluencies rate, in groups G1 and G2, in the final assessment when compared to the initial one. **Conclusion:** There was an improvement of stuttering level with speech training in both groups, with a tendency of G1, which made use of *SpeechEasy*® device to present higher reduction in the disfluencies rate and bigger gain in articulatory rate and information production rate.

Keywords: Speech, language and hearing sciences; Stuttering; Hearing; Equipment and supplies; Feedback

RESUMO

Objetivo: Verificar o efeito do *feedback* auditivo atrasado (*delay auditory feedback*) e da retroalimentação com a frequência alterada (*frequency altered feedback)* em indivíduos que manifestam gagueira. **Métodos:** Foram selecionados 16 indivíduos adultos com diagnóstico de gagueira, de ambos os gêneros, faixa etária entre 17 e 49 anos e com, no mínimo, 8 anos de escolaridade. Os indivíduos foram distribuídos em dois grupos, sendo um grupo (G1) formado por oito indivíduos gagos submetidos à terapia de fala com o uso do aparelho *SpeechEasy*® e o outro (G2), formado por oito indivíduos gagos submetidos à terapia sem o uso do aparelho. Todos os indivíduos passaram por avaliação fonoaudiológica convencional, avaliação específica da fluência da fala, avaliação audiológica básica e treinamento de fala com ou sem o uso do aparelho. Os dados obtidos foram submetidos à análise estatística pertinente. **Resultados:** Nos grupos G1 e G2 houve diminuição significativa do grau de gagueira e das disfluências atípicas na avaliação final, quando comparada à inicial. **Conclusão:** Houve melhora do grau da gagueira com o treinamento de fala em ambos os grupos, com tendência do G1, que utilizou o dispositivo *SpeechEasy*®, para apresentar maior redução no índice de disfluências e maior ganho nas taxas de velocidade articulatória e de produção de informação.

Descritores: Fonoaudiologia; Gagueira; Audição; Equipamentos e provisões; Retroalimentação

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Conflict of interests: No
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Received on: 4/24/2014; **Accepted on:** 1/21/2015

INTRODUCTION

Stuttering is a speech disorder known since ancient times, but until today, there is no consensus on its definition and probable cause. Thus, the Stuttering Foundation of America published in 1995, numerous definitions that vary according to the authors.

Although it is consensus that the cause of stuttering is still unknown, there are a variety of etiologic factors have been considered, suggesting multiple causes, including genetic, neurophysiological, environmental, personality, learning, auditory processing, language and speech production.

In relation to hearing aspects, research conducted with individuals who stutter have shown important data that emphasize its role in stuttering study. Research on the effect of delay auditory feedback (DAF) and frequency altered feedback (FAF) have shown that stutterers have improvement in their fluency when exposed to this type of stimulation, and even one of the techniques used in the treatment of stuttering[1-4].

There is controversy in the literature on the use of SpeechEasy® in stutterers. Some authors suggest that the use of this feature does not always have some positive change in stuttered speech, suggesting the influence of other factors[1]. Others consider the use of delayed auditory feedback as a therapeutic technique, which in addition to improving the flow of these individuals, presents results suggest that auditory processing and auditory feedback seem to have an important role in stuttering[5,6].

The objective of this research was to verify the effect of delayed auditory feedback and frequency altered feedback in individuals who manifest stuttering.

METHODS

This is a prospective, comparative study approved by the Research Ethics Committee of the *Universidade Federal de São Paulo* (UNIFESP) (nº. 0366/11). All participants were informed about the features and procedures of the study and signed the Informed Consent.

Data collection was performed at the Speech and Hearing Evaluation and Diagnostic Clinic of the São Paulo Hospital, Hearing Research Center for Speech and Fluency (NIFF).

The sample consisted of 16 adults diagnosed with stuttering, male and female, aged between 17 and 49 years, with education of at least eight years.

In the sample, the inclusion criteria were considered: to present the development stuttering history; between 17 and 59 years; have at least eight years of schooling; show 3% or more atypical speech disfluency and scoring at least 18 points in the Stuttering Severity Instrument (SSI-3)[7], which is equivalent to a mild stuttering; unattended speech therapy at the time of evaluation.

Exclusion criteria were evidence of deafness; language disorder, neurological and/or psychiatric diseases and severity of stuttering classified as "very mild".

Subjects were allocated into two groups: the G1 made up of eight stutterers undergoing therapy using the SpeechEasy® device during all sessions and the G2 group, made up of eight stutterers submitted to the same therapy, but without the use of SpeechEasy® device. The mean age of the G1 was 32.8 years, ranging 20-43 years and the G2 was 26 years, ranging from 19 to 43.

All subjects were submitted to speech and hearing assessment, pre- and post-therapy. The speech and hearing assessment consisted of anamnesis, speech and hearing screening and specific assessment of stuttering.

In the interview were collected relevant information about education, communication history, family history, hearing complaints and health in general. The speech screening was performed using the Neuropsychological Assessment Instrument-Brief NEUPSILIN[8].

For the evaluation specifies of the fluency of speech, spontaneous speech recordings were made (Digital Camcorder DCR-SR85 Sony® model) with transcribed speech samples (200 syllables), mapping them in typical and atypical disfluencies[7,9]. It was later estimated the severity of stuttering through the SSI-3 protocol[7]. For diagnosis of stuttering, we adopted the criterion of the presence of at least 3% of atypical disfluencies and score from 18 points in the SSI-3 instrument, excluding the very mild stuttering.

To evaluate the speech rate, the analysis was made of the articulatory speed rates (syllables per minute) and production information (words per minute) in spontaneous speech recordings. It was used as normality criteria for adult individual values between 219-257 syl/min in speech rate and 117-140 word/min in the production information, according to the criterion described in the literature[10].

The audiological evaluation consisted of pure tone audiometry and acoustic impedance. It was considered normal hearing when the mean of thresholds at 500 Hz, 1000 Hz and 2000 Hz was less than 25 dB HL. The tympanometric curve type A was considered normal.

Individuals of G1 group underwent with speech training based on the program Fluency Shaping (*Fluency Shaping Therapy*)[11,12], using digital electronic device - SpeechEasy® allowing altered auditory feedback in two ways: by delayed auditory feedback (DAF) and by altering the frequency of the feedback (FAF). It was used a single device with individual generic molds, only during the training session.

According to the Fluency Shaping, the following abilities were trained: speech rate, starting to issue smoothing and proprioception of the movements involved in speech through vocal relaxation exercises, breathing, phonation, articulatory and prosody. The exercises were presented in a hierarchical form, according to the sequence of simple transitions to the

most complex, i.e. the sound to syllable, word and sentence.

Setting the device used for each participant was established according to the manufacturer's protocol, which it regards as ideal personal preference regarding the signal quality associated with greater reduction of stuttering[5]. Initially it was used the default setting of 60 ms, 500 Hz and volume two. The default DAF was adjusted individually until reaching 100 ms, depending on the performance of the patient. The choice of the ear to initial adaptation was made according to individual preference, starting with the ear that said use to talk on the phone, as recommended by the equipment representative.

Then, samples were made from recordings of spontaneous speech (conversation) with the use of the device previously adapted for the left ear and right separately.

With the device adapted, began a speech training period with the use of the device for one hour (30 minutes in each ear), through exercises to model the speech, for two consecutive weeks, for a total of four days training. During the speech training, before each exercise, was recommended to the participant who should pay attention to the acoustic signal. The exercises were performed twice successively on each side of the ear, alternating every day of training, the ear to be stimulated initially.

After this training period, were recorded new speech samples with the device monaurally (right and left ears) and without the device.

All speech samples were transcribed and stuttering severity was verified by the SSI-3 Protocol[7].

The individuals of G2 group underwent the same speech training, but without the use of SpeechEasy® device, performing an initial recording and the other in the end to collect samples of speech and subsequent analysis of the level of severity of stuttering through SSI-3 Protocol.

In both groups, we performed the same speech training, making sure that all individuals receive exactly the same therapy. The author of the study that treated the patients. To maintain the reliability of the experiment, we opted for the transcription and analysis of samples by another speech therapist with experience in the area of fluency and without prior knowledge of the group to which the patient belonged (with or without SpeechEasy®) and in that situation (pre-therapy or post-therapy).

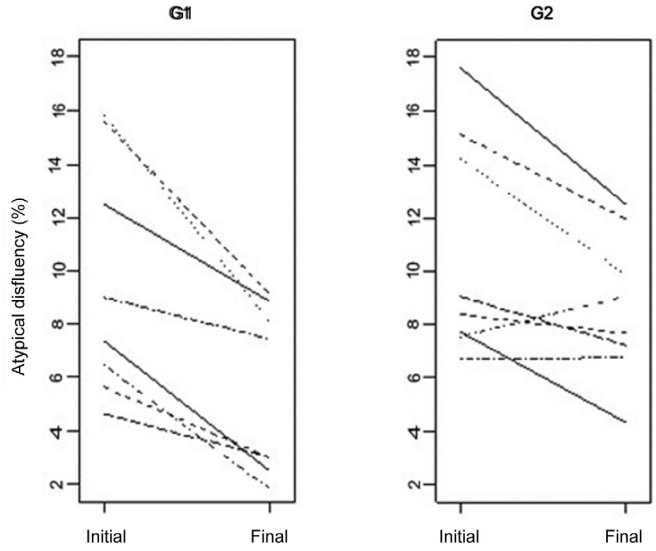
Statistics

For variables quantitative (numerical), were calculated some summary measures such as mean, median, minimum and maximum values and standard deviation. The qualitative variables (categorized) were analyzed by calculating the absolute and relative frequencies (percentages). Inferential analyzes used in order to confirm or refute evidence found in the descriptive analysis were non-parametric analysis of ordinal data, comparing the level of stuttering individuals by groups with and without equipment as pre- and post-therapy.

The analysis of variance (ANOVA) with repeated measures[13] was used for comparison of groups with and without the device, in the early stages, according atypical disfluency (%), speed articulatory rate (syl/min) and information production rate (word/min).

RESULTS

The distribution of level of stuttering and atypical disfluencies of individuals of G1 and G2 groups, in percentage, in the pre- and post-training is presented in Table 1 and Figure 1. There was a significant decrease in the level of stuttering and atypical disfluencies in the final evaluation when compared to baseline.



Note: G1 = stutterers undergoing therapy using SpeechEasy® device; G2 = stutterers submitted to the therapy, without the use of SpeechEasy® device

Figure 1. Individual distributions of atypical disfluency (%) of G1 and G2, the initial and final moments

The distribution of rates of speed articulatory and production information of individuals in groups G1 and G2, the pre- and post-training, is presented in Table 2. In the G1, there was an increase of speech rate and reduce the production information, the initial assessment to the final. In G2, there was a reduction in both assessments.

The mean values of the reduction of atypical disfluencies and earnings of speed articulatory rates and production information of individuals of G1 and G2, the pre- and post-training are presented in Table 3. It is observed that the G1 had a tendency to reduction in disfluencies index and higher gain in the articulatory speed rate and the rate of production information, compared to G2.

DISCUSSION

The results of the comparison between the groups in the pre and post-training time show an improvement with speech

Table 1. Level of stuttering and atypical disfluencies, pre- and post-treatment

		Level of Stuttering	G1 (%)		G2 (%)		Total (%)	
SSI 3	Pre	Mild	5	62.5	4	50.0	9	56.3
		Moderate	2	25.0	2	25.0	4	25.0
		Severe	1	12.5	2	25.0	3	18.8
		Total	8	100.0	8	100.0	16	100.0
(p<0.001*)	Post	Normal	4	50.0	-	-	4	25.0
		Very mild	-	-	1	12.5	1	6.3
		Mild	2	25.0	4	50.0	6	37.5
		Moderate	2	25.0	3	37.5	5	31.3
		Severe	-	-	-	-	-	-
		Total	8	100.0	8	100.0	16	100.0
		Atypical Disfluencies						
Datp (%)	Pre	n	8		8		16	
		Mean	9.6		10.8		10.2	
		Median	8.2		8.7		8.7	
		Minimum	4.7		6.7		4.7	
		Maximum	15.8		17.6		17.6	
		Standard Deviation	4.4		4.2		4.2	
(p<0.001*)	Post	n	8		8		16	
		Mean	5.5		8.7		7.1	
		Median	5.2		8.4		7.6	
		Minimum	1.9		4.3		1.9	
		Maximum	9.1		12.5		12.5	
		Standard Deviation	3.2		2.7		3.3	

*Significant values (p<0.01) – Analysis of variance (ANOVA)

Note: Datp = atypical disfluencies; G1 = stutterers undergoing therapy using SpeechEasy® device; G2 = stutterers submitted to the therapy, without the use of SpeechEasy® device

training in both groups. However, there was significant reduction in the level of stuttering and atypical disfluencies in the final assessment when compared to the initial in G1 group, ie the group with the *SpeechEasy*®. According to Perkins (1984), Fluency Shaping Therapy brings good results by training the specific abilities of speech, whose main objective is to obtain a basal fluency. The line therapy used was effective for both groups.

The group using the SpeechEasy® (G1) showed a tendency to reduction in disfluencies index and higher gain in speed articulatory rate and the rate of production information, compared to G2. This shows that, although both had positive results with speech training, the group that used the device obtained greater benefits. In G1, there was reduced mean atypical disfluencies of pre-training evaluation for post-training compared to G2.

This reduction of disfluencies using the device agrees with the literature, since several studies demonstrated improved speech stuttered under conditions of "auditory feedback", ie using masking, DAF, FAF, or a combination of them, showing strong correlation between stuttering and auditory aspects[1,3,5,11,12,14-20]. Due to the reduction of disfluency, improvement was observed in the level of stuttering, especially in G1. Therefore, there was significant reduction in the level of stuttering and atypical disfluencies in the post-training evaluation, compared to pre-training assessment of group using the SpeechEasy®.

Regarding the articulatory speed rates and production information, it was observed that in G1, there was an increased speech rate and production information, pre- to post-training, while G2, there was a reduction in both.

Studies on the syllables speed rates and words in speech stuttered indicate agreement concerning research on the relationship between the severity of stuttering and rates of production information (words per minute) and articulatory (syllables per minute) through speech samples for analysis at least 200 fluent syllables. The results found that the more severe the level of stuttering, lower rates of production information and articulatory of stutterers, ie stutterers have minor speech rates when compared to fluent individuals. They also observed a significant difference in speech rates, taking into account the different levels of severity of stuttering. Individuals with mild and moderate stuttering have similar speech rates, whereas those with severe stuttering, have lower rates[21-23].

A study on the effect of auditory feedback in speed rates found that all participants had a significant reduction in

Table 2. Rates of articulatory speed and the production information, pre- and post- treatment

			G1	G2	Total
TVA (syl/min)	Initial	n	8	8	16
		Mean	184.2	198.7	191.4
		Median	186.3	196.5	196.0
		Minimum	128.0	117.0	117.0
		Maximum	244.5	280.0	280.0
		Standard Deviation	47.3	48.2	46.8
		(G1XG2) p=0.550			
	Final	n	8	8	16
		Mean	223.6	191.4	207.5
		Median	234.5	193.0	211.4
		Minimum	150.7	104.0	104.0
		Maximum	281.0	277.0	281.0
		Standard Deviation	49.8	51.6	51.8
		(G1XG2) p=0.230			
			G1 initial X final (p=0.021*)	G2 initial X final (p=0.645)	
TPI (word/min)	Initial	n	8	8	16
		Mean	101.3	116.8	109.1
		Median	98.5	115.5	102.5
		Minimum	65.0	69.0	65.0
		Maximum	143.0	174.0	174.0
		Standard Deviation	28.0	31.7	30.0
		(G1XG2) p=0.862			
	Final	n	8	8	16
		Mean	118.6	107.1	112.8
		Median	121.0	108.0	115.0
		Minimum	75.7	62.4	62.4
		Maximum	151.4	146.0	151.4
		Standard Deviation	27.6	27.9	27.5
		(G1XG2) p=0.070#			

*Significant values (p<0.05) – Analysis of variance (ANOVA)

Tendency

Note: TVA = rates of articulatory speed; syl/min = syllables per minute; TPI = production information; word/min = words per minute; G1 = stutterers undergoing therapy using SpeechEasy® device; G2 = stutterers submitted to the therapy, without the use of SpeechEasy® device

stuttering, speaking with the use of SpeechEasy®. However, speech rates vary minimally, increasing only 8% in the reading assignment and 15% in monologue task, remaining below normal. Low speech rate while using the device is probably due to the manufacturer's instructions to encourage users to speak in chorus, with the sign of delayed auditory feedback[3].

For decades, several authors have used DAF for the reduction of speech rate, including therapy cluttering, maintaining the hypothesis that the effect, both in the severity of stuttering, and in cluttering be due to a reduced speech rate[11,12,14].

Investigations into the immediate effect of auditory feedback showed significant differences in the frequency of stuttering, but not in speech rate, indicating that stutterers showed no speech rate slower when exposed to auditory feedback. However, studies show great variability in results, which illustrates clearly the heterogeneity of the effects of these devices. There is strong evidence that the reduced speech rate is not essential for the improvement of stuttering when subjected to delayed auditory feedback conditions. This suggests that the auditory feedback actually plays an important role in improving the fluency and are not only subject to reduced speech rate[3,23,24].

The data in this study support the idea that the speech rate would not be responsible for the improvement of stuttering when underwent to delayed auditory feedback conditions, as was observed in G1, using the SpeechEasy®, the reduction index of atypical disfluencies and stuttering severity, associated with increased rate of speech articulatory and production information.

The results observed in several experiments and in the present study demonstrated that these auditory nature strategies

Table 3. Mean values reduction in atypical disfluency, the gains in speed articulatory rates and production information for G1 and G2

	G1	G2	Total
Reduction in disfluency (%)			
n	8	8	16
Mean	4.1	2.1	3.1
Median	4.1	2.5	3.3
Minimum	1.5	-1.5	-1.5
Maximum	7.7	5.1	7.7
Standard Deviation	2.2	2.3	2.4
(G1XG2) p=0.096#			
Gain in TVA (syl/min)			
n	8	8	16
Mean	39.4	-7.3	16.1
Median	41.9	-8.0	3.7
Minimum	-37.7	-45.7	-45.7
Maximum	135.3	28.0	135.3
Standard Deviation	55.5	23.9	47.8
(G1XG2) p=0.047*			
Gain in TPI (word/min)			
n	8	8	16
Mean	17.3	-9.7	3.8
Median	20.8	-9.2	1.7
Minimum	-39.5	-31.8	-39.5
Maximum	73.7	9.0	73.7
Standard Deviation	35.7	16.4	30.2
(G1XG2) p=0.072#			

*Significant values (p<0.05) – t-Student Test
#Tendency
Note: TVA = rates of articulatory speed; syl/min = syllables per minute; TPI = production information; word/min = words per minute; G1 = stutterers undergoing therapy using SpeechEasy® device; G2 = stutterers submitted to the therapy, without the use of SpeechEasy® device

cannot be used arbitrarily for all stutterers, because not all respond favorably, and should therefore be carefully tested in each individual[1,5,16,19,23-29].

CONCLUSION

There was an improvement of stuttering level with speech training in both groups, with a tendency of G1, which made use of *SpeechEasy*® device to present higher reduction in the disfluencies rate and bigger gain in articulatory rate and information production rate.

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