Stuttering treatment assessment in daily life with behind-the-ear devices for adults who stutter

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ABSTRACT: The efficacy of wearing behind-the-ear devices (delayed auditory feedback and metronome) in daily life to reduce disfluency was assessed with objective and subjective and subje weakly related to the frequency of using the devices. Their subjective evaluation reflected the objective speech data except one subject. It was also observed that the effect of the devices carried over beyond the cessation of the regular use.

INTRODUCTON

Most of those who stutter can speak fluently when they time their speech to the rhythmic beat of a metronome, or when they speak under a condition of altered auditory feedback (AAF). Although delayed auditory feedback (DAF), a type of AAF, and a metronome has been used in several therapy programs, their effect is reportedly difficult to transfer to daily life. On the other hand, body-worn, battery-powered DAF and metronome devices have been developed and used in daily life. However, there have been few reports assessing their effectiveness based on objective measures under the daily speech situations.

The purpose of this study was to investigate the effectiveness of long-term usage of these devices on daily speech, with the objective analysis of disfluency as well as the subjective evaluation of the devices by the users.

METHODS

Participants

Five adults with developmental stuttering (mean age 28.7 years, SD 11.13) were recruited at the Hospital of National Rehabilitation Center for Persons with Disabilities and at a self-help organization in Japan. The inclusion criteria were that they showed reduction of disfluency or felt easy to speak with one of the ear-level devices (see below) at their trial fitting, and that they experienced difficulty in speaking over the telephone. The detail information of participants was shown in table1.

Apparatus

AAF device

SpeechEasy® (Stuart, Xia, Jiang, et al. 2003), a behind-the-ear AAF device, was utilized for only the DAF function, because none of the participants preferred FAF (frequency altered feedback) (Figure 1).

Metronome

We developed an electronic metronome that could be worn behind the ear, and applied it to participants. Its beat rate can be programmed from 6 to 200 tone pips per minute. It has a user switch for two levels of loudness, programmable between 20 and 90 dB SPL (Figure 2).

Table 1. Individual participants information

Apparatus	Participants*	Gender	Age (years) at beginning of usage	Stuttering severity (SSI-3**)	Delay time /Pace***	Period of usage	usage	Frequency in use	Treatment history****
DAF	A	M	19	moderate	125 ms→ 180 ms	6 mons.	reading aloud, telephone and face to face conversation	everyday 15-20 min on average / day	From 7 mons. before the beginning of usage to the end
	В	F	27	moderate	150 ms→200 ms	4 mons.	reading aloud, telephone and face to face conversation	everyday 20-30 min on average / day	None before the beginning of usage Fluency shaping during the usage
	С	F	31	very mild	50 ms	1 yr.	reading aloud, telephone and face to face conversation	everyday 15 min on average / day	None before the beginning of usage Fluency shaping during the usage
Metronome	A	M	20	moderate	60 clicks/ min	8 mons.	reading aloud, telephone and face to face conversation	everyday 15-20 min on average/ day	From 1 yr. and 1 mon. before the beginning of usage to the end
	В	F	28	moderate	92 clicks/min	1 yr. and 3 mons.	reading aloud, telephone and face to face conversation	everyday 20-30 min on average / day	None before the beginning of usage Fluency shaping during the usage
	D	M	52	very mild	100 clicks/min	6 mons.	reading aloud, telephone conversation	3 days a week within 15 min on average / day	From 2 yrs. and 10 mons. before the beginning of usage to the end
	E	F	24	mild	75clicks/min→ 66clicks/min	1 yr. and 6 mons.	telephone and face to face conversation	1-4 days a week within 10 min on average /	From 1 yr. and 2 mons. before the beginning of usage

*Same alphabet indicates the same participant. Participant A and B used both devices in sequence.

***The change of delay time / pace was shown by arrow.

**** First or second author performed the treatment for participants B, C, D and E.

The treatment for participant A was performed by another therapist belonging to the National Rehabilitation Center for Persons with Disability.



Figure 1. SpeechEasy®



Figure 2. BTE Metronome

<u>Procedure</u>

The participants were instructed to use the device at least fifteen minuets everyday for several months (more than one year for two cases), when they read aloud printed materials (books or newspaper), made monologue, and conversed face to face and over the telephone. They were asked to log their daily usage and to record their speech during telephone calls once a week to a DAT (digital audio tape) recorder (TDC-D100, SONY). We also performed pre- and post- evaluation (before the beginning of the daily usage and at the end of it) on a monologue task without the devices. They were required to visit our laboratory monthly, when we adjusted the device if necessary and gave them advices or training on how to use the device. At each visit they were required to rate, on a seven-point rating scale, their own disfluency and the effect of the device.

RESULTS & DISCUSSION

Compliance and usage

Analysis of the logs showed that three participants (cases A, B and C) had spent on average 15 min or more per day in using the devices. The other two (cases D and E) spent less than 15 min on average per day, for three days a week (Table1).

Speech fluency: The pre- and post-tests without the devices at laboratory

First 100 words of recorded speech samples at our laboratory were transcribed. We counted the number of stuttering events and calculated the percentage of frequency of stuttering (= the number of stuttering / the number of phrases (= bunsetsu in Japanese) x 100). All participants except one who used the metronome showed reduction in disfluency at the post-test compared to the pre-test (Figure 3). This result suggestes that the effect of devices on stuttering may carry over in the speech task after the device use.

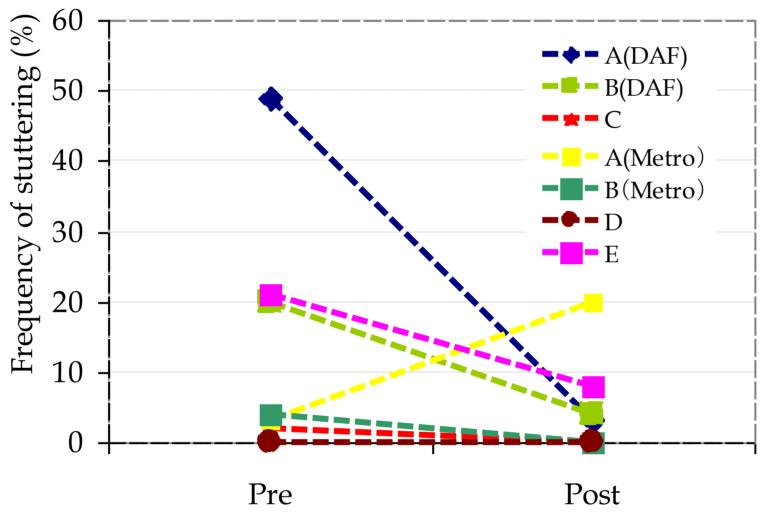


Figure 3. Frequency of stuttering without the devices at laboratory Pre: before the beginning of usage Post: after the end of the usage

Speech fluency: telephone calls in daily life

First 100 words of recorded speech samples of each participant's telephone calls were transcribed. We counted the number of stuttering events and normal disfluencies, and calculated the percentage of their frequencies. Figure 4 showes the averaged frequencies for two-month periods from the beginning of usage. Cases A and B showed the greatest reduction in the frequency of stuttering. Case A showed a reduction from 23% to 3.5% with the DAF device and from 14.5 to 2.2 with the metronome. Case B showed a reduction from 12% to 3% with the DAF device and from 20.6% to 7.5% with the metronome. Case C kept a low frequency of stuttering during the daily usage of DAF and showed a significant reduction in normal disfluency such as interjection (p < 0.01, U-test; Figure 5). Case D with the metronome showed a significant reduction in the frequency of stuttering from 4.4% to 2.2% (p < 0.01, U-test). Case E showed a 6% reduction in the frequency of stuttering after a year and six months of using the metronome. As a result, all subjects showed the reduction in disfluency during phone calls, although there was a difference in its degree among participants.

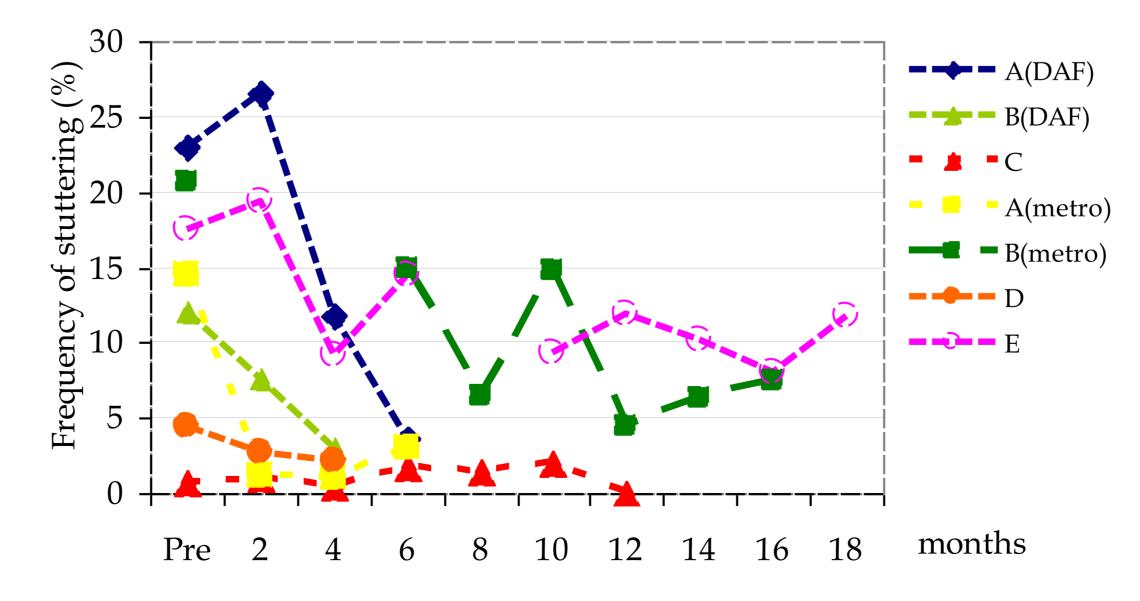


Figure 4 Frequency of stuttering during telephone calls Pre: before the beginning of usage

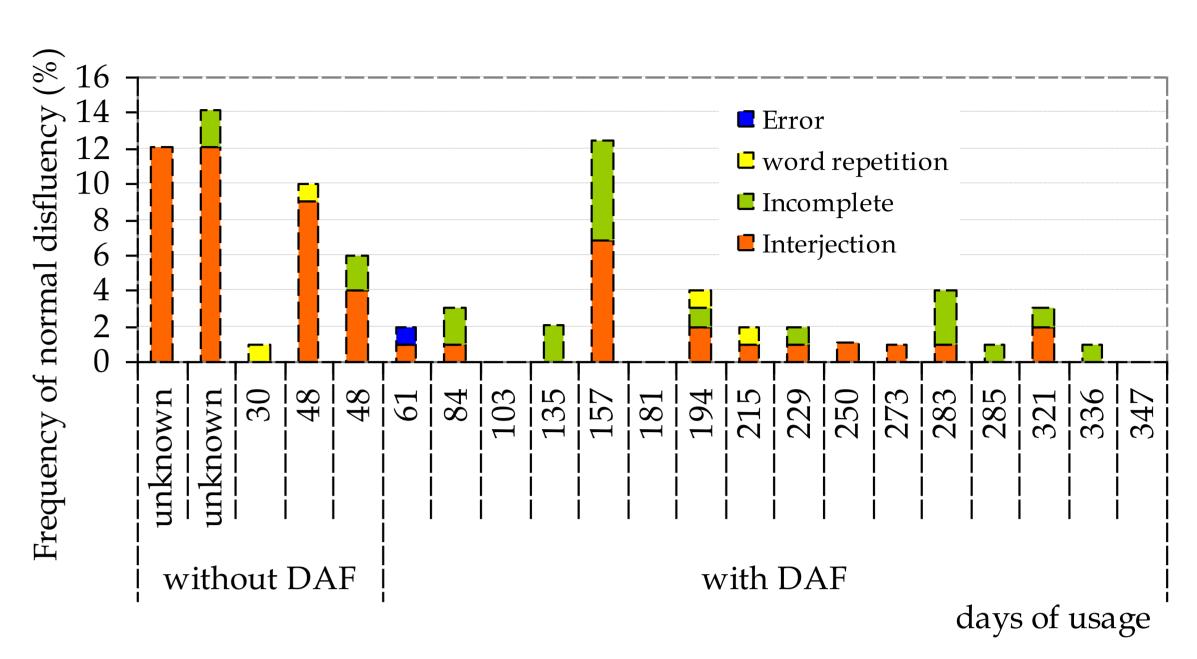


Figure 4. Frequency of normaldisfluency during telephone calsl in case C unknown: the accurate day was not recorded.

Participant perception: self rating

Table 2 showed the participants' self rating of their own disfluency and the effect of the devices. The numbers in table show the average of all the seven point ratings which participants undertook at the visits to our laboratory during the usage of the devices. Cases A and C evaluated highly the improvement in severity and difficulty to speak, and showed great satisfaction with the devices. Cases D and E also recognized positively the improvement in severity and difficulty to speak, and showed a certain level of satisfaction with the metronome that they used. Case B rated the improvement in severity and difficulty to speak as small on average while using the metronome for a year and three months, but she felt that her fluency became worse than before while using the DAF device and expressed dissatisfaction with the device. The gap between subjective and objective data shown in Case B may have arisen from the negative attitude for her stuttering. Overall, their subjective evaluation reflected the objective speech data except one subject.

table 2. Self rating for change in stuttering severity and satisfaction for devices

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participants	improvement on severity ¹⁾	improvement on difficulty to speak 2)	control for speech rate	satisfaction for devices 4)	times of rating during the pepriod of usage
A (DAF)	5	5.1	6.1	5.7	7 times / 6 mons.
B ⁽ DAF)	3.8	4.3	5	3.5	4 times / 4 mons.
C	6.5	6.5	6.7	6.7	12 times $\sqrt{1}$ yr.
A (Metronome)	5.7	6.3	6.7	6.7	6 times / 6 mons.
B (Metronome)	4.8	4.8	5	5.3	13 times 1 yr. and 3 mons.
D	5.1	4.5	4.6	4.5	5 times / 6 mons.
E	4.8	4.5	5.5	5.2	16 times 1 yr. and 8 mons.

^{*} seven-point rating scale

CONCLUSIONS

The objective measures of disfluency frequency as well as subjective scaling were used for assessing the efficacy of two types of behind-theear devices in facilitating daily and long-term fluency in the difficult situations. The subjects showed reduction of disfluency during phone calls to a varying degree. The degree of the objective efficacy of the devices was weakly related to the frequency of using the devices. Their subjective evaluation reflected the objective speech data except one subject. It was also observed that the effect of the devices carried over beyond the cessation of the regular use, which may imply that the regular usage in difficult situations could mediate therapeutic effects in some clients.

^{**}the Stuttering Severity Instrument (Riley, 1994)

^{1) 1:} change to very severe -4: no change -7: change to very mild

^{2) 1:} change to very difficult -4: no change -7: change to very easy 3) 1: very hard to control -4: no change -7: very easy to control

^{4) 1:} very dissatisfacted with -4: no change -7: very satisfacted with