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ABSTRACT

To determine whether or not a modified delayed auditory feedback would smooth the speech pattern and increase fluency in stutterers, eight severe stutterers were given individual 10 to 40 hour speech sessions. Feedback was delayed by .2 seconds, the rate of speech controlled by the experimenter, and speech patterns were smoothed by prolonging vowel sounds and shortening consonant sounds. The success rate of speech fluency was 100% to the time of the report; no subjects still stuttered after a 10 month elapse. It is felt that stutterers depend on feedback for speech guidance and that the middle ear mechanism many be a factor in the cause of stuttering. (JM)

Stuttering: A Way to Eliminate It and A Way to Explain It

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In this report I will try to accomplish two purposes: 1) I will describe how we have shaped fluent speech in stutterers using a modified version of the procedures described by Dr. Israel Goldiamond (1965), and 2) I will make some suggestions about a mechanism which may be basic to the phenomenon of stuttering.

Several changes were made in order to accommodate Goldiamond's procedures to our laboratory setting. First, we were aware that the continuous presentation of delayed auditory feedback (DAF) was effective in generating increased fluency in stutterers. Therefore, we decided to use DAF without the special contingent relationships specified by Goldiamond. Second, we did not exert direct manipulative control over the Ss' reading rate with apparatus; instead, we relied on instructions given to S by E who monitored experimental sessions. Third, we instituted an addition to the fluency shaping procedures outlined by Goldiamond. In the course of our initial work it became apparent that Ss had difficulty in discriminating their own speech rate. Therefore, we introduced a procedure that was designed to facilitate Ss' discrimination of their speech rate.

Method

Subjects. The Ss consisted of eight severe stutterers who ranged in age from 15 to 47 years. All Ss had experienced usual speech therapies with little success noted. Each S was run as an individual experiment.

Apparatus. The experimental apparatus consisted of a Lafayette modified Bell and Howell delayed feedback recorder with delay intervals that were continuously variable from 0.08 sec. to 3 sec. Speech signals which entered the microphone were delayed for a .2 sec. interval and were then returned to the Ss' ears through earphones. The equipment was adjusted so volume at the earphones at normal speech levels was approximately 65 - 70 decibels.

An Ampex video tape recording system V-R 7000 was used to record the behavior of Ss throughout experiment sessions. The camera was visible to the S at all times, but the picture which appeared on the monitor could only be seen by E. Selected articles from Reader's Digest were used as reading material.

Procedure. It is important to note that Ss were advanced through the fluency shaping program on the basis of their own progress at each of the steps of the program. Therefore, only the general steps were used in the fluency shaping procedures are outlined below.

On each of the first three days 40-min. sessions of oral reading were recorded. Video tape recordings were made of all sessions. Two Es independently counted stuttering responses (blocks) during video tape replays. Each word on which a nonfluency occurred was scored as a block. Agreement on counts by two Es ranged from 96% to 100%.

The first step in the fluency shaping process was self-definition. On day 4, at the start of the session, S was instructed to press a hand counter whenever he blocked. E recorded blocks at the same time. When the block counts agreed S went on to the next step in the program. Self-definition occurred for all Ss in about half of one experimental session.

The next portion of the fluency shaping program involved the use of DAF. At the beginning of the second half of day 4, S was put on continuous DAF and was instructed to prolong his speech. The correct responses were illustrated for S by E. DAF was faded out after a period of 30 min. simply by turning down the volume control knob on the DAF recorder. From day 5 on, Ss produced self-maintained fluent speech. The speech rate at this point in the program was approximately 30 - 35 words a minute.

The next step in our procedure involved smoothing out the slow speech which had been established. This was probably the most important step in the entire procedure. The smoothing operation involved instructing S to decrease the speed and amplitude with which he made consonant sounds while simultaneously prolonging vowel sounds. In addition, Ss were instructed to make smooth transitions from one speech sound to another within a word. When suitable smoothness was achieved, the S's speech rate was gradually increased to approximately 80 to 100 words a minute. During this time, S continued to concentrate on smoothness both within words and within sentences. Evenness of production of individual words was found to be important in generating smooth flowing speech. If stuttering occurred at any point in the program, S was first instructed to smooth his speech rate. If this instruction did not immediately aid fluency, S was instructed to slow his speech. Then, following the attainment of fluency, S's speech rate was gradually increased and the program was continued.

The next step, rate discrimination training, involved instructing S to speak at approximately 60 - 75 words a minute, for two minutes. Then S was instructed to increase his speech rate to approximately 110 words a minute for two minutes. Every two minutes S was cued to switch from one rate to the other. Once the rate discrimination skill was developed, conversation began. A magazine was given to S and he was told to describe in one sentence a picture or an advertisement. Thus, it was possible to generate a large amount of spontaneous speech which simulated conversation. When S was able to describe pictures fluently with single sentences, he was then instructed to describe a picture or advertisement with several sentences. When performance at this point in the program was judged to be correct, then actual conversation began between E and S. In this segment of the fluency shaping program, S used fluent speech during conversation in the laboratory. After a few days of conversation in the laboratory setting, S was instructed to begin the use of his fluent speech in settings outside the laboratory.

The S was asked to use his new fluent speech pattern for a short period of time in his home. He was instructed that if he was successful in using the new fluent speech pattern, he was to continue using it. If he had any trouble with it, he was to do one of two things; 1) either go completely to the new speech pattern which he had been using in the laboratory, or 2) return to his usual nonfluent speech pattern. We found that, once S began to use fluent speech in the home, fluency rapidly extended to other areas of conversation. During the portion of the program in which fluent speech was being transferred to settings outside of the laboratory Ss continued training in conversation in the laboratory. When Ss reported to us that they had had less than five blocks a day, we released them from the program.

Results

The total time in the program for eight Ss ranged from 10 - 40 hours. A summary of data derived from baseline and experimental sessions is shown in Table 1. The summary of experimental sessions does not include the periods of conversation. Blocking levels for Es were essentially zero by the time they were in the portion of the program that involved conversation.

Table 1

Total Number of Words Read and Total Number of Words Stuttered During Baseline Reading (B.L.) and During Experimental Sessions (Exp).

	S-1		S-2		S-3		S-4	
	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.
Total words read	9699	25401	11893	25739	2738	8608	3386	5581
Total words stuttered	4363	32	3684	115	459	2	1977	48
Percentage words stuttered	45	.001	31	.004	16	.0002	57	.008

	S-5		S-6		S-7		S-8	
	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.
Total words read	4300	12471	23956	11984	11805	21406	13425	2283
Total words stuttered	1765	7	424	3	3176	427	2578	27
Percentage words stuttered	41	.0005	2	.0002	27	.02	19	.01

By the 14th day of their participation in the fluency shaping program four Ss reported their speech was fluent outside the laboratory. The other Ss reported that their speech was markedly improved. Following additional laboratory sessions, these Ss reported their speech became fluent.

It is important to point out that the fluency generated by the present program has persisted in all eight Ss up to the time of this report, that is, approximately ten months. Only one S, the first one through the program, reported any recurrence of stuttering. He was returned to the laboratory, run through rate discrimination and conversation steps, and was then released. He has not reported any further difficulty with his speech.

(Video tape samples to be shown.)

Discussion

What explanation does one give for the success of the fluency shaping program? A rather careful study of the research literature and our own laboratory work have led me to conclude that interference in the auditory feedback of the stutterer's speech provides the stimulus for blockage of the vocal emission. The mechanism that mediates auditory feedback interference is probably the faulty temporal relationship between middle ear muscle activity and initiation of the vocal act. Shearer and Simmons (1965) have shown that when middle ear activity is measured by means of an acoustic bridge, increases in acoustic impedance occur from 65 to 100 ms. prior to the initiation of speech. Increases in acoustic impedance are produced by contractions of the two muscles (the tensor tympani and the stapedius) located in the middle ear. The tensor acts upon the tympanic membrane directly and the stapedius operates indirectly via the ossicular chain. These muscles increase the resistance of the middle ear to sound transmission. Simmons (1964) reported that the speech-associated contractions of the middle ear muscles do not seem to habituate and that their magnitude is roughly proportional to the intensity of the anticipated vocal response. This same investigator has pointed out that in cats contractions of middle ear muscles can attenuate sound transmission through the ossicular chain by approximately 20-25 db. A study on sound conduction of human temporal bones (Neergaard, Andersen, Hansen & Jepsen, 1964) showed that middle ear muscle contractions attenuate sound transmission by approximately 20 db. There is an additional interesting report by Galambos (1956) who made electrical response recordings from the round window membrane of cat cochleas during auditory stimulation with a series of clicks. During movement of the stapedius muscle electrical responses of the cochlea corresponding to the auditory stimuli were suppressed. Other investigators have reported similar findings. In discussing the function of the intratympanic muscles Simmons has suggested that these muscles act to reduce the intensity of low frequency air and bone conducted sounds produced by the speaker.

It seems likely that in stutterers the sudden attenuation of auditory feedback produced by late or unstable contractions of the middle ear muscles during speech initiation (and/or during transitions from sound to sound) produces sufficient interference in the auditory signal to halt the act of vocalizing. Shearer (1966) has shown that middle ear activity can occur coincident with stuttered responses. If it is assumed that stutterers are dependent on auditory feedback as a stimulus used for speech guidance, then the middle ear mechanism is a factor which may be the underlying cause of stuttering. Studies on auditory masking (Cherry & Sayers, 1956; Maraist & Hutton, 1957; Sutton & Chase, 1961) point to the importance of auditory feedback in speech guidance for stutterers. The fluency shaping program is effective because it probably alters the temporal relationship between middle ear muscle activity and speech initiation, thus reducing auditory feedback interference.

A comment about the topography of stutterers' speech is in order. We have used speech spectrograms to measure characteristics of stutterers' speech before and after they have participated in the fluency shaping program. Prior to fluency shaping Ss uttered rapidly articulated words, with short sounds, rapid onset of speech sounds and quick transitions from sound to sound. Following fluency shaping, even when speaking at normal rapid rates, Ss produced speech sounds that were more gradual in onset, had slower transitions from sound to sound, and of course, had longer durations of sounds than those they produced before their participation in the program. The observed changes in response topography provide some support for the auditory-interference hypothesis outlined here.

If the relatively simple unitary mechanism of interference in auditory feedback is basic to the phenomenon of stuttering, how does one explain the diversity of stuttering patterns seen? In the early stages of stuttering the occurrence of speech blockage is evident. However, as time passes one begins to observe a variety of the so-called "secondary symptoms" of stuttering: eye blinks, head jerking, the use of starters, forced breathing patterns, etc. These behaviors that give the distinctiveness to individual stuttering patterns probably develop as conditioned avoidance and/or escape responses to the speech blockage the stutterer has come to expect when he talks. It is interesting to note that in the fluency shaping program these secondary symptoms drop out immediately; almost as if they are, indeed, tied to a specific stimulus implicit in the act of speaking. All of the stutterers we have tested in our laboratory (about 40 at the present time) have shown this rapid dropping out of the secondary characteristics during prolonged speech.

A number of variables can enhance the fluency of stutterers. For example, masking noise, rhythmic cueing stimuli, repeated oral readings of a passage, whispering, choral reading, singing, unusual speech patterns, and delayed auditory feedback. Time limitations preclude discussion of these variables. The Middle ear muscle mechanism provides a key to understanding how these fluency enhancing variables produce their effects. A paper now in press (Webster & Lubker, 1968) goes into the details of explanation.

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