SUPPRESSION OF NORMAL SPEECH DISFLUENCIES THROUGH RESPONSE COST¹

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The speech disfluencies of five normal-speaking college students were modified in a series of 10 to 17 sessions by means of response cost. During Point-loss, each disfluency (repetition or interjection of a sound, syllable, word, *etc.*) resulted in the loss of a penny, as indicated on a screen in front of the subject. Disfluencies were suppressed and kept at very low levels for four of the subjects during the punishment procedures, and there was general resistance to extinction. Even though points were subtracted only during speech, there was a tendency for disfluencies to decrease, though not as markedly, during reading probes as well.

A number of investigators have attempted to identify the variables that influence the distribution of disfluencies in normal speakers, and these responses have variously been regarded as an index to the speaker's emotional state (Mahl, 1956), "speaker uncertainty" (Goldman-Eisler, 1961), or as indications of the functional units employed by the speaker as he "programs" speech (Boomer, 1965).

Speech disfluencies are of special interest to students of stuttering, because of the topographical similarity disfluent behaviors share with moments of stuttering, and because of the possibility that the speech disruptions of normal and abnormal speakers may somehow be functionally related. In recent years, several authors have presented the view that normal disfluencies and stuttering fall along a single continuum (Bloodstein, Alper, and Zisk, 1965; Shames and Sherrick, 1963; Goldiamond, 1965). This raises the possibility that the study of disfluency may prove a productive way of gathering insights into the problem of stuttering.

A considerable body of literature indicates that a variety of response-contingent stimuli will suppress the frequency of both stuttering and normal speech disfluencies (*e.g.*, Martin, 1968; Goldiamond, 1965; Siegel, *in press*). Reductions in speech disruptions have been ob-

tained with shock, loud noise, delayed auditory feedback, the word "wrong", and other stimuli. Studies of the effects of punishment on normal disfluencies are particularly interesting because of the important role that is usually accorded to punishment of early speech attempts in many contemporary theories of the origins of stuttering (Johnson, 1959; Shames and Sherrick, 1963).

Weiner (1962) has described response cost as a punishment procedure that seems to capture some of the natural contingencies inherent in behavior. Response cost would appear to be particularly relevant to the study of such maladaptive behaviors as stuttering in which the act of speaking almost inevitably involves both physical and social cost to the speaker. Halvorson (1968) found response cost to be a very effective method for reducing stuttering. The present experiment used a response-cost procedure with the disfluencies of five normal speakers. We were interested in determining the extent to which these apparently natural units of speech could be suppressed by response cost and whether results obtained with spontaneous speech would also generalize to a reading task.

METHOD

Subjects

Four female and one male student were recruited from an introductory Speech Pathology course at the University of Minnesota with the promise they would be reimbursed \$2.00 per session for participating in an experiment involving verbal behavior. They were selected

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from a larger group of volunteers and assigned to one of the three experimenters on the basis of convenience in scheduling. Each of the authors served as experimenter for two of the subjects except for the senior author who worked with only one subject.

Apparatus

The experiment was conducted in a two-room suite, consisting of a sound treated experimental room and an adjoining control room. The rooms were connected by means of a communication system and a one-way vision mirror. The subject sat alone at a table, facing two microphones and an 8-in. television screen. The experimenter monitored the sessions from the control room, and depressed a handswitch for each disfluency. Responses were cumulated on a printout counter wired to report every 2 min during the session. The sessions were also tape-recorded.

An add-subtract counter was located in the control room, in an enclosure with a portable television camera. The camera was trained on the counter so that when the television receiver in front of the subject was on, the numbers filled the screen. This method of displaying the numbers was chosen, rather than simply placing the counter in front of the subject, so that there would be no cues on the tape recordings as to when a disfluent response had been scored. The counter emitted a loud click when activated which would have been picked up on the recording. No sound accompanied the image on the TV screen.

Speech Task

The primary task for all subjects was spontaneous speech, but data on reading were also obtained for Subjects 1 through 4. At the beginning of the first session, Subjects 1 and 2 were given a copy of a textbook and a stack of index cards containing nouns that had been arbitrarily selected from a dictionary. They were told the following:

This experiment deals with verbal behavior, and involves reading and speaking. We will start out today by having you speak for the first half of the session. I'll be in the other room, listening, and tape recording the session. When I give you the signal, please start talking about any topic that comes to your mind. If you

have difficulty thinking about things to talk about, you can refer to the stack of word-cards we have prepared. Don't just define words. Use them to help you think of topics to discuss. The important thing is to keep on talking.

After you have been talking for awhile, I will ask you to begin reading. At that time, please turn to the first page of the book in front of you, Johnson's *People in Quandries*, and start reading. Continue reading until I tell you to stop. The entire session today will be a little more than a half hour, with no interruption except to switch from speaking to reading. Please do not stop at any other time.

The instructions for Subjects 3 and 4 were essentially the same, except that these subjects began in reading and were switched to speaking in the second part of the session. Since Subject 5 participated only in the spontaneous speech task throughout the experiment, all references to reading were deleted in her instructions.

Responses

Disfluencies were defined solely as interjections (usually "er", "um", "uh", or some variant) or repetitions of a sound, syllable, word, *etc.* Because of the difficulty in making immediate judgments, pauses and prolongations were not included in the response class. There is normative evidence (Johnson, 1961) to suggest that approximately 85% of the disfluencies of normal speakers are either repetitions or interjections, and this is borne out in previous experiments in this laboratory. Data on word rate were also obtained at the conclusion of the experiment by counting the number of words per minute from a sample of tapes for each subject.

Segments

Specific procedures varied somewhat among subjects, but the experiment was divided generally into three segments, Baseline, Point-loss, and Recovery (reinstatement of baseline). The basic design is shown in Table 1 for Subject 1.

Probes

In order to determine whether changes obtained during speech would generalize to read-

Table 1

Experimental design and description of sessions for Subject 1.

Sessions	Procedure	Task	Minutes
BASERATE			
1	Baseline	Reading	16
	Baseline	Speech	16
2	Baseline	Speech	16
	Baseline	Reading	16
3a	Baseline	Speech	16
	Baseline	Speech	16
POINT-LOSS			
3b	Point-loss	Speech	16
	Probe	Reading	4
4-9	Baseline	Speech	8
	Point-loss	Speech	8
	Probe	Reading	4
	Point-loss	Speech	16
	Probe	Reading	4
RECOVERY			
10-12	Baseline	Speech	16
	Probe	Reading	4
	Baseline	Speech	16
	Probe	Reading	4

ing, even though contingencies were never offered during the reading task, 4-min reading probes were included for Subjects 1 through 4 in the Point-loss and Recovery sessions, as indicated in Table 1.

Treatment

Just before the start of the Point-loss segment, the screen was illuminated showing 200 points and the subjects were read the following instructions:

There are 200 points on this screen, and each is worth a penny. At the end of the session you will be credited with \$2.00 plus what is left on the counter. You can't add points, but try to retain as many as possible. In that way you will earn the most money. Pay attention to the screen so that you know exactly how many points you have at all times.

Each session during Point-loss was started with an 8-min baserate period in which no points were subtracted. Then, one point was subtracted for each disfluency during Point-loss.

Recovery (Reinstatement of Baseline Procedure)

During these sessions, unless otherwise indicated, the counter was disconnected and the

TV screen was turned off, duplicating the original Baseline conditions. Subjects 1 through 4 continued to have the probes, as shown in Table 1.

Questionnaire

At the end of each Point-loss session, the subjects were asked to fill out a form containing the following three questions: (1) During today's session, under what circumstances did you lose points? (2) What did you do to keep from losing points? (3) If you are aware of why you lost points, why did you continue to lose them?

Reliability

Reliability for disfluency and word counts has been established in several previous experiments. Siegel and Martin (1967) had independent observers count disfluencies and words from 10 tape recordings of spontaneous speech; the correlation coefficients exceeded 0.90 for both measures. Brookshire and Martin (1967) selected two sessions for each of the five conditions in their study of disfluencies during reading. Each tape was cut and spliced so that the segments were scrambled. An independent observer then counted the disfluencies from the 10 tapes, without knowing from which condition a given tape was drawn, or the order of the segments on the tape. A reliability coefficient of 0.96 was obtained between the original disfluency counts during the session and those obtained from the tape recording. The two junior authors of the present paper independently counted words and disfluencies in fifteen 12-min samples of spontaneous speech collected for another experiment, and the coefficients were 0.94 and 0.98 for words and disfluencies respectively.

RESULTS

The data of primary interest were the frequency counts of disfluencies during the various stages of the experiment, though rate of speech was also determined for a sample of sessions for each subject.

The disfluency frequency data, averaged over 8-min periods, are presented in Fig. 1 through 5. The lower left-hand figure (A) represents disfluencies during speech; the upper right-hand graph (B) is based on reading during the initial Baseline sessions as well as the

reading probes during the rest of the experiment. In every instance, the data are converted into values appropriate for 8-min periods. For Subjects 1 through 4, the first two sessions consisted of 16 min of reading and 16 min of speech. The total for each task was divided by two to convert the data to a common base of 8 min. In all but Session 3, two 4-min probes were included, and they are totalled to yield a single value for the 8 min. In Session 3, only a single 4-min probe was included, and the disfluencies during that probe are doubled for graphic purposes. During the Point-loss sessions, the first 8 min was always a baserate

period, and is depicted as such in the figures. The disfluencies during the three 8-min Point-loss periods of these sessions are averaged to give the single value recorded in the graphs.

Subject 1

Subject 1 participated in 12 sessions, distributed among Baseline, Point-loss, and Recovery segments as indicated in Table 1. In the first session (Fig. 1), she averaged about 26 disfluencies per 8-min period during speech, and about 21 disfluencies in the reading task. During Session 2, she again averaged 26 disfluencies per 8 min of speech, but her reading dis-

Fig. 1. Mean disfluencies per 8 min for Subject 1 in Baseline, Point-loss, and Recovery segments in spontaneous speech (A) and reading (B). The single 4-min probe from Session 3 is doubled.

fluencies dropped to 16. The first 16 min of Session 3 (3a) was still speech Baseline, but her disfluencies decreased to 15 per 8 min.

The Point-loss procedure was initiated in Session 3b, and her disfluencies were reduced by half. Subject 1's baserate levels for subsequent sessions never reached the number she emitted in the initial sessions. In Session 6, her baserate was five disfluencies for 8 min. During the Point-loss portion of this session, she emitted only three disfluencies per 8 min. In the final treatment session (Session 9), she averaged four disfluencies in both the Baseline and Point-loss periods.

The Recovery segment was introduced in Session 10. The TV screen was turned off in this session and for the rest of the experiment, so that no additional money could be earned. As can be seen in Fig. 1, there was an increase in disfluencies in each of Sessions 10 to 12. For the most part, however, the disfluency rates

remained low and never approximated the original Baseline.

Though contingencies were not given during reading, the pattern in Fig. 1B is somewhat similar to that obtained with speech. There was a substantial decrease in reading disfluencies after the Point-loss was introduced in Session 3. During the remaining sessions of Point-loss, however, disfluencies increased somewhat during the probes, while they decreased during speech. There was a slight further increase during the Recovery probes.

In summary, Subject 1 appears to have been a relatively fluent speaker from the outset of the study. Once the response-cost method was started, her speech disfluencies were greatly reduced and remained infrequent, though there was some increase in the Recovery sessions. Though the baserates continued to drop throughout most of the Point-loss segment, the pattern during each Point-loss session was

Fig. 2. Mean disfluencies per 8 min for Subject 2 in Baseline, Point-loss, Recovery, and Point-add segments in spontaneous speech (A) and reading (B). The single 4-min probe from Session 3 is doubled.

characterized by a further drop in disfluencies when response cost was initiated. Examination of the probes suggests some generalization to reading.

Subject 2

The relevant data are summarized in Fig. 2. This subject was run by the same experimenter, but for a total of 18 sessions. The Baseline segment was comprised of Sessions 1, 2, and 3a exactly as shown in Table 1. In these sessions she averaged 58, 52, and 47 disfluencies per 8 min respectively. This is about twice as many disfluencies as were obtained with the previous subject, but once again the Baseline pattern indicates successive decrements in responses.

Response-cost treatment was begun in Session 3b, and resulted in a dramatic decrease in disfluencies. There were only eight disfluencies during the final 8 min of this session, and none during the probe. In Session 6, there were nine disfluencies during baserate, and an average of two during Point-loss. By Session 9, she was emitting only one disfluency for each 8 min.

The TV screen was turned off and Baseline conditions were reintroduced in Sessions 10 to 16, but there was no appreciable increase in disfluencies despite the extended series of Recovery sessions.

The contingencies were reversed in Sessions 16 and 17. After the initial baserate, the screen was illuminated and showed zero points. Subject 2 was instructed that points would now be added rather than subtracted, but was not told how to increase the points. The counter was set so that each disfluency resulted in an increase of one point (one penny). Introduction of this variation had only a minimal effect in Session 16, but the results were much more striking in Session 17, in which she averaged 100 disfluencies per 8 min. It is interesting to note that the probe disfluencies during Session 17 were virtually unaffected.

This subject was brought back for a final session, not shown in Fig. 2, in which the TV screen was blanked and all contingencies were withdrawn. Her disfluencies immediately dropped markedly; she averaged only one response per 8 min during this final 16-min session.

The effect of the Point-loss on the probes was similar to the results obtained with the previous subject. The immediate effect was a

sharp reduction in disfluencies with a gradual recovery in later Point-loss and Recovery sessions.

In summary, Subject 2 had many speaking disfluencies in the initial Baseline sessions. There was some reduction in disfluencies from session to session during Baseline, but the reduction that occurred after the contingency was added was much greater. Once the disfluencies stabilized at the low rates of the Point-loss segment, they persisted at these rates, even after an extended series of Recovery segments. It was only when points were added for each disfluency that an increase in disfluencies was obtained, but even here the increase did not persist into either the baseline or probe conditions.

Subject 3

Subjects 3 and 4 were run by the same experimenter. For these subjects, the order of tasks was reversed in Sessions 1, 2, and 3, and consisted of 16 min of speech followed by 16 min of reading. Subject 3 was the only male included in the experiment. During the first session he appeared to be very uneasy, and his spontaneous speech was marked by frequent silences. He averaged only six disfluencies per 8 min during speech, and eight disfluencies during reading (Fig. 3).

Subject 3 exhibited an increase in disfluencies in Session 2, but introduction of the Point-loss in Session 3b appears again to have reduced these responses. As may be seen in Fig. 3, the procedures were very effective in reducing this subject's disfluencies. In the final sessions of the Point-loss segment, he was emitting virtually no disfluent responses during either speaking or reading.

There was some increase in disfluencies when the screen was turned off during Sessions 10 to 13, but in Session 13 he was down again to only four disfluencies per 8 min. It is not shown in Fig. 3, but during the Recovery sessions Subject 3 continued to show a reduction in disfluencies from the first 8 min to the end of each session, almost as though he had become temporally conditioned to the introduction of punishment in the later portions of the session.

The pattern during the probes for this subject closely paralleled the results in speech. Disfluencies were considerably reduced while points were being subtracted, but increased

Fig. 3. Mean disfluencies per 8 min for Subject 3 in Baseline, Point-loss, and Recovery segments in spontaneous speech (A) and reading (B). The single 4-min probe from Session 3 is doubled.

again with the introduction of the Recovery segment.

Subject 4

Subject 4 was run in essentially the same sequence of sessions as the previous subject. As may be seen in Fig. 4, she averaged about 38 disfluencies per 8 min in the speech baserate of Session 1, and 48 during Session 2. Her reading rate for these two sessions was 20 in each instance. The baserate for Session 3a was taken for reading only, and was about 26 per period.

The Point-loss was made contingent on disfluencies in 3b and she averaged 25 disfluencies per 8 min, or about half of her rate in the speech period in the previous session. She had 17 disfluencies during the one probe included in this session (34 per 8 min). During Session 7, due to an experimenter oversight, the counter was not connected after the first probe, so that the last 16 min of this session consisted of Baseline, rather than Point-loss, as planned. Despite the fact that points were not subtracted, Subject 4 decreased her disfluencies during this portion of the session. Though this

Fig. 4. Mean disfluencies per 8 min for Subject 4 during Baseline, Point-loss, and Recovery segments in spontaneous speech (A) and reading (B). The single 4-min probe from Session 3 is doubled.

subject's performance was somewhat erratic, she did decrease her disfluencies during at least the punishment portions of the Point-loss segment, ending with only nine disfluencies in the final Point-loss session (9). In the Recovery segment, her disfluencies were similar to the Baseline periods of the

former segment, though still below the original Baseline. During Session 12, the experimenter noted what seemed to be an unusual number of "filler" remarks such as "then", or "and then". This was later checked from the tape recording and the observation proved correct. During Session 1 she had said "then"

only three times. At the termination of the Recovery segment, she was run in an additional session (Session 13), and 36 "thens" were counted per 8 min. Disfluencies during the probes were numerous, but were apparently unrelated to the procedures of the experiment.

In summary, the results were different for this subject in a number of respects. She alone of the five subjects substituted a non-punished filler ("then") for the punished interjections and repetitions. The response-cost method was generally less effective for this subject than for any of the others, and there appeared to be no generalization from the speaking to the reading tasks.

Subject 5

Subject 5 participated in a total of 10 sessions, each consisting of 32 min of spontaneous speech, summarized in Fig. 5. In Session 1, she had about 42 disfluencies per 8 min. Session 2 was also Baseline, but she averaged 71 disfluencies per 8 min. During Session 3, the disfluencies again dropped to 24 per period. The first 16 min of Session 4 was also Baseline, and she continued to be quite variable, with 18 disfluencies in the first 8 min and 37 in the next.

Since there was no evidence that Subject 5 was stabilizing in her disfluency rate as a function of repeated experience in the experiment, it was determined to see whether the response-cost procedure itself might not reduce the variability in her response rate. Accordingly, the point subtraction was started in 4b. For the remainder of that session, she averaged 11 disfluencies for the two periods.

During the first 8 min of Session 5, the TV screen showed 200 points, but none were subtracted for disfluencies. She had 11 disfluencies during this period. For the remaining 24 min, a point was subtracted for each response and she averaged five disfluencies per period. By Session 6, her disfluencies never exceeded two or three, whether the TV was on or not.

In Session 7, the screen was on for the first 8 min, but no points were subtracted. She was then told that no points would be subtracted for the rest of the session, and the screen was blanked, but she still emitted only two disfluencies during the remaining 24 min.

She continued to have very few disfluencies during the remaining sessions. The TV screen was off throughout Session 10, and she aver-

aged two disfluencies per 8 min. At this point, the experiment was terminated.

In summary, Subject 5 was run exclusively in speech, and for only 10 sessions. Initially, she showed great variability between and within sessions. Introduction of the experimental procedure rapidly brought her disfluencies down, and stabilized her performance in the process. In the final sessions, her disfluencies remained infrequent despite the fact that the screen was off and she was told she would not lose points.

Questionnaire

Responses to the questionnaire revealed that, in every instance, the essential character of the contingency had been solved by the end of the first or second Point-loss session. Subject 3 indicated he was losing points for "errors" or mistakes. All of the other subjects specified "uh" and repetitions. The general strategy reported to avoid losing points was to think more carefully about what was to be said, and to pause when uncertain, rather than intrude "uh". The response to why they continued to be disfluent was usually "habit" or some allusion to the difficulty of composing speech. Though the questionnaire did not specifically inquire about this, it is interesting that none of the subjects remarked about the substantial decreases in disfluencies that were occurring during the sessions.

Rate of Speech

It is possible to decrease disfluencies simply by reducing the number of words spoken, and so it seemed advisable to sample speech rates in several critical sessions for each subject. It has already been noted that Subject 3 had extended silences during his first session, and unusually few disfluencies. The word counts indicate he averaged only 79 words per minute in this session, in contrast to 105 words per minute in the next session. In his case the low disfluency rate in the first session seems directly attributable to the fact that he spoke relatively few words during that session.

In the other instances, the word rate data indicate that there was considerable disparity among the subjects in characteristic speech rates, and even some variation among the sessions within a given subject. The variations that did occur, however, do not appear to have been systematically related to the comings and

goings of the experimental treatment, or to fluctuations in the disfluency data. For example, Subject 1 averaged about 199 words per minute during Session 3a, which was Baseline, and 207 words per minute during 3b, which was Point-loss. Subject 2 averaged 112 words

Fig. 5. Mean disfluencies per 8 min for Subject 5 during Baseline, Point-loss, and Recovery segments in spontaneous speech.

during Sessions 3a and 3b, and about 101 words during the Baseline and Point-loss periods of Session 7. Point-loss was first introduced for Subject 5 in Session 4, and she had 142 words per minute in the Baseline and 144 words per minute in the Treatment portion of that session. Results for the other subjects were similar.

DISCUSSION

Response cost proved to be a very effective means of suppressing disfluencies during spontaneous speech when the points were backed up by money. There is no way to determine in the current experiment just how necessary the money was, but it is evident that the subjects maintained low disfluency levels even in the Recovery sessions, when there was no possible extrinsic cost attached to these responses. Halvorson (1968) found that the same technique is very effective with stutterers, even when the points are not backed up by money.

The reductions in disfluencies obtained by this method were substantial and persistent. In all but one subject, the disfluencies were reduced to near-zero levels during spontaneous speech and there was some generalization to reading. Once the disfluencies were reduced, the subjects appeared to be motivated by considerations other than the money in maintaining the low disfluency levels. All subjects solved the contingency almost immediately and, on the basis of the questionnaires, they tended to agree that disfluencies were unattractive features of their speech. Though there was no apparent deterioration in either the rate or quality of speech as the disfluencies were decreased, a more careful analysis of a number of other language features should be made.

The fact that the disfluencies were so markedly suppressed is interesting from a number of theoretical vantage points. Johnson's (1959) theory suggests that stuttering develops when the young child's normal disfluencies are punished by some significant member of the environment. Implicit in this theory is the premise that these disfluencies are inevitable and that the only alternatives available to the child are either to become completely silent or to struggle with his speech disruptions. No consideration is given to the possibility that the child might simply become less disfluent. It is

very possible, of course, that procedures of the sort used in this experiment would yield very different results if applied to young children. Data relating to this question are currently not available.

In other contexts, it has been suggested that stuttering (Wischner, 1952; Brutten and Shoemaker, 1967), and at least certain forms of normal disfluencies (Mahl and Schulze, 1964) are basically anxiety-bound responses and should, therefore, increase in the face of threatening or punishing situations. The present results, as well as other studies referred to earlier, indicate that punishment will suppress disfluencies when appropriate contingencies are arranged. Again, it may be that not all forms of speech disruption would respond in the same manner. Though it is somewhat difficult to instrument, it might be particularly interesting to apply punishment procedures to pauses in spontaneous speech and to note the effects on overall disfluency rate, as well as on other features of the subject's linguistic performance.

Siegel and Martin (1968) found that speech disfluencies were reduced when normal speakers were simply instructed to be more fluent, but that the combination of these instructions with the response-contingent presentation of the word "wrong" for each disfluency resulted in much greater reductions than would be predicted from either the instructions or the contingency alone. Martin and Siegel (1969) noted that an ordinary door buzzer, which had no effect on college students' performance in a simple motor task, did function as a punisher when presented to these same subjects as the contingency for disfluencies.

These results, in combination with the present findings, suggest that there may be more than "simple" punishment effects involved in the suppression of disfluencies in normal adults. It may be that the subjects in these experiments were already disposed, by prior experience, to regard disfluencies as evidence of poor verbal skills. The crucial part of our procedure, therefore, may have been that it "highlighted" or called the subjects' attention to their disfluencies. This would suggest that, in essence, the punishing qualities were somehow inherent in the disfluent responses themselves, and that virtually any stimulus change that highlighted the responses would function at least to some degree as a punisher for these particular responses.

To the extent that this highlighting hypothesis is a correct analysis, it raises some interesting questions concerning the possibility of response-produced punishment, at least for this particular response. It also calls into question the degree to which experiences with the punishment of their disfluencies are unique to those children who ultimately become stutterers. If even normal adults regard disfluencies as "undesirable" behaviors, the difference between stutterers and normal speakers becomes much less clear in this regard.

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