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INDIVIDUAL DIFFERENCES IN SPEECH FLUENCY UNDER DELAYED AUDITORY FEEDBACK

by

STEPHEN BRESKIN

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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CHAPTER I

INTRODUCTION

Field dependence-independence is a measure of psychological differentiation having relevance for personality assessment. Delayed auditory feedback (DAF) is a laboratory technique which produces wide individual responses. Both these domains of research began separately about two decades ago. Though individual differences in field behavior have been explained by Witkin's theories on personality development, the differential effects of DAF have not been satisfactorily explained by any theory of personality. Based on the concept of psychological differentiation, the present study attempts to render certain DAF effects explicable.

Field Dependence-Independence

Witkin and Asch (1948a, 1948b) and Asch and Witkin (1948a, 1948b) were the first to investigate systematically the role of visual and postural cues in space orientation. Initially, this was accomplished by requiring the subject to locate the upright in a visual field distorted by use of mirrors (Asch and Witkin, 1948a) and later by actually placing the subject in a tilted room (Asch and Witkin, 1948b). The results showed that under all conditions there were striking and consistent individual differences in the extent to which the perceived upright was affected by the surrounding field. In subsequent experiments (Witkin and Asch, 1948a, 1948b), the normal visual field was eliminated by seating the subject in a darkened room, within which the surrounding field was replaced by a luminous frame containing an adjustable luminous rod at its center. In addition, the subject was seated in a chair capable of tilting, and thus the experimenter was free to vary postural cues. It was found that in estimating the upright position, some individuals would depend upon the surrounding visual field, while others would depend upon their own postural framework. These individual modes of perception were consistent across varying experimental conditions. In order to determine the generalizability of this result, Witkin (1949c) compared a group of subjects on both the space orientation tests and a number of non-orientational perceptual tests. He found a high degree of correlation between performance on an embedded figures test derived from Gottschaldt's original figures and the orientation tasks. He concluded that "similarity of perception under such very different circumstances provides very effective proof of the presence of consistent and pervasive characteristics in the individual's perception (p. 159)." He labelled the individual mode of perception which is dependent on external cues as field dependent, and that which is dependent on internal cues as field independent.

Witkin and his co-workers next sought to relate these differences in perception to personality variables. In extensive research (Witkin, et al, 1954, 1962) the field dependence-independence dimension has been shown to have persistent implications for personality. Witkin, et al (1962) have aptly stated the general characteristics of field dependent and field independent persons:

> Field-dependent people take a rather long time to locate a familiar figure hidden in a complex design. Because they are less likely to attempt to structure ambiguous stimuli, as Rorschach inkblots, they usually experience such stimuli as vague and indefinite. They often find difficulty with the block-design, picture-completion, and object-assembly parts of standard intelligence tests. Yet, they are no different from more field-independent people on other portions of intelligence tests which require concentrated attention; and they may even do better on portions concerned with vocabulary, information, and comprehension. They are also not different from field-independent people in the ability to learn new material. In Duncker's well-known insight problems they may not readily see alternative uses for items serving a familiar function.
>
> Sitting in a tilted chair within a markedly tilted experimental room, with room and chair aligned, they are likely to experience themselves to be very inaccurate. However, the very tendency reflected by this way of performing, to be guided by the axes of the surrounding visual field rather than by sensations from within the body, causes these people to be highly accurate in determining body position in a centrifuge type of situation, where the experimental room in which they are seated is upright, and the body is pulled to one side by a strong centrifugal force.

They are apt to experience themselves as appreciably shorter than they really are. When asked to draw a person, the figures they produce are likely to show few characteristics of masculinity or femininity.

These people are likely to change their stated views on a particular social issue in the direction of the attitudes of an authority. They are also particularly attentive to the faces of those around them and, as a result, tend to be better than relatively field-independent persons at recognizing people they have seen only briefly before. Their impressions of people are usually based on the physical characteristics these people show and the actions they engage in. On the whole, they favor occupations that involve contact with people and that are popular within their group.

When shown a TAT picture that portrays an aggressive act, field-dependent people are likely to give immediate expressions to the ideas and feelings of aggression stimulated by the picture. Under conditions of stress, they will probably show labile psychogalvanic skin responses. The central characters they create for TAT stories are not likely to have a driving interest in achievement. In their over-all adjustment they are clearly no more prone to disturbances or pathology than field-independent perceivers, although the disturbances they show are likely to take a very different form.

People whose performances in the rod-and-frame test indicate a predominantly field-independent way of perceiving present a direct contrast in many of these attributes. Not always, however, are the characteristics common to field-independent perceivers polar opposites of those found among field-dependent perceivers, and they may or may not contribute to optimal adjustment. Thus, although field-independent people are often able to function with a fair degree of autonomy from others, some of them are strikingly isolated individuals, over-controlled, cold and distant, and unaware of their social stimulus value. We have in fact frequently encountered field-independent performances among hospitalized psychiatric patients

> who were actively delusional and apparently destined to remain in an institution for the remainder of their lives. (pp. 3-4)

In addition to these individual characteristics of field dependence-independence, there are relevant group differences. With respect to sex differences, studies have shown women to be more field dependent than men (Witkin, 1949b, 1949c, 1950) and developmentally, a strong argument has been made for field independence increasing with age. Witkin, et al (1962) maintain that as the person becomes older, he becomes more psychologically differentiated and hence more complex, with a process of de-differentiation occurring in later life. Studies have shown an increase in field independence in individuals aged 5 to 17 (Goodenough and Eagle, 1963; Witkin, Goodenough, and Karp, 1967), and an increase in field dependence in individuals beyond the age of 17 (Schwartz and Karp, 1967).

Summarizing the research on field dependence-independence, Witkin's laboratory began in the late 1940's to study the effects of postural and visual cues on space orientation. Consistent individual differences were found with respect to the dependence of perception on internal versus external cues. These differences were found across a variety of perceptual tasks, and were then related to various personality variables. Persons whose perception was dependent on the field tended to relate to their environment in a global fashion, seeing themselves as not clearly differentiated from the world about them. On the other hand, persons whose perception was independent of the field, were described as viewing their environment in more analytical terms, defining a role articulated from external circumstances. It was found that women were more field dependent than men, and that field independence increased and then decreased with age.

Delayed Auditory Feedback

When a person is speaking in a recorded session with headphones on, it is possible to play back the individual's speech to him by means of the headphones. If the feedback is simultaneous with the individual's speech, we obtain a condition known as synchronous auditory feedback (SAF) which seems to have little effect on normal speaking patterns. However, if the feedback is delayed over a short period of time (about 200 milliseconds), a condition known as delayed auditory feedback (DAF) is produced in which the individual's speech is quite disturbed. In the original experiments on DAF, Lee (1950a, 1950b) noted that subjects speaking under DAF would appear to be under tension, frustrated and embarrassed by their performance, and fatigued. The major effects of DAF on speaking have been found to be slowed rate of speech, increased intensity of speech, and artificial stuttering (Black

1951, 1955; Fairbanks, 1955; Lee, 1950, 1951). Chase (1958), Fairbanks (1954), Lee (1951) and Smith (1962) have presented theoretical models to account for effects of DAF on speech. However, these models are highly mechanical and are not directly applicable to the study of psychological variables.

The effects of DAF on speech are such that there are wide individual differences, yet within a particular subject, the DAF produces consistent behavior. Yates (1963) states that, "One of the most striking features of DAF has been the marked individual differences in the degree to which S can continue to speak normally under SAF. A few Ss show little disturnance; others are almost totally incapacitated; the majority fall somewhere between these two extremes." (p. 222)

Researchers have become interested in investigating personality correlates of DAF performance. Spilka (1954) performed that first personality study of DAF effects. Taking the position that personal adjustment is a balance between attention to external versus internal stimulation, and that DAF represents an experimental analogue to such balance, he tested the relationship of various personality trends to DAF. He found increases in vocal intensity variation under DAF to be related to paranoid behavior tendencies, and decreases in vocal intensity variation to be related to schizoid behavior tendencies.

Sex differences and rigidity have also been examined in relation to DAF performance. Spear (1963) had a group of psychiatric patients (58 males and 10 females) read a passage under SAF and DAF conditions, and found women to be more affected than men. Sutton, Roehrig, and Kramer (1964) confirmed this result with a group of hospital personnel (13 males and 17 females). Bachrach (1964) found women to be more affected by DAF than men in a group of college students (8 males and 8 females). The treatment of results was qualitative rather than quantitative and subjects were asked to perform the speaking tasks in front of the class. Rankin and Balfrey (1966) asked college students (72 males and 72 females) to respond orally to MMPI items, anxiety questionnaire items, and other self-report inventory type items while under SAF and DAF. They found women to be significantly less affected by the DAF than the men. With respect to rigidity, Beaumont and Foss (1957) used the Einstellung test of rigidity to find that rigid subjects were significantly more affected by DAF than non-rigid subjects. Spilka (1954) used the extremes of an ethnocentrism scale as the measure of rigidity, and found that the rigid subjects tended to be the least affected by DAF. Taken together, the above studies are so diverse with regard to results, procedures, and subjects, that no clear interpretation is possible.

A number of studies have been reported, which when taken together show a bow-shaped developmental curve for the DAF effect. Fargo, et al, (1968) found that in a group of children 6 to 19 months old the best predictor of DAF effect was the linguistic development of the child. Yeni-Komshian, et al (1968) have shown that in a group of 2 to 3 year olds, the younger children were less affected by DAF, and that as a group these children had little disturbance in relation to the 4 to 9 year old group. Chase, et al, (1961) found that 4 to 6 year old children were less disrupted by DAF than 7 to 9 year olds. Waters (1968) found that in a 10 to 18 year old group the DAF effect decreased with age. Some degree of caution should be taken with these developmental findings in that the procedures for the above studies, while similar, were not all equivalent.

Summarizing, DAF is an experimental technique which alters the person's normal speaking pattern. While subjects vary in their DAF performance, an individual's ability to cope with DAF remains fairly consistent. Studies investigating personality variables in relation to DAF have provided contradictory results. With respect to development changes, studies have shown a tendency for speech disruption under DAF to exhibit a bow-shaped function from infancy to adolescence.

Previous Research on DAF and Field Behavior

Spilka (1954) presented a theoretical framework for future studies of DAF and personality variables. Since subjects capable of dealing with DAF cite as their explanation the ability to avoid and ignore the auditory feedback, while maintaining concentration on their speech, Spilka asserts that such individuals are able to attend to internal cues over external cues. He hypothesized that the extent to which speech is affected by DAF is a function of an emphasis on either exteroceptive or proprioceptive cues of speech and the ability to shift from one set of cues to the other. One hundred and fifty males were asked to read a phonetically balanced passage during both SAF and DAF conditions, and were then required to take a variety of paper and pencil tests reflecting self concept and enthnocentrism. Increases in vocal intensity variation were found to be positively related to paranoid tendencies, and negatively related to schizoid tendencies, and this was considered to be support for his hypothesis.

Rabenstein (1958) applied Spilka's theoretical frame of reference to test the effects of DAF in relation to field dependent-independent persons. He hypothesized that field dependent persons, who are said to depend on the surrounding field or external cues, would be most affected by DAF. Testing 30 male subjects on a reading task, he found differences in total reading time between SAF and DAF conditions to be positively correlated (r = +.12) with field independence. The direction of the relation, had the result proved significant, was opposite to the one hypothesized.

Erlich (1965) adopted a theoretical frame of reference which elaborates on Spilka's work. He apparently was unaware of Rabenstein's prior result, and hypothesized, as had Rabenstein, that those subjects who are less articulated (more field dependent) would be most affected by DAF. Using 80 male subjects in speech tasks of reading, no relationship was found between performance on the rod and frame test (RFT) and DAF, while significant correlations in the direction <u>opposite</u> to that predicted were found between field independence, as measured by the embedded figures test (EFT), and DAF (r = +.27).

Erlich concluded that the effects of DAF are largely a function of interference and that individual differences in DAF performance should be related to susceptibility or adaptation to interference in other perceptual situations. He also criticized the internal-external framework of Spilka (1954) on the grounds that his formulation did not derive from the perceptual-motor realm of functioning, as does DAF performance.

Limitations of Previous Research

The studies of Erlich (1965) and Rabenstien (1958) represent, to the best of knowledge, the only investigations of DAF and field behavior. Both experiments appear to be limited in several respects.

First of all, the results of these studies are contrary to those hypothesized. Since this research has evolved mainly from the theoretical framework of Spilka (1954), it would appear that unless experimental errors were able to account for the data, the theoretical formulation is faulty.

Secondly, neither study controlled for the variable of verbal facility, which is known to correlate with DAF performance (Arens and Popplestone, 1959; Atkinson, 1954) making interpretation of results equivocal. Fortunately, Rabenstein reports the correlations of verbal facility with DAF and field dependence, taken separately, permitting one to calculate the partial correlation between DAF and field dependence with individual differences in language ability partialled out. This computation inflates the original correlation from +.12 to +.23, which, while still non-significant, suggests the desirability of controlling for individual differences in verbal facility.

Thirdly, these studies used only male subjects. Since Witkin and his co-workers make the strong assertion that females are more field dependent than men, sex differences would appear to be relevant to any study of DAF and field behavior. The prediction from Spilka's (1954) internal versus external cue hypothesis is that women will be more disrupted by DAF than men, and this should have been tested.

Finally, generalizing beyond these two studies, the prediction that field independent persons will be less disrupted by DAF than field dependent persons is at variance with developmental data. Since children show a trend to be more field independent and more affected by DAF with age, the developmentally coherent prediction would be that severity of DAF effect is associated with field independence.

DAF as Stress-Producing Stimulus

The basic assumption of Spilka's work (1954) is that DAF is an external stimulus which acts as a distractor to normal speech performance, and that individual differences in response to DAF are dependent upon ability to avoid or ignore these distractions. While there is considerable evidence in support of DAF as being distracting (Fillenbaum, 1963; Forney, et al, 1965; King, 1963; King and Wolf, 1965a, 1965b; Rankin, 1968), Witkin, et al, (1962) clearly state that "...tests of field dependence measure ability to overcome embedding contexts and that this ability is distinct from [i.e., independent of] the ability to overcome the effects of distracting contexts (p.49)." Of additional concern is the fact that DAF is a stress-producing distractor which interacts both externally and internally with the subject.

There is wide experimental support for the view that DAF is a stress-producing stimulus. Schaffer (1954) regards a stressful situation as one in which a major disruption of the relationship between the organism and his environment has taken place, and DAF would seem to be a prototype of this situation. The original work of Lee (1950a, 1950b) noted that subjects appeared to be tense, frustrated and embarrassed by their DAF performance. Researchers interested in reactions to stress or in conflict situations, have often used DAF as an experimental condition (Hughes, et al, 1963; Jensen, 1967; Leith and Pronko, 1957; Pronko and Leith, 1956; Korowbow, 1955; Rankin, 1967, 1968; von-Felsinger, 1953). Pronko and Leith (1956) tested subjects in three experimental conditions of preparedness for the DAF effect. They found that the group which had been thrust into the DAF situation with no prior opportunity for practice or guidance, exhibited the most disruption and number of "frozen" reactions. There have also been a number of studies which have attempted to find physiological correlates of DAF. Doehring (1956) and Doehring and Harbold (1957) found that regardless of the extent of DAF effect, changes in response from non-delayed speech to DAF produced an increase in forearm tension and heart rate, and a decrease in skin resistance. Hanley, et al, (1958) were able to show that both latency and pattern of GSR were affected by DAF.

Individual Differences in Ability to Resist DAF Stress

An alternative to Spilka's theoretical framework (1954) may be derived from a later formulation of Witkin asserting that field dependent persons use global repressive defense mechanisms, whereas field independent persons use analytical intellective types of defenses (Witkin, et al, 1962; Witkin, 1965, 1969). Strong support for this assertion comes from research on clinical cases (Witkin, et al, 1954, 1962), on dreams (Schonbar, 1959, 1961, 1965; Singer and Schonbar, 1961), and on perceptual defense (Minard and Mooney, 1969). Since stress is known to arouse defense mechanisms (Freud, 1946), it is reasonable to suppose that the ability to avoid or resist the external stimulation of DAF stress is contingent upon the ability to repress experiences generally. Since the field dependent persons are more inclined to use global repressive mechanisms of defense, it would seem likely for them to be better able to repress or ignore the DAF. Thus, according to this formulation, field dependent persons would be predicted to show a lesser DAF effect than field independent persons.

Psychoanalytic literature has stated that women are associated with clinical syndromes characteristic of repression, and men with clinical syndromes characteristic of intellectualization (Fenichel, 1945; Freud, 1896). From these assertions one may infer that women ought to be more likely to resist DAF stress than men. However, it is not at all clear that this inference outweighs a simpler one deriving directly from sex differences in psychological differentiation. As noted earlier, women tend to be more field dependent than men (Witkin, 1949b, 1949c, 1950), and this fact in itself might lead one to expect that women should be less susceptible to the stress of DAF than men. Caution would suggest having an open mind regarding sex differences on DAF, in favor of comparing the DAF performances of men and of women possessing matched degrees of field dependence-independence.

DAF Stress and Task Demand

In commencing research on individual differences in resistance to DAF stress, it seems worthwhile to focus on the speech activity itself. While spontaneous speech is the most usual form of verbal behavior, a review of the DAF literature (Chase, et al, 1959; Fargo and Armacost, 1968; Yates, 1963) finds that the vast majority of research has used a standard reading passage as the representative behavior of speech. However, spontaneous speaking is not the same as reading. It is well known from research on aphasia that individuals may lose the capacity for either self generated speech or for reading ability, while maintaining the other function (Jones and Wepman, 1961). Chase (1967) states that,

> We should be mindful of the fact that the speech motor system can undoubtedly also operate in different modes. If I am imitating another person's speech, without any concern about transmitting information but simply doing an acoustic matching job, the neurophysiology underlying the organization of my speech motor activity is probably quite different from the neurophysiology underlying the organization of the same patterns of sounds when I am spontaneously piecing these sounds together in an effort to transmit information. Our laboratory experiences have taught us that the disorganization of speech motor activity that results from delayed auditory feedback of speech is less marked if the subject is reading a passage than if the subject is engaged in spontaneous propositional speech. (p. 50)

A possible behavioral correlate of this underlying neurophysiology alluded to by Chase, has been found in the temporal patterns of speech. Goldman-Eisler (1967, 1968) and Henderson, et al, (1966) have found that successive periods of sound and of silence show evidence of "cognitive planning" in spontaneous speech, while similar data for reading do not.

Though the foregoing research gives strong support for the investigation of spontaneous speech, prior researchers have been unable to use this speaking condition due to lack of controls or appropriate measures upon which subjects may be compared. However, recent experimental work, involving the analysis of the on-off properties of speech at durations as low as 200 milliseconds, has made possible the objective measurement of spontaneous speech, as well as reading, and made the results of both comparable to each other (Breskin, et al, 1970; Cassotta, et al, 1964, 1967; Jaffe, et al, 1964; Jaffe and Feldstein, 1970). Thus, there is every reason to suspect that since spontaneous speech involves higher cognitive processing than reading, it will have greater relevance to the prediction of individual differences than will the reading task.

Hypotheses of this Investigation

1. Since from Witkin's work we may infer that field dependent persons are more likely to repress stressful experiences than field independent persons, it is predicted that if field independent and field dependent persons, defined according to their performance on the EFT, are subjected to the stress of delayed auditory feedback, then persons who are field independent will suffer more speech disruption than those who are field dependent.

2. Since women are in general more field dependent than men, it is predicted that if men and women are both subjected to the stress of delayed auditory feedback, then men will suffer more speech disruption than women.

2a. It is further predicted that if men and women are equated for EFT performance, then there will be no difference between them in their responses to the stress of delayed auditory feedback.

3. Since spontaneous speech is a higher order cognitive process than reading aloud, and thereby more subject to interaction with personality variables, it is predicted that if field independent and field dependent persons both speak spontaneously and read aloud under the stress of delayed auditory feedback, then there will be a greater difference between the two groups' performance when speaking spontaneously than when reading aloud.

CHAPTER II

METHOD

An Overview

24 female and 24 male subjects were selected, from a group of 263 City College students, on the basis of field dependence-independence scores, prior speech history, verbal ability test scores, and willingness to participate. After this selection, each of the 48 subjects was asked to participate, as a paid volunteer, in an additional individual experimental session. In this session, each subject was given a color-vision test, an individual test of field dependence-independence, a hearing threshold test, and a variety of speaking tasks. The speaking tasks required the subject to speak for 20 minutes under four 5-minute conditions of synchronous auditory feedback (SAF) reading, delayed auditory feedback (DAF) reading, SAF spontaneous speech, and DAF spontaneous speech. SAF always preceded DAF, and the reading and spontaneous speaking conditions were counterbalanced within sex and within field dependence-independence status.

Subjects

An initial group of 263 volunteer City College students were screened as to both suitability and willingness to participate in future experimentation. This group was comprised of 143 males and 120 females, whose ages ranged from 16 to 41 years with a mean of 19.61 and a standard deviation of 2.52. From these subjects, 24 female and 24 male subjects were selected as paid volunteers for an individual experimental session. Their ages ranged from 17 to 27 years with a mean of 18.63 and a standard deviation of 1.84. These 48 subjects are the population for the test of the hypotheses of this study and the details of their selection are described below.

Procedure

Subject Screening

The 263 subjects were screened according to a number of criteria, by means of a group administration of a questionnaire. The complete questionnaire is shown in Appendix B, while its subparts are described briefly below.

1. Personal Data

This section contained identifying information on the subject.

2. Speech History and Color vision

The questions in this section screened subjects as to both abnormal speech history (since the individual experimental sessions involved speech performance) and abnormal color vision (since the individual experimental sessions involved hidden figure performance with chromatic plates).

3. VAT

The VAT is a verbal abilities test which was derived from a verbal scholastic aptitude test (Brownstein and Weiner, 1958). The VAT is composed of sixteen multiple choice items with five choices per item. The subject's score (S) was given by the following relationship: $S = C - \frac{W}{4}$ where C = number of items answered correct, and W = number of items answered wrong. With this formula scores may range from 16 to -4.

4. Hidden Figures Test

This section contained a group form (French, et al, 1963) of the embedded figures test (EFT) to assess field dependence-independence. The group EFT (GEFT) is a 16 problem multiple-choice test in which the subject is required, for each problem, to locate which of five figures is hidden in the more complex figure. The subject's score on the GEFT was calculated in a fashion similar to that described in the previous section on the VAT. A score of sixteen indicated the extreme of field independence, while a score of minus four indicated the extreme of field dependence.

5. BRT

The BRT (Breskin, 1968) is a non-verbal measure of rigidity, which requires the subject to select the item he likes better when presented with a pair of visual stimuli differing in "goodness of fit." Tests were scored so that choice of figure which indicated a "better fit" was credited toward a score in the direction of rigidity. There are fifteen pairs of visual items on the BRT and a score of fifteen indicated the maximum in rigidity while a score of zero indicated the minimum in rigidity.

6. This subsection questioned the willingness of the subject to partake in the individual experimental session.

<u>Subject Selection</u>

The Questionnaire served as the basis of selecting, for a future individual experimental session, those subjects who met the following criteria.

1. With regard to the Speech History and Color Vision section, those subjects were rejected from future experimentation who a) answered "yes" to having been a sutterer, or b) answered "no" to English being their native language, or c) answered "yes" to receiving special training in speech, or d) answered "no" to the USA being their birthplace, or e) answered "yes" to believing their color vision to be abnormal in any way.

2. Since verbal skills are correlated with DAF performance (Arens and Popplestone, 1959; Atkinson, 1954; Rabenstein, 1958) and show "...little or only limited relation to mode or field approach and other characteristics of differentiation

(p. 203; Witkin, et al, 1962)," subjects were equated on VAT score. This was accomplished by including, for future experimentation, only those subjects whose VAT scores were in the middle 68% of the distribution of the entire group of 263 subjects.

Consideration of the above criteria, for inclusion-exclusion in the individual experimental session, resulted in a pool of 55 females and 57 males. From this pool, subjects were then selected on the basis of their GEFT scores. Explicitly, for each sex, 8 subjects were chosen from each of the extremes and 8 subjects from the middle group. During this procedure, an attempt was made to equate, on GEFT score, those males and females selected. Since GEFT and individual EFT scores intercorrelate significantly ($r = .56$; Jackson, et al, 1964), it was hoped that the foregoing would promote a balancing of groups on the more reliable and yet to be administered individual EFT.

While no selection criteria were applied to the BRT scores, it was of interest to include the BRT since rigidity was mentioned in the literature review as a variable effecting DAF performance. The BRT shows significant sex differences (Breskin, 1968; Breskin and Gorman, 1969) and correlates negatively with measures of creativity and field independence (Breskin and Gorman, 1969; Gorman and Breskin, 1969).

Individual Experimental Session

On the basis of the previous selection, 52 subjects were paid volunteers for the individual experimental session described below. Of these, 4 subjects were subsequently dropped due to failure to comply with instructions, thus leaving the 48 prescribed subjects. The procedure for the individual session, which lasted between 1 and 1-1/2 hours, is described below in order of administration.

1. Color Vision Test

To test for normal color vision, the AO H-R-R Pseudo-isochromatic Plates (Hardy, Rand, and Rittler, 1957a), illuminated by the New London Easel Lamp (American Optical Co. Catalog No. 1368), were employed. This was accomplished by use of the first six plates for the Simple Screening Test (Hardy, et al, 1957b) which is designed to separate subjects with defective color vision from those with normal color vision. No subject was found to be color-blind.

2. Individual EFT Test (IEFT)

In previous work, Witkin's laboratory has produced a number of perceptual tests of psychological differentiation. These tests include the rod and frame test (RFT: Witkin, 1948; Witkin and Asch, 1948b; Witkin, et al, 1954), the room adjustment test and the body adjustment test (RAT and BAT; Witkin, 1948, 1949a; Witkin, et al, 1954) and the embedded figures test (EFT: Witkin, 1950). Witkin, et al, 1962) state that "The correlations among scores for the BAT, RFT, and EFT are for the most part significant, giving a picture of substantial consistency in individual functioning in these situations (p. 44)." The EFT was chosen for this study, since it alone is available in both group and individual forms, as required for this experimental design. A short form (Form A) of the IEFT (Witkin, 1969) was administered in each subject. This is a 12-problem timed test, with a 3-minute time limit on each problem. The problems are chromatic, and the subject's field dependence-independence score is the total time taken to locate the hidden figures in each of the 12 complex figures (the longer the time, the greater the field dependence).

The group and individual forms correlate significantly (r = .56; Jackson et al, 1964) with each other, and the short individual form is well correlated with the longer 24 problem form (r = .96; Jackson, 1956). For college age populations, odd-even reliabilities on the individual short form have ranged from .90 (Linton, 1952) to .95 (Gardner, Jackson, and Messick, 1960), and a test-retest reliability of .89 after a 3-year follow-up was found (Bauman, 1951). A Kuder-Richardson (Formula 21) reliability of .71 has been found with the GEFT (Jackson, Messick, and Myers, 1964).

3. Speech Reception Threshold

The speech reception threshold (SRT) is the threshold intensity below which speech cannot be understood and above which speech can be understood. In the present study, there were two reasons for the measurement of the SRT. Firstly, since subjects spoke under a DAF condition, it was required that there be no gross hearing loss among the subjects. The measurement of the SRT provided a test for gross hearing loss. Secondly, it was considered essential (Yates, 1963) that the intensity level of the feedback signal, in the speaking conditions, have an individual reference level for each subject. That is, if two people have an equivalent feedback signal coming into their ears via a set of headphones, they may not experience the intensity of these signals as equivalent. Clearly, if one person is deaf while the other has normal hearing, the point is obvious. The SRT was therefore determined as a reference level for the intensity of feedback signal in both the SAF and DAF conditions.

It was first required that the materials for the determination of the SRT be obtained. This was accomplished by use of the W-1 spondee words of the Central Institute for the Deaf (Hirsh, et al, 1952). Spondee words are two-syllable common words (See Appendix C for complete list of the 36 words), and were obtained from an unused commercial record of the word list (Technisonic Studios, St. Louis, Missouri). This record was played on a Grason-Stadler (Model 162) speech audiometer, the output of which was terminated at the Channel 1 input of an AG-500 Ampex tape recorder. A tape recording was made on 1/4-inch Mylar tape[1] at a tape speed of 7-1/2 inches per second. In addition to the spondaic words, a 1000 cycle per second (Hz) calibration tone was also recorded onto tape via the commercial recording.

The use of the calibration tone was as follows. The spondee words were originally recorded on the record disc in a standardized manner such that the average intensity of the spoken words were all equivalent. This equivalence represented itself on the tape recorder via a meter, called a VU meter, which monitors intensity, and consequently showed all spondee words averaging at the same point. The input level on the tape recorder was adjusted so that all spondee words averaged 0 VU $\pm$0.25 db. The 1000 Hz tone was also recorded onto the tape at the intensity level of 0 VU.

The problem then arose as to what was the intensity equivalent of a reading of 0 VU on the tape recorder. In

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[1]Prior to recording, the tape was degaussed using a Robins Magnetic Eraser (Model TM-77).

order to accomplish this the following procedure was employed. The playback level of the recorder was adjusted so that the 1000 Hz tone yielded an output of 0 VU. a stereophonic pair of headphones (Akg K-60), connected to the tape recorder, output the 1000 Hz calibration tone. An artificial Ear (Type 4152)[2] was connected to a single headphone, and then fed into the Bruel and Kjaer Sound Level Meter (Type 2203)[3] via an Octave Filter Set (Type 1613)[4]. When the calibration tone was played through this setup, the output intensity at the headphones was found to be 106 db at one phone and 108 db at the other. The average intensity of 107 db was considered the output intensity at the headphones of 0 VU auditory signal.

The above procedures were all carried out prior to the testing of any individual subject. In the individual experimental sessions, the SRT was obtained in the following manner. The tape recording containing both the calibration tone and

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[2]The Artificial Ear is an apparatus which has the acoustic properties of the outer ear, and is able to transmit sound energy from one source to another.

[3]A sound level meter yields a measure of intensity, in decibels (db), above the sound pressure level of .0002 dynes per cm^2 (= 0 db).

[4]The octave filter set insured that the measurement was of only the 1000 Hz calibration tone.

the spondee words was placed on the Ampex AG-500 tape recorder, while stereophonic headphones were placed comfortably on the subject. Prior to the playing of the spondee words, the 1000 Hz calibration tone was adjusted by the playback level to output 0 VU (107 db). The tape recording of the spondee words (which followed the cessation of the 1000 Hz tone) was output to a Hewlett-Packard 350D Attenuation Set which was then input into the headphones. The attenuator allowed the experimenter to reduce the output at the headphones in 5 db steps. The measurement of the SRT then followed the instructions and procedure specified by Chaiklin and Ventry (1964). Explicitly, this procedure called for the presentation of a maximum of six spondee words at each 5 db step. The criterion for reduction in intensity to the next 5 db step was that the subject repeat correctly at least three spondee words in the previous step. The criterion for the completion of threshold sampling was four incorrect responses at two consecutive 5 db levels. The SRT was operationally defined as the lowest hearing level at which three words were repeated correctly.

For the 48 subjects, the SRT's ranged from 32 db to 52 db with a mean of 40.65 db and a standard deviation of 4.22 db. Since perfect hearing is taken to be at 22 db, the subjects had hearing losses ranging from 10 db to 30 db, and thus were within the range of normal hearing loss limits (Davis, 1970).

4. Procedure for Speech Tasks

During the next 20 minutes subjects read a passage for 5 minutes under SAF and for 5 minutes under DAF, and spoke spontaneously on a topic of personal interest for 5 minutes under SAF and for 5 minutes under DAF. The SAF control condition always preceded the experimental DAF condition, and the reading and spontaneous speech tasks were counterbalanced within sex and within field dependence-independence status. By this is meant that when the 24 subjects of each sex are ranked on their IEFT scores, there was an alternation between those subjects who read first and spoke spontaneously second, and those subjects who read second and spoke spontaneously first.

The reading passage was taken from an APA Presidential address delivered by George A. Miller (1969). The free monologue or spontaneous speech condition was such that the subject was free to speak on any or as many topics of personal interest as was desired. A list of ten suggested general topics of personal interest was supplied as an aid to each subject. Since the spontaneous speech condition was relatively unstructured, it was of interest to retrospectively examine the manner in which the subjects dealt with this task. While the explicit results appear elsewhere (See Appendix D), the average subject chose to speak on 2.52 topics (with 2.39

topics being on the suggested list) in the SAF condition and on 2.79 topics (with 2.33 topics being on the suggested list) in the DAF condition. Differences between number of topics chosen on SAF and DAF conditions were non-significant. In addition, there were no sex differences or EFT-related differences in relation to the number of on-list or off-list choices in either the SAF or DAF conditions.

The choice for the duration of each speech sample is clearly a relevant parameter. Since the durations for on-off samples of speech have ranged from 1-minute (Ramsay, 1968) to 90 minutes (Goldiamond, 1962), there is a wide choice of times. The choice of a 5-minute speech sample per condition for the present study was based primarily upon two findings: 1) Jaffe and Breskin (1970) showed that with respect to the on-off patterns of speech there were no significant differences in reliabilities between 5-minute, 16-minute, and 20-minute speech samples. Thus, a 5-minute speech sample is statistically as reliable, in assessing on-off properties of speech, as are larger samples. 2) Breskin, et al (1970) found that pause and vocalization distributions for 5-minute durations did not significantly differ from the pause and vocalization distributions of the five individual 1-minute samples. Thus, since the minute-to-minute fluctuations in the pause and vocalization distributions are such that they do not differ widely from the distributions taken on the 5-minute baseline, it was reasoned that the speech sample of 5 minute duration did not hide or cover up any idiosyncratic speech behavior which may be less than 5 minutes in duration.

5. Production of SAF and DAF

During the speaking conditions, the subject kept the headphones on, while a microphone was hung (by means of a cord) approximately six inches from the subject's mouth. The microphone was input into the tape recorder, which output the speech signal to the headphones via the attenuator. The production of the SAF and DAF condition necessitated the selection of two crucial parameters: 1) the intensity of the auditory signal (that is, the feedback from the person's own voice) coming into the headphones, in both SAF and DAF conditions, and 2) the choice of a delay time between voice input and playback into the headphones, in the DAF condition.

Yates (1963) has commented that the superior method of setting the intensity of the DAF signal is to use a reference level for each subject (e.g. SRT) and then set the intensity of feedback at a fixed level above that reference level. Then, the feedback coming over the headphones varies with the subject's own variations in vocal intensity, but is always attenuated a fixed amount with regard to the reference level. The fixed level for attenuation has previously ranged from

10 db to 75 db above the SRT (Yates, 1963). In the present study, the intensity of the feedback coming over the headphones was regulated by use of the decade attenuator to be 50 db above the SRT. This effectively meant that during the SAF condition the subject was barely able to hear his voice over the headphones simultaneously with his speech, and that during the DAF condition the subject clearly was able to hear his delayed speech coming over the headphones.

The delay time of 200 milliseconds (1/5 of a second), which produces maximal speech disturbance (Fairbanks, 1955), was used in the DAF condition. This was accomplished by taking advantage of the displacement between the record and playback heads of the tape recorder. That is, the heads of the recorder are fixed so that the tape systematically passes from the erase, to record, to reproduce heads, in that order. In the SAF condition, the feedback is delivered synchronously from the record head. In the DAF condition, the turning of a switch to the playback position, delivers the feedback from the reproduce head. When speaking under the DAF condition, the time for a spoken word to be played back over the headphones is fixed by the time equivalent displacement between the record and playback heads. For the tape recorder employed in this experiment, the distance between record and reproduce heads is 1-1/2 inches. At a tape speed of 7-1/2 inches per second, 1-1/2 inches is equivalent to a fifth of a second. Consequently, the 7-1/2 inches per second speed with the Ampex AG-500 tape recorder was employed to produce the delay time of 200 milliseconds in the DAF condition.

Processing of Speech Data

The major effects of DAF on speech are artificial stuttering, slowed rate of speech, and increased intensity of speech. Previous research on DAF has examined articulatory changes such as repetition of syllables (Tiffany and Hanley, 1956), mispronounciations (Atkinson, 1953), omissions (Tiffany and Hanley, 1956; Fairbanks and Guttman, 1958), and number of word endings omitted (Korobow, 1955). However, if articulatory changes are to be measured, then the experimenter is obliged to present the subject with speech tasks which are carefully controlled for phonetic balance (Spilka, 1954) and difficulty level (Winchester, et al, 1959). Since the present investigation is interested in spontaneous speech behavior, articulatory measures have been rejected. In reviewing the literature on DAF (Chase, et al, 1959; Fargo and Armacost, 1968; Yates, 1963), it was found that the time taken to read a standard passage was the most widely used measure of speech change under DAF stress. Referring to the promise of methods of analysis which subdivide total reading time measures into smaller units of behavior, Yates (1963) states that,

> Verzeano (1950, 1951) has described the use of a frequency analyzer which records 'units' of speech in terms of an arbitrarily determined pause in the flow of speech, e.g., it records each time the flow of speech is interrupted for a period longer than one second. Although this technique has not been used to analyze speech under DAF, it could prove a very useful method of analysis. (pp.218-219)

A measuring device (AVTA), which describes the on-off variations in speech patterns as a function of time, was developed (Cassotta, et al, 1964a, 1964b) out of a psycholinguistics project at the William Alanson White Institute. AVTA samples the presence or absence of speech at intervals as short as 100 msec (i.e., every 100 msec. a relay opens for 30 msec. to test for the presence or absence of speech), and was used in the present study to assess the disruption of the on-off patterns of speech from SAF to DAF. There are a number of options affecting the processing of the on-off patterns which are available to the user of AVTA, and these options plus the relevant choices are discussed below.

<u>Threshold</u>

The threshold setting determines the level above or below which AVTA decides the presence or absence, respectively, of the speech signal. Clearly, a threshold setting too high will reject all speech and a setting too low will include non-relevant noises such as breathing or background noise. After listening to the tapes, an optimal threshold lever, which included relevant but excluded irrelevant noises, was fixed and standardly used for the processing of all tapes.

Level (Gain Setting)

The level or gain setting permits the use of AVTA to raise or reduce the intensity of the speech sample being processed. Thus, for a person who has a very soft voice the constant threshold setting might exclude some relevant speech, whereas for the person who is shouting the speech signal may be such as to include irrelevant speech sounds. Since the intensity of the speech being processed by AVTA is simultaneously monitored by a VU meter, the gain was set such that the subject's intensity varied between -20 VU and 0 VU for most speech, with only the loudest speech sounds rising above 0 VU.

Time Constant

With reference to the pre-set threshold, the absence of speech is termed state 0 and the presence of speech state 1. Observations of adjacent samples in the identical state are presumed to have been continuous in the interval between samples. Within this framework, however, is the intervening variable of "hangover time" or time constant. To illustrate the effects of this variable, consider the spoken word "football." This word is actually pronounced in the three separate parts of "foot," a pause, and then "ball." The pause between "foot" and "ball," which is called a stop gap, is a pause which the ear does not normally perceive. In order to make the output of AVTA comparable to what the human ear perceives, a tail ("hangover time") of 150 milliseconds is added to each vocalization by means of setting a knob to the appropriate dial position. This effectively bridges over all pauses of durations less than 150 milliseconds.

Sampling Rate

The sampling rate refers to the number of samples per minute which AVTA takes in processing the data. Clearly, large sampling rates will distort the actual on-off pattern (a rate of 1 per minute would give for each 5-minute condition a total of just 5 samples), whereas excessively small sampling rates will pick up linguistic events not relevant to perceptible speech (such as of the order of the unvoiced stop consonants mentioned previously). The optimal procedure is to select a sampling interval which is not included in any of the time-related experimental procedures. Explicitly, it is not sensible to sample in intervals less than 150 milliseconds, since by virtue of the reasoning concerning "hangover time" pauses of less than 150 milliseconds are considered to be irrelevant to perceptible speech. Also, it is not sensible to sample in intervals more than 200 milliseconds, since under such a procedure it would then be possible to just miss the effects of the DAF which occur in 200 millisecond intervals (the delay time of the DAF). Consequently, a sampling rate of 300 times per minute or one sample every 200 milliseconds was chosen as the nearest time after a first sample that the second sample could be physically independent.

Once the above parameters were set, AVTA was able to generate strings of 0's (silence) and 1's (sound). At the sampling rate of 300 per minute, each 5-minute sample of speech was thus replaced by a collection of 1500 0's and 1's. In conjunction with the PDP 8/I computer, AVTA output two frequency distributions; one for the 0's, and one for the 1's (See Appendix F for a sample of output). These distributions formed the basis for the measurement of the dependent variables.

Dependent Measures

The degree of alteration of speech for each subject under DAF was objectively measured according to a collection of procedures described by Breskin, et al, (1970) (See Appendix E). In connection with the AVTA device, these procedures permit the researcher to obtain measures of speech which are independent of the observer, which can depart from prespecified texts, and which can examine behavioral units closer to the physiological process.

The dependent measures to be used in this study are represented as difference scores between SAF and DAF, thereby using each subject as his own control, and are described below:

1. DTPT

TPT refers to the traditional measure of total pause time and is equivalent in the data to the number of O's counted times the sampling interval of .2 sec. DTPT is equivalent to TPT for SAF minus TPT for DAF. A negative value for DTPT indicates a greater pause time in DAF than in SAF.

2. Dq_o

q_o is the conditional probability of speaking given previous silence and is equivalent to the number of transitions from state O to state 1, divided by the total number of O's. Dq_o is equivalent to q_o for SAF minus q_o for DAF. A positive value for Dq_o indicates a greater conditional probability of speaking (given previous silence) in SAF than in DAF.

3. Dq_1

q_1 is the conditional probability of speaking given previous speech and is determined by the number of transitions from state 1 to state 1, divided by the total number of 1's. Dq_1 is equivalent to q_1 for SAF minus q_1 for DAF. A positive value for Dq_1 indicates a greater conditional probability of speaking (given previous speech) in SAF than in DAF.

4. DMPT

MPT is the mean pause time and may be obtained from the frequency distribution of 0's or equivalently, from the product of the reciprocal of q_o and the sampling interval of .2 sec. DMPT is equivalent to MPT for SAF minus MPT for DAF. A negative value for DMPT indicates greater mean pause times in DAF than in SAF.

5. DMVT

MVT is the mean vocalization time and may be obtained from the frequency distribution of 1's or equivalently from the product of the reciprocal of $1 - q_1$ and the sampling interval of .2 sec. DMVT is equivalent to MVT for SAF minus MVT for DAF. A positive value for DMVT indicates greater mean vocalization time in SAF than in DAF.

6. DMDPT

MDPT is the median pause time and was obtained from the frequency distribution of 0's. DMDPT is equivalent to MDPT for SAF minus MDPT for DAF. A negative value for DMDPT indicates greater median pause time in DAF than in SAF.

7. DMDVT

MDVT is the median vocalization time and was obtained from the frequency distribution of 1's. DMDVT is equivalent to MDVT for SAF minus MDVT for DAF. A positive value for DMDVT indicates greater median vocalization time in SAF than in DAF.

8. DPSIR

PSIR is the pause semi-quartile range and is determined by subtracting the pause duration at the 25th percentile from that duration at the 75th percentile and then dividing by 2. DPSIR is equivalent to PSIR for SAF and minus PSIR for DAF. A negative value for DPSIR indicates a greater range in the pause distribution of DAF than of SAF.

9. DVSIR

VSIR is the vocalization semi-interquartile range and is determined by subtracting the vocalization duration at the 25th percentile from that duration at the 75th percentile and then dividing by 2. DVSIR is equivalent to VSIR for SAF minus VSIR for DAF. A positive value for DVSIR indicates a greater range in the vocalization distribution of SAF than of DAF.

10. PDMX

PDMX is the maximum difference between the percentage cumulative distribution functions of 0's under SAF and DAF conditions. Values close to 0 indicate minimal difference between SAF and DAF, and values close to 1 indicate maximum difference.

11. VDMX

VDMX is the maximum difference between the percentage cumulative distribution functions of 1's under SAF and DAF conditions. Values close to 0 indicate minimal difference, between SAF and DAF, and values close to 1 indicate maximum difference.

Additional measures not described in Breskin, et al, (1970), but used in this study are:

12. DLEV

LEV is a calibration on AVTA which indicates the intensity at which the subject is speaking. DLEV is equivalent to the LEV setting under SAF minus the LEV setting under DAF. A positive value for DLEV indicates that the subject was speaking louder in the DAF condition.

13. DWORD

WORD is the number of words read during the reading passage. DWORD is equivalent to WORD for SAF minus WORD for DAF. A positive value for DWORD indicates more words read under SAF than under DAF.

These 13 variables, together with all other abbreviations, are gathered for reference in Appendix A.

Independent Measures

1. Sex

Sex differences were assessed by contrasts between the 24 females and the 24 males on all of the aforementioned variables.

2. Field dependence-independence

Field dependence-independence was measured as the total time taken (in seconds) to find the hidden figure on the 12 problems of the IEFT. The longer the time, the more field dependent the score.

3. Rigidity

Rigidity was measured by the total number of keyed "rigid" items on the BRT.

CHAPTER III

RESULTS

Strategy for the Analysis of Results

For each of the 48 subjects, the results of this study consisted of individual scores pertaining to sex, field independence-dependence, non-verbal rigidity, twelve measures of speech disruption under DAF in the spontaneous speech condition, and thirteen measures of speech disruption under DAF in the reading condition. Prior to the statistical analysis of these results or the tests of the hypotheses, it was felt that a strategy was required in order to deal with this rather large set of data. Clearly a more parsimonious description of the collection of twenty-five dependent measurements provides for a more general description of the DAF effect. In turn, a more general description of speech disruption under DAF renders the test of hypotheses more general, readily interpretable, and more amenable to statistical analysis. Thus, in this interest, the following reduction of data was employed.

Data Reduction on Dependent Measures

The intercorrelations among the various dependent measures provide an indication of the amount of shared information that any pair of two parameters possess. Table 1 shows the

Table 1

Intercorrelation Among Dependent Variables
(Spontaneous Speech)

	DMPT	DMDPT	Dq_o	DPSIR	PDMX	DMVT	DMDVT	Dq_1	DVSIR	VDMX	DLEV
DTPT	.821	.616	-.859	.764	.375	-.403	-.400	-.548	-.399	-.269	-.050
DMPT		.729	-.806	.817	.367	-.010	-.037	-.016	-.048	-.150	.235
DMDPT			-.633	.690	.607	-.039	-.054	.012	-.081	-.114	.261
Dq_o				-.711	-.387	.366	.258	.234	.389	.289	-.016
DPSIR					.286	-.116	-.114	-.147	-.134	-.151	.059
PDMX						-.053	.004	-.057	-.063	.132	.084
DMVT							.905	.688	.963	.507	.343
DMDVT								.741	.822	.448	.317
Dq_1									.648	.282	.408
DVSIR										.471	.335
VDMX											.163

intercorrelation among the twelve dependent measures for the spontaneous speech condition, and Table 2 shows the intercorrelation among the thirteen dependent measures for the reading condition. It is to be noted from these tables that there are a number of correlations which are relatively high. Particularly, the measures which were derived solely from the distributions of pauses (i.e., DMPT, DMDPT, Dq_o, DPSIR, and PDMX) are all highly correlated among themselves (with correlations as low as .286 and as high as .817), and the measures which were derived solely from the distributions of vocalizations (i.e., DMVT, DMDVT, Dq_1, DVSIR, and VDMX) are also highly correlated among themselves (with correlations as low as .282 and as high as .963). It is to be noted further that there is relatively little intercorrelation between the pause and vocalization measures (with correlations as low as .004 and as high as only .389). This kind of patterning, in Tables 1 and 2, suggested that a factor analysis be performed.

Since it was felt that certain dependent measures provided information which in and of themselves were of particular interest or relevance, all the measures of Tables 1 and 2 were not included in the factor analysis. Specifically, 1) since DTPT is the traditional gross measure of speech disruption under DAF, it was retained individually as a useful

Table 2

Intercorrelation Among Dependent Variables
(Reading)

	DMPT	DMDPT	Dq_o	DPSIR	PDMX	DMVT	DMDVT	Dq_1	DVSIR	VDMX	DLEV	DWORD
DTPT	.615	.328	-.526	.571	.030	-.625	-.658	-.928	-.561	-.496	-.442	-.683
DMPT		.752	-.936	.826	.084	-.068	-.054	-.291	-.079	-.129	-.040	-.383
DMDPT			-.750	.563	.242	-.062	.003	-.059	-.099	-.081	.069	-.173
Dq_o				-.816	-.208	.057	.034	.206	.051	-.026	.061	.339
DPSIR					.134	-.114	-.111	-.292	-.096	-.211	-.078	-.310
PDMX						-.150	-.123	-.022	-.153	.173	.102	-.006
DMVT							.968	.727	.963	.562	.495	.364
DMDVT								.770	.903	.608	.504	.435
Dq_1									.649	.510	.524	.644
DVSIR										.545	.460	.341
VDMX											.166	.252
DLEV												.307

comparison between previous studies and the present one, 2) since PDMX and VDMX are statistics which are referrable to a standard sampling distribution (the Kolmogorov-Smirnov test, see Siegel, 1956), these measures are thus capable of making statistical inferences about individual subjects and were consequently retained for this purpose, and 3) since DLEV and DWORD are post hoc measures, not directly relevant to the on-off patterns of speech, their results are shown separately in the section on "Additional Results." The remaining variables of DMPT, DMDPT, Dq_o, DPSIR, DMDVT, Dq_1, and DVSIR were submitted to a principal components factor analysis and Varimax orthogonal rotation (Kaiser, 1965). Tables 3 and 4 show the results for the unrotated and rotated factor matrix for the spontaneous speech and reading conditions respectively.

From Tables 3 and 4, the first and second factors accounted for 48% and 35%, respectively, of the variance in the spontaneous speech condition, and for 48% and 38%, respectively, of the variance in the reading condition. These substantial percentages for accountable variance suggested that the two factor structure replace the eight variables originally input into the factor analysis. That is, the results of the factor analysis suggested that the two factor scores, per subject per condition, replace the eight measures per subject per condition, which were previously used. While there are

Table 3

Factor Loading for Spontaneous Speech

Variables	Unrotated Factor Matrix Factor I	Unrotated Factor Matrix Factor II	Rotated Factor Matrix Factor I	Rotated Factor Matrix Factor II
DMPT	-.521	.792	.049	.947
DMDPT	-.468	.722	.050	.859
Dq_o	.753	-.513	.303	-.859
DPSIR	-.597	.675	-.081	.897
DMVT	.824	.515	.969	.072
DMDVT	.762	.559	.945	-.001
Dq_1	.686	.453	.821	-.040
DVSIR	.818	.463	.933	-.111

Table 4

Factor Loadings for Reading

Variables	Unrotated Factor Matrix Factor I	Unrotated Factor Matrix Factor II	Rotated Factor Matrix Factor I	Rotated Factor Matrix Factor II
DMPT	-.671	.700	.071	.967
DMDPT	-.533	.636	.005	.829
Dq_o	.640	-.720	-.035	-.963
DPSIR	-.648	.601	-.116	.876
DMVT	.768	.614	.983	-.016
DMDVT	.748	.631	.979	.009
Dq_1	.761	.369	.821	-.201
DVSIR	.742	.586	.945	-.022

several methods available to attain this end, the "short" regression method of Harman (1960) was available in the IBM computer program and was consequently employed.

Results for Dependent Measures

On the basis of the foregoing analysis, five measures of disruption of speech were available for the testing of hypotheses. These measures were DTPT, PDMX, VDMX, Factor I and Factor II. The results on these measurements are being presented first, without regard to the independent measures, in order to display the effects of DAF. Tables 5 and 6 show the means and standard deviations of the DAF effect on the five dependent measures for the spontaneous speech and reading conditions, respectively.

Table 5

Mean and Standard Deviation of Dependent Variables
(Spontaneous Speech)

	DTPT	PDMX	VDMX	FACTOR I	FACTOR II
Mean	-12.000	.135	.133	.000	.000
SD	26,453	.064	.061	.980	.957

Table 6

Mean and Standard Deviation of Dependent Variables
(Reading)

	DTPT	PDMX	VDMX	FACTOR I	FACTOR II
Mean	- 2.300	.117	.193	.000	.000
SD	22.592	.064	.122	.991	.979

The results of Table 5 show that when speaking spontaneously the "average" subject 1) pauses 12 seconds more in 5 minutes under DAF, 2) has a cumulative pause distribution under DAF which is maximally 13.5 percentage units displaced from the SAF distribution, and 3) has a cumulative vocalization distribution under DAF which is maximally 13.3 percentage units displaced from the SAF distribution.

The results of Table 6 show that when reading aloud the "average" subject 1) pauses 2.3 seconds more in 5 minutes under DAF, 2) has a cumulative pause distribution under DAF which is maximally 11.7 percentage units displaced from the SAF distribution, and 3) has a cumulative vocalization distribution under DAF which is maximally 19.3 percentage units displaced from the SAF distribution.

Variability of DAF Effect

While the standard deviations of Tables 5 and 6 give some information as to the variability of the DAF effect, there exists a much better indicator. As mentioned previously, PDMX and VDMX are the sample statistics for the K-S test (Siegel, 1956). The K-S test compares the cumulative percentage distributions of two sample distributions and determines the maximum deviation (Dmax). On the basis of Dmax and the frequency counts of the two distributions (N_1 and N_2), a chi-square statistic tests the null hypothesis that these distributions indeed come from an identical population. Thus, it is therefore possible to determine, for each subject, if there is a significant difference between the pause distributions of SAF and DAF or the vocalization distributions of SAF and DAF. For a two-sample test Dmax is distributed as chi-square according to the formula:

$$\chi^2 = 4\ Dmax^2\ \frac{N_1 + N_2}{N_1\ N_2}$$

where df = 2; N_1 = # of frequency counts for SAF; and N_2 = # of frequency counts for DAF. Four K-S tests were performed per subject; that is, on PDMX and VDMX, for both spontaneous speech and reading conditions. Employing a one-tailed test at the .05 level of significance the following results emerged: under spontaneous speech, 27 of 48 subjects and 28 of 48 subjects were significantly affected by the DAF as measured by PDMX and VDMX respectively; under reading, 16 of 48 subjects and 28 of 48 subjects were significantly affected by the DAF, as measured by PDMX and VDMX, respectively.

Intercorrelation Among the Dependent Measures

It should be recalled that the high intercorrelation among the dependent measures suggested the data reduction which was accomplished by the factor analysis. Since the purpose of this reduction of data base was to provide a more parsimonious description of the DAF effect, it was of considerable interest to determine the shared amount of information between the obtained factor scores and those dependent variables DTPT, PDMX and VDMX, which were retained from the factor analysis. Tables 7 and 8 show the intercorrelations among DTPT, PDMX, VDMX, Factor I, and Factor II, for the spontaneous speech and reading conditions, respectively.

Table 7

Intercorrelation Among Dependent Measures after Factor Analysis (Spontaneous Speech

	PDMX	VDMX	FACTOR I	FACTOR II
DTPT	.375	-.269	-.382	.842
PDMX		-.132	-.017	.429
VDMX			.482	-.166
FACTOR I				.000

Table 8

Intercorrelation Among Dependent Measures after Factor Analysis (Reading)

	PDMX	VDMX	FACTOR I	FACTOR II
DTPT	.030	-.496	-.650	.550
PDMX		.173	-.135	.144
VDMX			.589	.045
FACTOR I				.000

Results for the Independent Measures

Since the test of the hypotheses is also contingent upon the variability among the subjects with regard to the independent measurements, results of the subjects' performance upon these measurements are presented below.

In order to get a clear indication of the variability in IEFT performance, the ranked distribution of IEFT scores was split into thirds, within sex. Explicitly, within sex, the eight lowest IEFT scores were termed field independent (FI), the next eight field independent/dependent (FI/D), and the highest eight scores field dependent (FD). Table 9 shows the descriptive statistics for each of these groups and the accompanying two-factor (3x2) analysis of variance of these scores. Table 10 shows the descriptive statistics of the BRT scores.

Test of Hypotheses

A gross description of the relationship between the independent and dependent measures of this study are provided by the intercorrelations shown in Table 11. These correlations serve as an indication for the test of hypotheses. Which are presented in large detail in the subsequent analyses.

Table 9

Descriptive Statistics and Analysis of Variance on IEFT

Descriptive Statistics

		Females	Males	Total
FI	Mean	243	232	237
	SD	90	99	91
FI/D	Mean	541	451	496
	SD	125	56	105
FD	Mean	1095	997	1046
	SD	312	430	366
Total	Mean	626	560	593
	SD	409	410	406

Anovar

Source	df	Mean Square	F	P
FI-D	2	2,730,450	51.44	$<.01$
Sex	1	53,000	<1	ns
FI-D x Sex	2	9,200	<1	ns
Error	42	53,076		

Table 10

Descriptive Statistics - BRT

	Females*	Males*	Total
Mean	6.13	8.71	7.42
SD	3.55	3.48	3.72

*(t = 1.93; $p < .01$)

Table 11*
Intercorrelation Among Dependent
and Independent Measurements

	SPONTANEOUS SPEECH			READING		
Dependent Variable	IEFT	SEX	BRT	IEFT	SEX	BRT
DTPT	.041	.054	-.152	-.101	.027	-.121
PDMX	-.022	.008	-.067	.098	.091	.075
VDMX	.058	-.123	-.288	.015	-.144	-.015
Factor I	-.155	-.063	.020	.040	-.185	-.170
Factor II	-.117	.148	-.056	.063	-.254	-.232

*Sex is a dichotomous variable with 0 = female and 1 = male.

Hypothesis I and Hypothesis 2

Hypotheses 1 and 2 refer to the ability of IEFT to predict DAF effect (Hyp. 1) and to the variability in DAF effect between males and females (Hyp. 2). To test these hypotheses, a two factor (3x2) analysis of variance was performed (Winer, 1962). The results of the analysis of variance plus descriptive statistics are shown, for the five dependent measures of each speaking condition, in Tables 12 to 21.

It should be noted that the analyses of variance presented in Tables 12 through 21 test hypothesis 1 on the arbitrary trichotomy of IEFT scores. That is, the analyses of variance consider the field independence-dependence variable to have three levels (FI, FI/D and FD). A comparison of FI and FD groups is required in order to determine if the FI/D group produced effects which masked differences between FI and FD subjects. To test for this, the group means of FI and FD subjects were compared with regard to which group showed the greater speech disruption in response to DAF. FD subjects showed more disruption than FI subjects in three out of five cases in the spontaneous speech condition, and in four out of five cases in the reading condition. Taken together, the trend of seven out of ten cases in the same direction is by use of the binomial test (Runyon and Haber, 1967) statistically non-significant. A scatter plot conformed this result.

Table 12

Analysis of Variance of DTPT (Spontaneous Speech) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	2,296.9	3.714	ns
Sex	1	94.6	<1	ns
FI-D x Sex	2	1,111.7	1.797	ns
Error	42	618.5		

Descriptive Statistics

		Females	Males	Total
FI	Mean	-10.65	10.57	-.04
	SD	28.33	25.04	28.05
FI/D	Mean	-18.37	-29.62	-24.00
	SD	33.72	18.21	26.81
FD	Mean	-11.17	-12.72	-11.95
	SD	17.09	22.83	19.50
Total	Mean	-13.40	-10.59	-12.00
	SD	26.31	27.09	26.45

Table 13

Analysis of Variance of DTPT (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	1,158.5	2.351	ns
Sex	1	17.8	<1	ns
FI-D x Sex	2	480.6	<1	ns
Error	42	492.7		

Descriptive Statistics

		Females	Males	Total
FI	Mean	7.72	6.77	7.25
	SD	15.42	14.45	14.44
FI/D	Mean	-15.62	-2.52	-9.07
	SD	30.72	22.89	27.03
FD	Mean	-.83	-9.33	-5.06
	SD	12.33	29.83	22.48
Total	Mean	-2.91	-1.69	-2.30
	SD	22.42	23.22	22.59

Table 14

Analysis of Variance of PDMX (Spontaneous Speech) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	.00165	< 1	ns
Sex	1	.00001	< 1	ns
FI-D x Sex	2	.00164	< 1	ns
Error	42	.00448		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.130	.151	.141
	SD	.039	.053	.046
FI/D	Mean	.150	.131	.141
	SD	.116	.060	.090
FD	Mean	.122	.124	.123
	SD	.039	.061	.049
Total	Mean	.134	.135	.135
	SD	.072	.057	.064

Table 15

Analysis of Variance of PDMX (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	.00287	<1	ns
Sex	1	.00158	<1	ns
FI-D x Sex	2	.00003	<1	ns
Error	42	.00442		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.117	.104	.111
	SD	.105	.062	.083
FI/D	Mean	.113	.104	.108
	SD	.066	.058	.060
FD	Mean	.138	.126	.132
	SD	.044	.046	.044
Total	Mean	.123	.111	.117
	SD	.073	.054	.064

Table 16

Analysis of Variance of VDMX (Spontaneous Speech) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	.00698	1.897	ns
Sex	1	.00267	<1	ns
FI-D x Sex	2	.00167	<1	ns
Error	42	.00368		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.127	.089	.108
	SD	.059	.037	.052
FI/D	Mean	.147	.147	.147
	SD	.087	.060	.072
FD	Mean	.146	.139	.142
	SD	.063	.043	.052
Total	Mean	.141	.125	.133
	SD	.068	.053	.061

Table 17

Analysis of Variance of VDMX (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	.0289	2.050	ns
Sex	1	.0145	1.028	ns
FI-D x Sex	2	.0167	1.184	ns
Error	42	.0141		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.175	.139	.157
	SD	.101	.063	.083
FI/D	Mean	.289	.191	.240
	SD	.193	.108	.159
FD	Mean	.167	.196	.181
	SD	.034	.142	.101
Total	Mean	.210	.175	.193
	SD	.134	.108	.122

Table 18

Analysis of Variance of Factor I (Spontaneous Speech) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	1.347	1.428	ns
Sex	1	.181	<1	ns
FI-D x Sex	2	1.345	1.426	ns
Error	42	.943		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.004	-.252	-.124
	SD	.570	.244	.444
FI/D	Mean	.643	.019	.331
	SD	2.044	.660	1.502
FD	Mean	-.463	.049	-.207
	SD	.664	.470	.615
Total	Mean	.061	-.061	.000
	SD	1.311	.487	.980

Table 19

Analysis of Variance of Factor I (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	3.293	4.026	ns
Sex	1	1.582	1.934	ns
FI-D x Sex	2	1.811	2.214	ns
Error	42	.818		

Descriptive Statistics

		Females	Males	Total
FI	Mean	-.478	-.322	-.400
	SD	.584	.378	.482
FI/D	Mean	1.054	-.069	.493
	SD	1.895	.538	1.465
FD	Mean	-.031	-.154	-.092
	SD	.404	.618	.508
Total	Mean	.182	-.182	.000
	SD	1.296	.509	.991

Table 20

Analysis of Variance of Factor II (Spontaneous Speech) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	3.047	3.308	ns
Sex	1	.947	1.028	ns
FI-D x Sex	2	1.087	1.180	ns
Error	42	.921		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.187	.812	.500
	SD	.950	.816	.915
FI/D	Mean	-.159	-.473	-.316
	SD	1.339	.661	1.033
FD	Mean	-.449	.083	-.183
	SD	.682	.754	.747
Total	Mean	-.140	.140	.000
	SD	1.016	.893	.957

Table 21

Analysis of Variance of Factor II (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	.060	<1	ns
Sex	1	2.904	2.942	ns
FI-D x Sex	2	.278	<1	ns
Error	42	.987		

Descriptive Statistics

		Females	Males	Total
FI	Mean	.257	-.152	.053
	SD	.731	.864	.801
FI/D	Mean	.073	-.206	-.067
	SD	1.091	.663	.884
FD	Mean	.407	-.380	.014
	SD	1.008	1.412	1.253
Total	Mean	.246	-.246	.000
	SD	.924	.989	.979

While the analyses of variance in Tables 12 through 21 also provide tests of significance for sex differences in relation to DAF effect, they do not explicitly test hypothesis 2. Since males and females have been equated on IEFT scores (with a tendency for the males to be more field independent than the females), the most extreme test of hypothesis 2 is provided by the contrast of FI males with FD females. The group means show FI males to be more disrupted than the FD females in three out of ten cases. This result is, by use of the binomial test, statistically non-significant.

Hypothesis 3

Hypothesis 3 requires a direct comparison between the spontaneous speech condition and the reading condition. Specifically, this hypothesis asserts that the independent variables will be able to better predict the DAF effect in spontaneous speech condition. The optimal procedure, to test for this result, is to obtain a joint prediction (of the three independent variables) on each of the dependent measures and then intercompare on condition. Accordingly, a stepwise multiple regression (Dixon, 1967) was employed. The multiple prediction (R) on each of the dependent measures is shown in Table 22.

Table 22

Multiple R's on Dependent Measures for Spontaneous Speech and Reading Conditions

	Spontaneous Speech	Reading
DTPT	.204	.163
PDMX	.076	.164
VDMX	.302	.149
Factor I	.186	.221
Factor II	.208	.304

The assumption was made that the smaller of the two multiple R's for each dependent measure was based upon a prediction from two variables rather than the actual three. This change, facilitated the use of an F-test (Guilford, 1965, p. 403) to test for significant differences between the multiple R's of the spontaneous speech and reading conditions. All five F-tests proved to be non-significant.

Additional Results

Effects of Subject Selection on GEFT and BRT

The means and standard deviations on the GEFT for the experimental and total group of subjects are shown in Table 23.

Differences between experimental and total group subjects were found to be significant for females ($t = 2.02$; $p < .05$), significant for males ($t = 2.08$; $p < .05$), and non-significant ($t = .10$; $p > .05$) for the sexes combined.

Table 23

Descriptive Statistics on GEFT for Experimental and Total Groups

		Females	Males	Total
Experimental Group	Mean	7.167	5.500	6.333
	SD	3.615	3.836	3.782
	M	24	24	48
Total Group	Mean	5.465	7.241	6.428
	SD	4.061	4.018	4.120
	M	120	143	263

The means and standard deviations on the BRT for the experimental and total group of subjects are shown in Table 24.

Table 24

Descriptive Statistics on BRT for Experimental and Total Groups

		Females	Males	Total
Experimental Group	Mean	6.125	8.708	7.417
	SD	3.555	3.483	3.718
	M	24	24	48
Total Group	Mean	5.612	7.979	6.901
	SD	3.234	3.834	3.758
	M	120	143	263

Differences between experimental and total group subjects were found to be non-significant for females ($t = .64$; $p > .05$), for males ($t = .91$; $p > .05$), and the sexes combined ($t = .80$; $p > .05$).

Effects of Counterbalancing

The experimental design called for the counterbalancing of the spontaneous speech condition and reading condition within both sex and field independence-dependence status. Consequently, it was of additional interest to determine if the ordering of the task conditions had any significant effects on the outcome of the results.

To accomplish this, the condition variable (COND) was added in the stepwise multiple regression analysis presented in Table 22. That is, COND as a dichotomous variable (with 1 = reading first, and 2 = reading second), was allowed to enter the multiple regression after the three independent variables. If COND had a significant effect, this would be evidenced by statistically significant increases in the prediction of the dependent variables. The multiple R's with COND as an added variable are shown in Table 25.

Table 25

Multiple R's on Dependent Measure for Spontaneous Speech and Reading Conditions with COND added

	Spontaneous Speech	Reading
DTPT	.209	.208
PDMX	.180	.175
VDMX	.303	.151
Factor I	.241	.223
Factor II	.253	.326

F-tests of significance between the multiple R's in Table 22 with the multiple R's in Table 25 were non-significant in each case.

Results for Additional Dependent Measures

The analysis of variance and descriptive statistics on DLEV, are shown for the spontaneous speech condition in Table 26 and for the reading condition in Table 27. The multiple R's were .195 ($p > .05$) and .409 ($P < .05$) for the spontaneous speech and reading conditions respectively. The multiple R of .409 was obtained by the joint prediction, in order of entry, of SEX, IEFT, and BRT.

Table 26

Analysis of Variance of DLEV (Spontaneous Speech) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	2.05	< 1	ns
Sex	1	4.16	< 1	ns
FI-D x Sex	2	2.77	< 1	ns
Error	42	5.05		

Descriptive Statistics

		Females	Males	Total
FI	Mean	2.63	1.72	2.17
	SD	2.29	1.57	1.96
FI/D	Mean	3.14	1.94	2.54
	SD	2.47	2.28	2.38
FD	Mean	1.65	2.01	1.83
	SD	2.41	2.34	2.30
Total	Mean	2.48	1.89	2.18
	SD	2.37	2.00	2.19

Table 27

Analysis of Variance of DLEV (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	2.02	<1	ns
Sex	1	22.85	7.77	$<.01$
FI-D x Sex	2	7.04	2.39	ns
Error	42	2.94		

Descriptive Statistics

		Females	Males	Total
FI	Mean	2.55	1.94	2.24
	SD	1.73	1.70	1.69
FI/D	Mean	4.27	1.59	2.93
	SD	1.77	1.61	2.14
FD	Mean	2.62	1.76	2.19
	SD	1.66	1.88	1.77
Total	Mean	3.15	1.76	2.45
	SD	1.83	1.66	1.87

The analysis of variance and descriptive statistics on DWORD are shown on Table 28. The multiple R of .189 was non-significant.

Table 28

Analysis of Variance of DWORD (Reading) and Descriptive Statistics

Source	df	MS	F	p
FI-D	2	70,160	5.949	$<.01$
Sex	1	23,809	2.019	ns
FI-D x Sex	2	5,387	<1	ns
Error	42	11,794		

Descriptive Statistics

		Females	Males	Total
FI	Mean	27.9	19.5	23.7
	SD	29.8	49.3	61.5
FI/D	Mean	196.5	114.8	155.6
	SD	172.1	122.6	150.5
FD	Mean	121.4	77.9	99.6
	SD	106.1	82.3	94.5
Total	Mean	115.3	70.7	93.0
	SD	181.3	94.8	119.4

Since the analysis of variance of DWORD was significant for FI/D, a Duncan's multiple range test (Edwards, 1964) was performed in order to test for significant differences among the means. At the .05 level the studentized ranges were 77.6 and 81.6 for means of range 2 and 3, respectively, and at the .01 level were 103.8 and 108.3 for means of range 2 and 3, respectively. Only the difference between the FI and FI/D groups was statistically dignificant with $p < .01$.

CHAPTER IV

DISCUSSION OF RESULTS

Factor Analysis on Dependent Measures

From the rotated factor loadings in Tables 3 and 4, the interpretation of the factors seems relatively clear. For both spontaneous speech and reading conditions, Factor 1 loads on those dependent measurements associated with vocalization, while Factor II loads on those dependent measures associated with pausing. Those subjects most severely disrupted by the DAF are noted by high positive scores on Factor I (that is, the subject has decreased vocalizations between SAF and DAF) and high negative scores on Factor II (that is, the subject has increased pausing between SAF and DAF.

It is of some interest to note the similarity between the factor structures of spontaneous speech and reading. In the spontaneous speech condition, Factors I and II accounted for 48% and 35% of the variance, respectively, and in the reading condition, Factors I and II accounted for 48% and 38% of the variance, respectively. In addition, the magnitude and pattern of factor loadings, for the rotated factor matrix, appear also to be almost identical. The implication of this finding is that the dependent measures employed in this study account equally well, for the individual differences in DAF effect under both reading and speaking conditions.

Table 7 shows that PDMX correlates with Factor II while VDMX correlates with Factor I, in spontaneous speech, and Table 8 shows similar results for the reading condition. Thus, PDMX and VDMX are associated with the pause and vocalization factors, respectively. The magnitude of the correlations, however, is not high enough to suggest that these measures are are wholly dependent upon the two factors.

Tables 7 and 8 also indicate that the measure DTPT is somewhat fickle. DTPT correlates most highly with Factor II (pause) in the spontaneous speech condition and with Factor I (vocalization) in the reading condition. It would appear then, that DTPT yields a measure of pause behavior in the reading condition and a measure of vocalization behavior in the spontaneous speech condition. Thus, DTPT, which has been used as the dependent variable in many invesitgations of DAF, does not provide a consistent measure for the spontaneous speech and reading conditions.

Individual Differences in DAF Effect

Yates (1963) has already pointed to the previous findings of wide individual differences in response to DAF. Therefore, prior to the test of hypotheses it was essential to determine if in the present investigation there were indeed such differential DAF effects. The finding that approximately 50% of the subjects showed statistically significant alterations in their on-off speech patterns, under both speaking conditions (as measured by PDMX and VDMX), indicate that there are differences in DAF effect to be predicted and that any failure in prediction is not due to a conformity in DAF response.

Significance of the Findings

Hypothesis 1

From Table 11 it can be seen that all correlations between IEFT and the dependent measures of DAF effect are relatively low and non-significant. The correlation of -.101 between IEFT and DTPT, for the reading condition, indicates a slight tendency for field dependent persons to be more affected by the DAF than field independent persons. This finding, taken together with weak findings of Erlich (1965) and Rabenstein (1958) probably represent random deviations from chance.

The analyses of variance presented in Tables 12 through 21, for the field independence-dependence (F I-D) factor, are substantially the tests of Hypothesis 1. None of the dependent measures of the DAF effect show significance, thus failing to sustain Hypothesis 1. Comparison of the FI and FD groups on the descriptive statistics provides an indication as to whether or not the middle group (FI-D) produced effects which masked differences between FI and FD subjects. Comparison of the means showed FD subjects more disrupted than FI subjects, on the spontaneous speech condition, in three out of five cases, and in four out of five cases in the reading condition. A binomial test (Runyon and Haber, 1967) indicated that a trend for seven out of ten cases is not statistically significant. A scatter plot confirmed this result. Thus, it must be concluded that in general, there is no trend for either FD or FI subjects to be more affected by the DAF.

Since field dependence-independence does not predict individual differences in DAF performance, it is of interest to consider, in view of the hypothesis, why such a result was obtained. It is to be recalled that Hypothesis 1 predicted that since field dependent personalities are more capable of repressing experiences generally, they would be better able to ignore the DAF and consequently be less disrupted. In more general terms, prediction concerning speech performance under the disruption of the auditory channel was made, on the basis of prior performance on a visually oriented task. Accordingly, the possibility exists that the concept of field dependence-independence cannot be generalized to the auditory modality. There is some research which supports this contention. Jackson (1955) found a statistically significant relationship, for men but <u>not</u> for women, between field independence (as measured by the IEFT) and ability to recognize a word in a background of noise. DeFazio and Moroney (1969) used the more sophisticated approach of signal detection theory, and required subjects to identify an auditory signal in a background of white noise. They found no relationship between IEFT performance and the signal detection task in either a group of males or females. Sherman (1967) has made a strong case for attributing sex differences in field behavior to the factor of differential ability in space perception rather than a difference in mode of analytical cognitive approach. She concluded that "...the term analytical consequently implies an unwarranted generality, especially since the construct is unrelated to the verbal area (p. 297-298)." Taken together, these studies question the extrapolation of field behavior beyond the visual framework.

Witkin, et al, (1962) have suggested that the ability to overcome the embedded context, in the tests of field dependence-independence, are distinct from the ability to overcome distracting stimuli. More recent work (Karp. 1967) has found that the tests of field dependence-independence load and define different factors than do tests that measure ability to resist distraction. The nature of DAF may be such as to be primarily distracting to the subject and consequently unrelated to field behavior.

Hypothesis 2 and Hypothesis 2a

Prior to the actual experimental study it was not known whether or not the males and females could be matched on their IEFT scores. Since men are known to be more field independent than women, and since field independence, from Hypothesis 1, was associated with speech disruption under DAF, Hypothesis 2 was the natural consequent. However, since the results of Hypothesis 1 were not sustained there is little reason to suspect that a group of males and females differing with respect to IEFT would show a differential DAF effect. Nonetheless, an extreme test of Hypothesis 2 is provided by contrasting the FI males with the FD females on the means described in Tables 12 through 21. FI males show more disruption than FD females in only three out of ten cases, which is not a significant trend.

The analysis of variance of Table 9 shows that there are no significant sex differences with regard to IEFT performance and the point-biserial correlation between sex and IEFT is -.083. Consequently, Hypothesis 2a, which is contingent upon the sexes being equated in IEFT performance, is the more relevant hypothesis. As predicted, the analyses of variance in Tables 12 and 21 show no significant sex effect under DAF.

Hypothesis 3

The assertion that the spontaneous speech condition would be more fruitful than the reading condition in yielding significant results was not sustained. F-tests between the multiple R's of spontaneous speech and reading conditions in Table 22 were non-significant and showed no indication of any trend. This is not particularly surprising in that Hypothesis 3 is somewhat contingent upon the previous hypotheses. That is, since IEFT, Sex, and BRT are unable to account for the obtained DAF effects, it is unlikely (if not impossible) for their joint prediction of the DAF effect to prove significant. Thus, the test of Hypothesis 3 is reduced to a comparison between non-significant multiple R's. A more meaningful test of Hypothesis 3 would have been provided had Hypothesis 1 or Hypothesis 2 been sustained.

Additional Results

DLEV

DLEV was included as a gross indication of intensity changes under DAF. As with previous studies, the positive means of Tables 26 and 27 show that subjects have increased the intensity of their speech under DAF. The analysis of variance for DLEV shows significant sex effects in the reading condition. These effects are such that females tend to speak louder under DAF, with reference to SAF, than do their male counterparts. A possible explanation for this lies in the fact that in the initial SAF condition females spoke more softly than the males. Since the intensity of the DAF signal varied with the subject's own natural speaking intensity, the males who are speaking at a somewhat louder intensity to begin with in the DAF condition, may have less of a temptation to try and shout down their own voice on feedback than would the females.

DWORD

Previous studies using reading passages as the SAF and DAF task have characteristically asked subjects to twice read a passage of given length until completion (once under SAF and then again under DAF). The time for the two readings is noted and the difference score then represents the measure of DAF effect. This procedure produces experimental sessions which vary in length for each subject and in the present study this would introduce questions pertaining to fatigue for those subjects who read first and then spoke spontaneously second. It was felt that the procedure of having the subject read for a specified period of time and for the experimeter to then examine total pause time (or equivalently total vocalization time) would provide similar results. The positive means of Table 28 indicate the usual DAF effect of fewer spoken words under DAF than under SAF, and the significant correlation of -.683 between DTPT and DWORD shows the association of longer DAF pause times with fewer spoken words.

The analysis of variance of DWORD (Table 28) shows a significant FI-D effect. Both the FI and FD groups of subjects show lower mean DWORD scores than the FI-D, and a Duncan's multiple range test (Edwards, 1964) shows significant differences between only FI and FI-D subjects. Consequently, there is no clear interpretation of the significant analysis of variance for FI-D on DWORD.

BRT

The results for the BRT as a predictor of the DAF effect show, from Table 11, substantially no significance with the exception of VDMX in the spontaneous speech condition. For VDMX, the correlation of -.288 (significant at the .05 but not at the .01 level) with the BRT indicates that more rigid subjects are less affected by the DAF. Since the experiment employs five dependent variables, however, the .01 level of significance would appear to be more appropriate. With regard to previous results, Beaumont and Foss (1957) using the Einstellung test as the measure of rigidity, found more rigid subjects to be more affected by DAF. Spikla (1954) found more rigid subjects to be less affected by DAF, having used the extremes of an ethnocentrism scale as his measure of rigidity. Thus, it must be stated that the proper directional relationship between rigidity and DAF effect is speculative and dependent upon which test of rigidity is used.

Effects of Subject Selection

Tables 23 and 24 show that with regard to the GEFT and BRT, subjects in the total selected experimental group do not differ from subjects in the total larger group. The higher GEFT mean for females in the experimental group and for males in the total group represent the effects of the selection, for the IEFT, of a more field independent female and a more dependent male than a random selection would have afforded. The correlation of the GEFT with the IEFT of .57 compares favorably with the correlation .56 found by Jackson, et al, (1964).

Implications for Future Research

The present study has investigated without success individual differences in response to DAF with regard to the personality variables of field dependence-independence, sex, and non-verbal rigidity. It is unlikely that further research with these particular variables would provide significant results. The present study was designed with constant regard for the control of those extraneous or intervening variables which could confound the results. Consequently, a large group of subjects was screened as to speech history, verbal ability, and abnormal color vision. From this pool, subjects were chosen for an individual session and then screened as to gross hearing loss and color blindness. The intensity of the feedback in both the SAF and DAF speaking conditions controlled for the speech reception threshold of each individual subject. In addition, males and females were equated on IEFT performance.

The foregoing controls have not been employed by other investigators. The two previous studies relating field behavior to DAF performance (Erlich, 1965; Rabenstein, 1958) failed to control for speech history or differences in verbal behavior. It is noteworthy that in one of them (Rabenstein), the highest correlation obtained was that between the DAF effect and subjects' scores on an English placement test. In addition, neither these studies nor any other involving personality variables (e.g., Bachrach, 1964; Beaumont and Foss, 1957), controlled for feedback intensity as a function of individually-measured thresholds. Control of this variable is indeed crucial as evidenced by a range of 20 db in Speech Reception Thresholds in the present study.

The methods of measurement of the DAF effect employed in this study, with the exception of DTPT, represent a new approach. The intercorrelations among these various measures are not consistently high and this indicates that the measures represent independent information pertaining to the DAF effect. VDMX and PDMX are measures which when referred to the appropriate sampling distribution yield statistical inferences concerning the speech disruption of individual subjects. The finding of two orthogonal factors indicates that the on-off properties of speech cannot be described by a single measure, but are rather composed of independent periods of "ons" and "offs." Thus these new measures supply the experimenter with readily available and objectively quantifiable statistics which can be more sensitive and potentially of greater relevance to the particular covariate(s) of DAF performance under investigation.

While previous research has generally neglected spontaneous speech as a speaking task due to its uncontrolled nature, the present study has included it and found it to show DAF effects which are as quantifiable as those of a highly structured reading task. Consequently, it is possible to study differential DAF effects with regard to these speaking tasks, since the nature of the reading task is such that the stimulus for speech is externally determined as opposed to the spontaneous speech task in which the stimulus is internally determined. Accordingly, there may be some systematic effects such that certain personality types are most affected by the DAF under the spontaneous speech condition, whereas others would be most affected under the reading condition.

Thus the present study has established with a combination of appropriate controls, sophisticated methods of measurement, and two different speaking tasks, the occurrence of large and quantifiable individual differences in speech fluency under DAF. While field dependence-independence, sex, and non-verbal rigidity fail to explain these differences, it is reasonable to consider the kinds of experiments which possibly could explicate them. In this connection, it seems somewhat surprising that there are perhaps over one thousand published articles on DAF and less than twenty which relate to personality variables. A major source of difficulty appears to be the general neglect of researchers in specifying the cognitive variables which intervene in the S-O-R chain. Cognitive variables delineate those parameters which affect the processing of information, and in the case of DAF could indicate a trend for personality research by a determination of what about the DAF situation makes it so disruptive for some subjects but not for others. The fact that certain critical delay times and intensity levels of feedback are required to produce the DAF effect, provides a necessary but not sufficient explanation of the phenomenon.

It is of interest to consider the following hypothetical explanations for the DAF effect: Individual A finds DAF to be an antagonistic, competitive factor to speech and thus becomes highly anxious and unable to speak properly; or, Individual B is used to speaking in a very proper, clear, and articulate manner, and finds the DAF to be an intrusion on his orderly form of speech; or, Individual C finds that not only does he dislike a voice coming over the headphones but that he particularly dislikes the sound of his own voice and is therefore disrupted by the DAF; or, Individual D finds DAF to be distracting to his attentional process and is therefore unable to concentrate and maintain speech. In each of the above cases, and the list is certainly not exhaustive, a different area of personality theory applies. The DAF performance for Individual A would be explained by variables associated with anxiety (e.g. manifest anxiety, test anxiety, trait anxiety); for Individual B the concepts of anality, compulsivity, and the related psychoanalytical literature would be relevant; for Individual C the concept of self and self actualization (e.g. the theories of Rogers and Maslow) would be relevant; and for Individual D, cognitive variables rather than personality variables would be most appropriate. Some research in this direction has already been done.

Fillenbaum (1963) has investigated DAF performance in relation to the difficulty or structure of the task, and found that automated tasks (e.g. reading serial numbers aloud) are the most disrupted by DAF. Also, Erlich (1965) has found that persons who have difficulty with the Stroop color-word test and with mirror tracing, tend to be more affected by DAF. Of particular interest in these studies, as well as in future work, is the more complex question of whether disruption under DAF reflects some unitary underlying trait(s) or whether it reflects single traits which are applicable to groups of people. For example, in the latter case, explanation for DAF disruption may well be due to a negative concept of self in some subjects, while in others it may reside in their underlying inability to cope with stress. Clearly, such a distinction is important, and should be addressed in future experimental work. Thus, while the effects of DAF are readily quantifiable, a model which predicts individual differences has yet to be developed.

Conclusions

From the foregoing discussion the following conclusions emerge:

1. While there is a logical theoretical basis to connect or suggest a parallelism between the phenomena of delayed auditory feedback and field independence-dependence, the empirical results of the present study do not support this connection. It must be concluded that the concept of field independence-dependence adds little information to the prediction of DAF effects.

2. With regard to sex differences, this study has found that when subjects are matched on both measures of field independence-dependence and verbal ability, there are no differences in DAF effect between males and females.

3. Non-verbal rigidity, as measured by one test of perceptual preferences, also fails to predict individual differences in DAF effects.

4. While speaking spontaneously is quite different from reading aloud, there were no differences found in the potentiality of either condition to provide a more fruitful platform for the interaction of personality variables with the DAF effect. Hopefully, when variables are found which yield greater predictability of DAF effects, it will become possible

to demonstrate their differential relevance to different speaking tasks.

5. Numerous controls are required for a true explication of the DAF effect. Their absence in prior studies would account in part for discrepant results. The present study has employed these controls yet retained wide individual differences.

6. The fact that certain critical delay times and intensity levels of feedback are required to produce the DAF effect, provides a necessary but not sufficient explanation of the phenomenon. Future experimental work might profitably explore the interaction of organismic and cognitive variables with DAF performance.

CHAPTER V

SUMMARY

From the work of Witkin one may infer that field dependent persons are more likely to repress stressful experiences than field independent persons. Thus it was predicted that if field independent and field dependent persons were subjected to the stress of delayed auditory feedback (DAF), the former group would suffer more speech disruption than the latter. Since women are generally more field dependent than men, it was also hypothesized that they would be less disrupted than men while experiencing DAF, but that any sex differences would vanish if the two groups were equalized on field dependence-independence. Finally, on the basis of speculations in the literature of personality theory, the variable of rigidity was included as a source of variation in DAF performance.

To test these hypotheses, a group of 263 volunteer college students were screened as to both suitability and willingness to participate in an individual experimental session. Only those subjects were selected who were unremarkable with regard to prior speech and hearing history, color vision, and verbal ability as measured by an aptitude test. Each subject was also administered a group form of the Embedded Figure

Test and a non-verbal test of rigidity. From this screening, 24 males and 24 females were selected for paid participation in the individual session. In that session, each subject was given a color-vision test, an individual test of field dependence-independence, a hearing threshold test, and four speaking tasks. The tasks required the subject to talk for 20 minutes, five minutes each of: reading with synchronous auditory feedback (SAF), reading with delayed auditory feedback (DAF), speaking spontaneously with SAF, and speaking spontaneously with DAF. SAF always preceded DAF, but the reading and spontaneous speaking conditions were counterbalanced within sex and within field dependence-independence status. The subject's vocal output was tape recorded for subsequent analysis.

The tape recordings were processed by a special-purpose analogue-to-digital converter which assessed the on-off characteristics of the speech every fifth of a second. This form of data is independent of lexical content and thus permits the examination of spontaneous speech or reading with equal facility. The digital output of each five-minute segment of the experiment was processed by computer, which automatically yielded up to 13 different measures of the individual distributions of pauses and vocalizations. For each subject, these were stated in the form of SAF-DAF scores, both for reading and for spontaneous speech. To achieve a more parsimonious description of the DAF effects, the scores for all subjects were next subjected to a factor analysis with the result that a two-factor solution accounted for 83% of the variance in the spontaneous speech task and 88% of the variance in the reading task. Finally, multiple regression techniques were employed in an attempt to predict the factor scores from individual ratings of field dependence-independence, sex, and non-verbal rigidity.

Despite large individual differences in speech disruption under DAF, neither in reading nor spontaneous speech did any of the three independent variables, either alone or in combination, account for the variation. In comparing this result with prior studies it is noted that none of them employed the rigid controls of the present study, especially in regard to delivering the subject's feedback at a fixed intensity above his own speech reception threshold. It is concluded that while certain critical delay times and intensity levels are required to produce speech disruption, their specification provides a necessary but not sufficient explanation of the phenomenon. Future research might profitably explore the interaction of organismic and cognitive variables with DAF performance.

APPENDIX A

GLOSSARY OF ABBREVIATIONS

SAF - synchronous auditory feedback

DAF - delayed auditory feedback

EFT - embedded figures test

VAT - verbal abilities test

GEFT - group embedded figures test

BRT - Breskin rigidity test

IEFT - individual embedded figures test

SRT - speech reception threshold

AVTA - analogue to digital converter of speech

DTPT - differences in total pause time (SAF - DAF)

Dq_o - differences in the conditional probability of speaking given previous speech (that is, q_1, for SAF - DAF)

DMPT - difference in mean pause time (SAF - DAF)

DMVT - difference in mean vocalization time (SAF - DAF)

DMDPT- difference in median pause time (SAF - DAF)

DMDVT- difference in median vocalization time (SAF - DAF)

DPSIR- difference in pause semi-interquartile range (SAF - DAF)

DVSIR- difference in vocalization semi-interquartile range (SAF - DAF)

PDMX - maximum cumulative percentage difference between the pause distributions of SAF and DAF

VDMX - maximum cumulative percentage difference between the vocalization distributions of SAF and DAF

DLEV - difference in level or intensity (SAF - DAF)

DWORD- difference in the number of words read (SAF-DAF)

FI - field independent group of subjects

F I/D- field independent/dependent group of subjects

FD - field dependent group of subjects

F I-D- refers to the factor of field independence-dependence

QUESTIONNAIRE

1. Personal Data

   (a) Name ______________________________

   (b) Sex ________

   (c) Age ________

   (d) Major ________________

2. Speech History and Color Vision

   (a) Have you ever been a stutterer? Yes ___ No ___

   (b) Is English your native language? Yes ___ No ___

   (c) Have you ever received special training in speech? (e.g. acting school, speech therapy, radio announcer, elocution lessons) Yes ___ No ___

   (d) Is your birthplace in the USA? Yes ___ No ___

   (e) Do you believe your color vision to be abnormal in any way? Yes ___ No ___

<u>DO</u> <u>NOT</u> <u>TURN</u> <u>PAGE</u> <u>UNTIL</u> <u>INSTRUCTED</u>

VAT

Directions: Read the following paragraph and answer the questions based on this paragraph.

Only twice in literary history has there been a great period of tragedy, in the Athens of Pericles and in Elizabethan England. What these two periods had in common, two thousand years and more apart in time, that they expressed themselves in the same fashion, may give us some hint of the nature of tragedy, for far from being periods of darkness and defeat, each was a time when life was seen exhalted, a time of thrilling and unfathomable possibilities. They held their heads high, those men who conquered at Marathon and Salamis and those who fought Spain and saw the Great Armada sink. The world was a place of wonder; mankind was beauteous; life was lived on the crest of the wave. More than all, the poignant joy of heroism had stirred men's hearts. Not stuff for tragedy, would you say? But on the crest of the wave one must feel either tragically or joyously; one cannot feel tamely. The temper of mind that sees tragedy in life has not for its opposite the temper that sees joy. The opposite pole to the tragic view of life is the sordid view. When humanity is seen as devoid of dignity and significance, trivial, mean and sunk in dreary hopelessness, then the spirit of tragedy departs.

1. The title that best expresses the ideas of this paragraph is:

    1. Two thousand years of tragedy
    2. Periclean Athens
    3. The tragedy of war
    4. The psychology of happiness
    5. Mainsprings of tragic drama

2. The mental attitude that finds tragedy is characterized by

    1. sordidness
    2. indifference
    3. exaltation
    4. triviality
    5. hopelessness

3. The two periods in which great tragedies were written were periods of

    1. gloom
    2. serenity
    3. defeat
    4. confusion
    5. valor

4. In an age of glory one

    1. is not indifferent
    2. usually feels tragic
    3. feels happy
    4. is apathetic
    5. feels mean and hopeless

Directions: Each of the questions below consists of an underlined word, followed by five words numbered 1 to 5. Choose the numbered word which is most nearly opposite in meaning to the underlined word.

5. ribald 1. refined 2. scurrilous 3. insignificant 4. impolite 5. impolitic

6. diatribe 1. monologue 2. hypocrisy 3. praise 4. clan 5. autocracy

7. pithy 1. epigrammatic 2. anecdotal 3. verbose 4. fancy 5. plain

8. furtive 1. nearer 2. stealthy 3. apathetic 4. open 5. affable

Directions: Select the word or words which best complete the sentence.

9. Disturbed by the ______ nature of the plays being presented, the Puritans closed the theaters in 1642.

   1. mediocre 2. fantastic 3. moribund 4. salacious 5. witty

10. The columnist was very gentle when he mentioned his friends, but he was bitter and even ______ when he discussed people who irritated him.

   1. laconic 2. splenetic 3. remorseful 4. militant 5. stoical

11. _______ with the waters of melting snow, the rivers threatened to overflow their banks.

   1. Ineffable 2. Chilled 3. Turgid 4. Filled 5. Berserk

12. To be _____ is to be ______ .

   1. pugnacious-supercilious 2. obsequious-servile 3. contradictory-hostile 4. puerile-strong 5. effete-violent

Directions: Select the best relationship

13. chauvinism:country :: 1. frugality:money 2. patriotism: country 3. gluttony:food 4. jingoism:loyalty 5. criticsm:book

14. frugal:parsimonious :: 1. joy:ecstasy 2. caution:wisdom 3. honor:loyalty 4. poor:miserly 5. eager:anxious

15. convention:mores :: 1. antics:caprice 2. corruption: maggots 3. popularity:ephemeral 4. books:library 5. honesty:falsity

16. automobile:gasoline :: 1. fire:fuel 2. man:energy 3. airplane:propeller 4. man:food 5. disease:germs

DO NOT TURN PAGE UNTIL INSTRUCTED

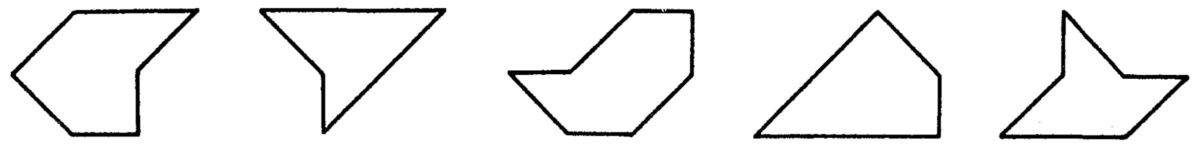
Name: ______________________________

HIDDEN FIGURES TEST — Cf-1

This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by putting an X through the letter of the figure which you find in the pattern.

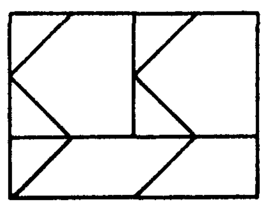
<u>NOTE</u>: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five lettered figures.

Now try these 2 examples.



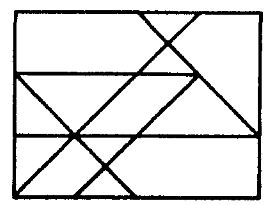
A B C D E

I



A B C D E

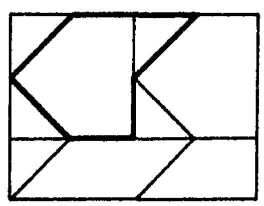
II



A B C D E

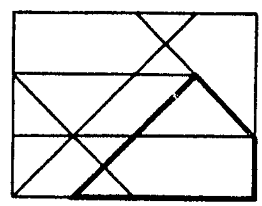
The figures below show how the figures are included in the problems. Figure A is in the first problem and figure D in the second.

I



~~A~~ B C D E

II



A B C ~~D~~ E

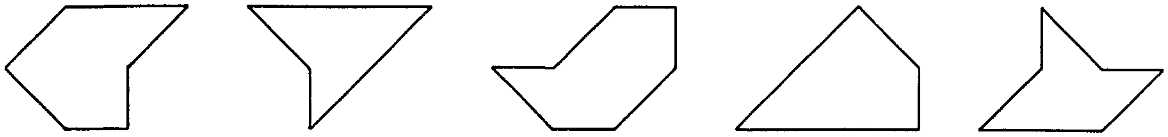
Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will <u>not</u> be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have <u>10 minutes</u> for each of the two parts of this test. Each part has 2 pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

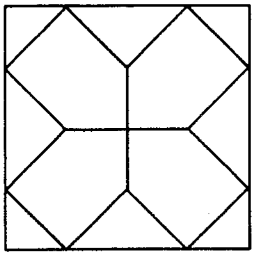
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Developed under NIMH Contract M-4186

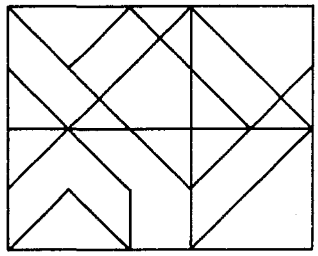
Part 1 (10 minutes)



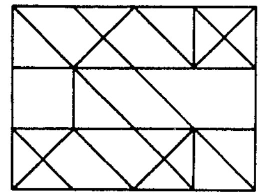
A B C D E

1. 

A B C D E

2. 

A B C D E

3. 

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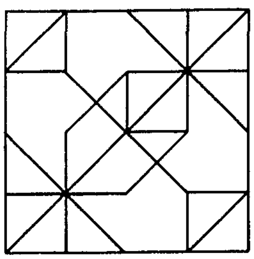
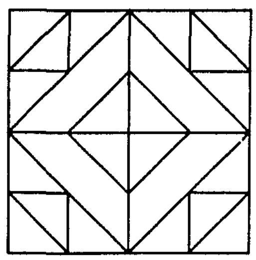
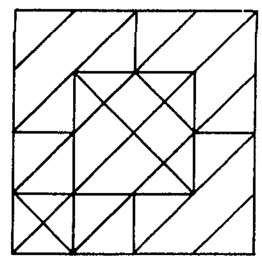
4. 

A B C D E

5. 

A B C D E

6. 

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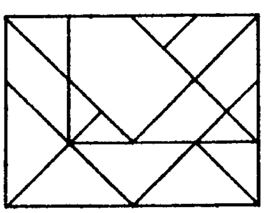
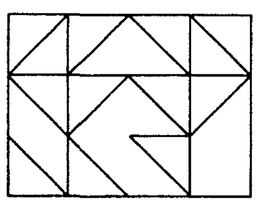
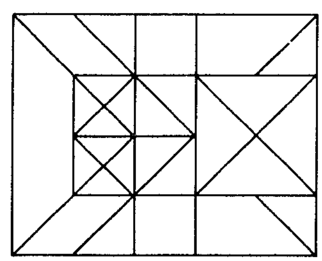
7. 

A B C D E

8. 

A B C D E

9. 

A B C D E

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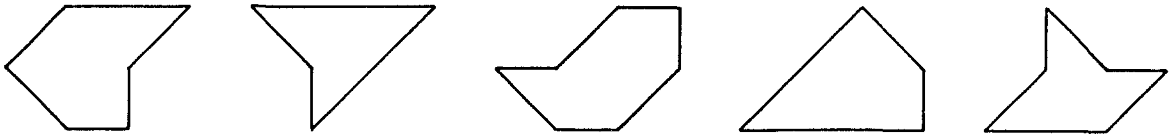
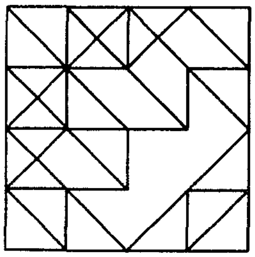
Part 1 (continued)



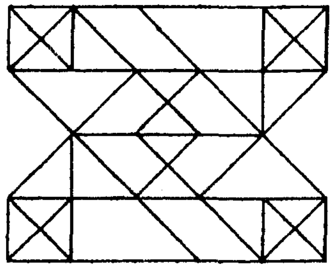
A B C D E

10.



A B C D E

11.



A B C D E

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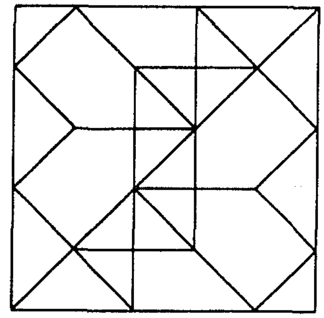
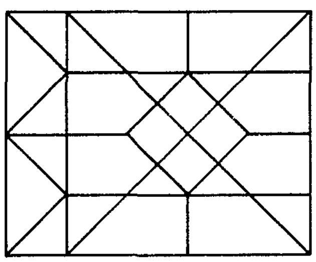


A B C D E

13.



A B C D E

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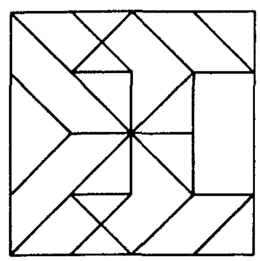
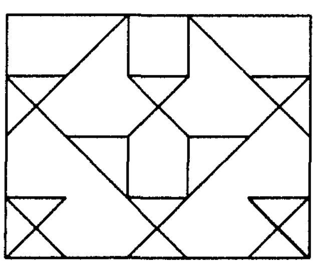


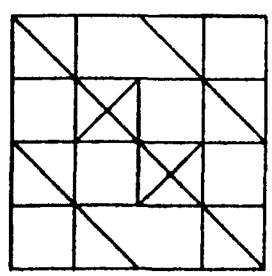
A B C D E

15.



A B C D E

16.



A B C D E

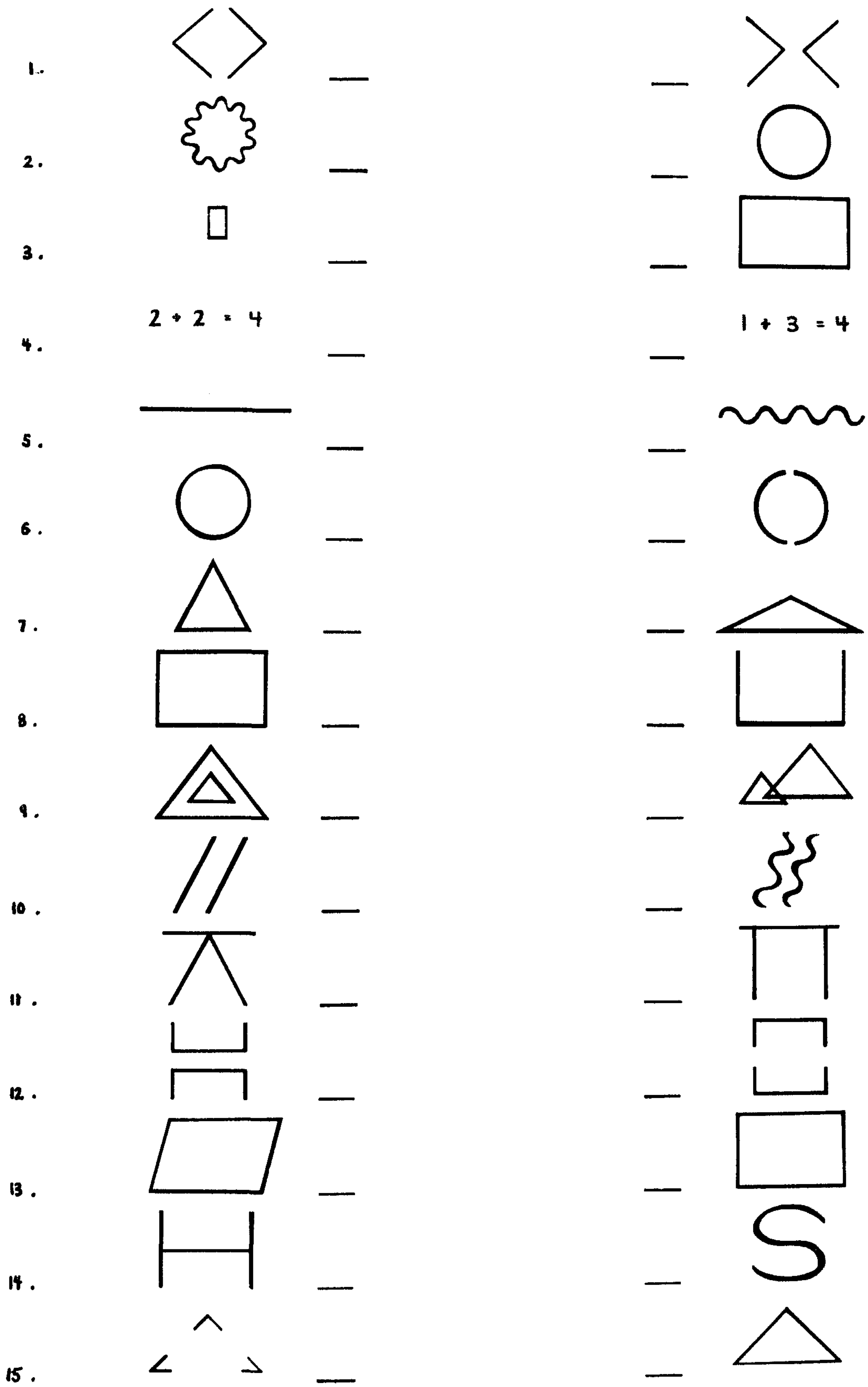
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

STOP.

BRT

Name: ______________________________ Age: __________ Sex: ________

Instructions: There are 15 pairs of items on this test. For each pair, place a check, (✓), in the space provided, next to the symbol you like better. You will have 3 minutes.



This booklet has contained the first part of research for a doctoral dissertation entitled "Individual Differences in Speech Fluency under Delayed Auditory Feedback." The second part of the experiment will be conducted this spring at City College, and I am asking those persons interested in participating to fill out the information below.

Participation involves a single 1½ hour experimental session and all subjects will receive a written report at the conclusion of the research.

Name ______________________________

Phone number ______________

Please circle free hours

M	T	W	Th	F	S
9	9	9	9	9	9
10	10	10	10	10	10
11	11	11	11	11	11
12	12	12	12	12	12
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5

Thank you for your cooperation,

Stephen Breskin

Stephen Breskin

APPENDIX C

SPONDAIC WORD LIST FOR SRT

1. northwest
2. doormat
3. railroad
4. woodwork
5. hardware
6. stairway
7. sidewalk
8. birthday
9. fairwell
10. greyhound
11. cowboy
12. daybreak
13. drawbridge
14. duckpond
15. horseshoe
16. armchair
17. padlock
18. mousetrap
19. headlight
20. airplane
21. inkwell
22. grandson
23. workshop
24. hotdog
25. oatmeal
26. sunset
27. pancake
28. eardrum
29. mushroom
30. whitewash
31. hothouse
32. toothbrush
33. playground
34. baseball
35. iceberg
36. schoolboy

APPENDIX D

SPONTANEOUS SPEECH TASK

List of suggested topics

1. Who would you like to see run for President in 1972? Why?

2. Which movies have you enjoyed most? Why?

3. When and if space travel becomes available for the public, would you like to go? Why?

4. What school subjects or activities have you most enjoyed, and what, if any, are your career plans?

5. Which type of summer vacation do you prefer? Describe your most pleasant summer vacation experience.

6. What sports activities do you prefer as a participant and/or spectator? If you have any hobbies please describe them.

7. Which types of entertainment do you prefer? Why?

8. What do you think of the current women's and men's fashions in hairdos, clothes, etc.?

9. Do you think New York is a fun city? Why?

10. If you had all the money you could ever want, what would you do with it?

Number of topics chosen, IEFT, and Sex

Tables 29 and 30 show the relationship between the number of topics the subject chose to speak on, in the SAF and DAF conditions, and the IEFT and sex differences.

Table 29

Analysis of Variance of Total Number of Topics Spoken (SAF - DAF)

Source	df	MS	F	p
FI-D	2	.146	<1	ns
Sex	1	.187	<1	ns
FI-D x Sex	2	2.177	1.313	ns
Error	42	1.658		

Table 30 shows the analysis of variance of the number of topics spoken (SAF - DAF) from the suggested list supplied to the subject.

Table 30

Analysis of variance of Number of On-List Topics Spoken (SAF - DAF)

Source	df	MS	F	p
FI-D	2	1.584	<1	ns
Sex	1	.333	<1	ns
FI-D x Sex	2	2.083	1.054	ns
Error	42	1.976		

APPENDIX E

Methods for Quantifying On-Off Speech Patterns under Delayed Auditory Feedback[1]

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Abstract:- Changes in the on-off patterns of speech under delayed auditory feedback (DAF) have been represented by gross measures such as total reading time, percent phonation time, and total pause time. The research reported in the present paper employed an analogue to digital converter to assess changes (from normal speech to DAF speech) in eleven descriptive measures derived from the distribution of pause and vocalization durations. These measures reflected variations in individual speech performance under DAF which were consistent with the subjective ratings of the authors. It was concluded that independent correlates of subject, task, and environmental variables would be required to determine the usefulness of these measures.

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Methods for Quantifying On-off Speech Patterns under Delayed Auditory Feedback[1]

Stephen Breskin, Louis J. Gerstman[2] and Joseph Jaffe

Department of Communication Sciences
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This paper proposes a new approach to the specification of speech performance under delayed auditory feedback (DAF). Its virtues reside in the method being objective and quantitative, independent of the talker's articulatory intent or lexical content, free from the subjectivity of listener ratings, yet yielding measurements presumed to be relevant to the physiological substrate of speech.

Previous attempts to quantify DAF effects have depended on the experimenter knowing in advance what the talker is trying to say, which he insures by having the talker read a standard passage aloud. Thereafter he may either focus on articulatory deviations from the talker's presumed intent or opt for acoustic descriptors of the overall differences between two readings of the same passage, once with no interference and again under SAF. Examples of the former approach are reports of stuttering (Fairbanks, 1955; Fairbanks and Guttman, 1958), mispronunciation (Atkinson, 1953), syllable repetitions and omissions (Tiffany and Hanley, 1956), and omitted word endings (Korowbow, 1955). Examples of the latter are reports of increased reading time and increased speech intensity (Black, 1951; Lee, 1950; Spilka, 1954). In either approach, however, the experimenter achieves his precision at the price of foregoing analysis of spontaneous speech, which not only constitutes the majority of talking behavior, but which has already been shown to possess markedly different temporal properties from those of reading (Goldman-Eisler, 1968).

In an important symposium commentary, Chase asserts that:

> "We should be mindful of the fact that the speech motor system can undoubtedly also operate in different modes. If I am imitating another person's speech, without any concern about transmitting information but simply doing an acoustic matching job, the neurophysiology underlying the organization of my speech motor activity is probably quite different from the neurophysiology underlying the same patterns of sounds when I am spontaneously piecing these sounds together in an attempt to transmit information. Our laboratory experiences have taught us that the disorganization of speech motor activity that results from delayed auditory feedback of speech is less marked if the subject is reading a passage than if the subject is engaged in spontaneous propositional speech (1967, p. 50)."

It seems clear that the above distinction cannot be meaningfully examined until techniques are devised which can so easily be applied to spontaneous speech as to passages read aloud.

METHOD

Our laboratory has developed both a measuring device and a mat ematical model to describe speech rhythms and variations in them a a function of time (Cassotta, Feldstein and Jaffe, 1964; Jaffe and

Feldstein, 1970). An analogue to digital converter samples the presence or absence of speech at intervals as short as 100 msec. With reference to a pre-set threshold, we term absence of speech as state 0 and presence of speech as state 1. Observations of adjacent samples in the identical state are presumed to have been continuous in the interval between samples. The system has a built in "hangover time" so that unvoiced stop consonants may be bridged (i.e., pauses less than 190 msec.) and thus make the system's output comparable to what the human ear perceives.

In the experiment which follows we employ this system to analyze the effects of DAF on the on-off properties of speech, and explore the basis for the use of various descriptive measures to assess these effects.

Six female college students participated in the experiment as paid volunteers. They were seated comfortably in a room having a microphone connected to an Ampex PR-10 recorder (located in another room) and spoke spontaneously for a 15 minute monologue on a topic of personal interest. The first 5 minutes was a normal monologue (NM) free of experimental manipulation, while during the next 10 minutes S spoke with headphones on. This 10 minute condition comprised 5 minutes of DAF interspersed with 5 minutes of synchronous auditory feedback (SAF)[3]. The DAF was produced at 190 msec. delay, and was played back at an intensity which varied with S's own vocal intensity.

A sampling rate of 300 times per minute was chosen as the nearest time after a first sample that the second sample could be physically independent.[4] The results were then analyzed using the PDP-8/I computer. Since a preliminary analysis indicated a carryover effect from DAF to SAF, the SAF condition was dropped from subsequent analyses, and the NM condition was used as the S's own control.

While speech samples of 5 minutes duration have been found to reliably represent the temporal characteristics of speech (Jaffe and Breskin, 1970), it was of interest to determine if the 5 minute speech samples were representative of an individual's performance, or whether the sample overlooked some idiosyncratic behavior occurring in periods of less than 5 minutes duration. To test for this, the 5 minute frequency distributions of sound and of silence, for each S and in both NM and DAF conditions, were compared to the distributions for each minute by means of the Kolmogorov-Smirnov test (K-S test; Siegel, 1956). No significant differences were found in any of the comparisons and thus, for all further analyses, data within each 5 minute set are combined.

RESULTS

Prior to any statistical investigation of results, the authors listened to the actual speech of the Ss and made the following observations. For the speech of two Ss it was difficult to distinguish minutes of DAF from those of NM. These Ss suffered little disturbance by the DAF and were termed "mildly disrupted." For two other Ss, speech under DAF was quite different from NM. During DAF these Ss stammered frequently, their temporal rhythm of speaking was altered markedly, and they were termed "severely disrupted." The remaining two Ss were somewhere in between, and were termed "moderately disrupted."

Table 1 shows for each S the frequency distributions of sound

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Insert Table 1 about here
\- - - - - - - - - - - - - -

and of silence under NM and DAF conditions. Table 2 lists a number

\- - - - - - - - - - - - - -
Insert Table 2 about here
\- - - - - - - - - - - - - -

of descriptors of the NM and DAF monologues which have been derived from the distributions above. These descriptors will be discussed in turn.

Experimenters' rating Subjective ratings as described in the preceding section.

Subject # Identifies the performance of an individual S.

TPT Refers to the traditional measure of total pause time[5] and is equivalent in our data to the number of 0's counted times the sampling interval of .2 sec. When DAF is compared to NM, we note that on the average, the mildly disrupted Ss paused 2% less, the moderately disrupted Ss 16% more, and the severely disrupted Ss 75% more.

g_0 is the conditional probability of speaking given previous silence and is equivalent to the number of transitions from state 0 to state 1, divided by the total number of 0's. We note an increase in g_0, for the mildly disrupted Ss, a decrease for the moderately disrupted Ss, and an even greater decrease for the severely disrupted Ss.

q_1 is the conditional probability of speaking given previous speech and is determined by the number of transitions from state 1 to state 1, divided by the total number of 1's. We note that q_1 decreased for all Ss, with S# 1 showing the largest decrease and S# 2 showing the least.

MPT is the mean pause time and may be obtained from the frequency distribution of 0's or equivalently, from the product of the reciprocal of q_0 and the sampling interval of .2 sec. We note a decrease in MPT for the mildly disrupted Ss, and a progressive increase for the moderately and severely disrupted Ss.

MVT is the mean vocalization time and may be obtained from the frequency distribution of 1's or equivalently from the product of the reciprocal of $1 - q_1$ and the sampling interval of .2 sec. We note a decrease in MVT for all Ss, with S# 1 showing the largest decrease and S# 2 the least.

MEPT is the median pause time and was obtained from the frequency distribution of 0's. When NM is compared to DAF, we note a slight decrease for mildly disrupted Ss, a slight increase for moderately disrupted Ss, and a large increase for the severely disrupted Ss.

MEVT is the median vocalization time and was obtained frm the frequency distribution of 1's. When NM is compared to DAF, we note decreases for all Ss, with the largest taking place for the severely disrupted Ss.

PIR is the pause interquartile range and is determined by subtracting the pause duration at the 25th percentile from that duration at the 75th percentile. With the exception of S# 6, we note an increase in the PIR from NM to DAF conditions with the largest increase occurring in the severely disrupted Ss.

VIR is the vocalization interquartile range and is determined by subtracting the vocalization duration at the 25th percentile from that duration at the 75th percentile. With the exception of S# 6, we note a decrease in the VIR from NM to DAF conditions with the largest decrease occurring in the severely disrupted Ss.

PDmax is the maximum difference between the percentage cumulative distribution functions of pausing under NM and DAF conditions. These distribution functions are shown in Figure 1. A statistical test of the percentage difference of these functions

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Insert Figure 1 about here

(the K-S test) yielded significant results for both of the severely disrupted Ss.

VDmax is the maximum difference between the percentage cumulative distribution functions of vocalization under NM and DAF conditions. These distribution functions are shown in Figure 2. The K-S test

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Insert Figure 2 about here

Yielded significant results for both of the severely disrupted Ss.

DISCUSSION

This paper has examined various quantitative descriptions of alteration in individual speech performance under NM and DAF conditions. The measure TPT provides a gross description of pause behavior, while MPT, MVT, MEPT, MEVT, q_0 and q_1 provide measures of central tendency, and PIR, VIR, PDmax and VDmax provide measures of the range in individual variation.

The interdependence of the above measures is largely determined by the nature of theunderlying distributions of pause and vocalization durations. Jaffe, Feldstein, and Cassotta (1964) have found these distributions, for individual talkers, to be independent of each other and to approximate decaying exponential functions, under normal spontaneous speech. These findings impose direct interdependencies upon q_0 and MEPT, q_0 and PIR, q_1 and MEVT, and on q_1 and VIR.[6] Consequently, we need only refer to q_0 and q_1 to specify the entire distribution of pauses and vocalizations, respectively. In the present study, subsequent analysis has indicated that the distributions of pause and of vocalization under DAF are independent of each other for all Ss, but that these distributions are not describable by the decaying exponential functions.[7] Thus, under DAF, there is additional information in the measures MEPT, MEVT, PIR and VIR which is not derivable from either q_0 or q_1.[8]

There is a particular advantage to the use of the measures PDmax and VDmax. Both may be referred to a standard sampling distribution (Goodman, 1954), thereby enabling the experimenter to statistically evaluate alterations in individual speech performance. With the subject serving as his own control, the experimenter avoids the pitfalls attendant on the formation of equivalence groups.

While there is no necessary correlation among the eleven descriptive measures (except for q_o with MPT, and q_1 with MVT as previously noted), it is of interest to know the potential of each measure for describing alteration of speech under DAF. This can best be accomplished by obtaining a large group of subjects upon which all measures are calculated and then inter-correlated. As far as the potential use of these measures to reflect relevant speech changes under DAF, independent correlates of subject, task, and environmental variables are required in order to determine the predictability of each of these measures. This research is presently being conducted by our laboratory.

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Table 1

Frequency Distribution of Pause and Vocalization Durations for NM and DAF (in number of sample units at 300/min.)

	Pause Distribution											
	1		2		3		4		5		6	
Duration	NM	DAF	NM	DAF	NM	DAF	NM	DAF	NM	DAF	NM	DAF
1	69	19	55	27	44	45	72	23	63	80	25	41
2	30	24	21	21	29	26	44	17	15	23	7	22
3	16	18	18	16	9	19	17	8	19	14	6	9
4	21	18	13	10	9	7	10	10	12	16	8	8
5	8	14	4	1	16	6	5	9	12	9	5	6
6	9	11	10	11	7	5	5	5	8	7	1	5
7	5	13	10	3	7	7	3	2	4	7	4	1
8	5	12	9	4	9	3	1	3	4	2	3	1
9	3	10	6	1	1	4	1	4	1	2	2	1
10 or more	11	24	11	34	10	23	3	26	8	17	11	11
	Vocalization Distribution											
Duration												
1	21	34	19	13	13	27	19	12	19	27	6	7
2	33	60	32	12	14	22	25	14	31	40	11	17
3	19	52	27	24	14	13	14	15	23	29	2	11
4	15	25	19	17	13	21	19	15	9	24	6	11
5	20	4	8	23	11	10	6	15	15	11	6	5
6	13	4	8	6	13	12	11	9	3	12	3	11
7	15	0	8	9	12	5	13	4	5	7	7	6
8	17	2	5	6	13	12	7	3	8	4	3	6
9	4	0	8	6	11	6	11	4	2	2	6	6
10 or more	20	0	22	12	27	17	34	16	31	21	13	25

Table 2

Descriptive Statistics of NM and of DAF

		Experimenter's Rating					
		Mildly disrupted		Moderately disrupted		Severely disrupted	
S#		5	6	2	3	1	4
TPT (sec)	NM	132	181	169	109	117	108
	DAF	139	155	179	153	205	177
q_0	NM	.221	.080	.234	.260	.303	.424
	DAF	.256	.136	.143	.189	.176	.121
q_1	NM	.819	.876	.808	.852	.806	.848
	DAF	.776	.855	.800	.805	.615	.810
MPT (sec)	NM	.904	2.517	1.075	.770	.660	.672
	DAF	.783	1.472	1.400	1.058	1.136	1.651
MVT (sec)	NM	1.103	1.617	1.039	1.353	1.032	1.317
	DAF	.892	1.381	1.002	1.023	.520	1.050
MEPT (sec)	NM	.433	.633	.533	.486	.433	.340
	DAF	.378	.410	.700	.522	.850	.820
MEVT (sec)	NM	.700	1.367	.710	1.192	.911	1.033
	DAF	.652	1.136	.876	.804	.490	.874
PIR (sec)	NM	.692	1.156	.958	.848	.644	.348
	DAF	.734	.640	1.564	1.068	1.004	1.402
VIR (sec)	NM	1.214	1.124	.970	1.144	1.020	1.322
	DAF	.750	1.420	.708	1.078	.324	.666
PDmax		.048	.158	.196*	.108	.322*	.369*
VDmax		.128	.112	.132	.190*	.448*	.164*

*Significant beyond the .05 level.

FOOTNOTES

[1]We thank Mr. Edward L. Lorick for computer processing of the data.

[2]Also at City College of The City University of New York.

[3]The order of conditions for each of the 10 minutes was: SAF, DAF, SAF, SAF, DAF, DAF, SAF, DAF, DAF, SAF.

[4]The sampling rate of 300 times per minute is equivalent to one sample every 200 msec. This rate was chosen to be slightly longer than the delay time and hangover time of 190 msec.

[5]Other traditional measures such as total phonation time, percent phonation time, and percent pause time are linearly derivable from the TPT result.

[6] Explicitly, MEPT= $((\log .5/\log(1-q_0)) + .5) \times (.2 \text{ sec.})$; PIR= $(-\log 3/\log(1-q_0)) \times (.2 \text{ sec.})$; MEVT= $((\log .5/\log q_1) + .5) \times (.2 \text{ sec.})$; and VIR= $(-\log 3/\log q_1) \times (.2 \text{ sec.})$.

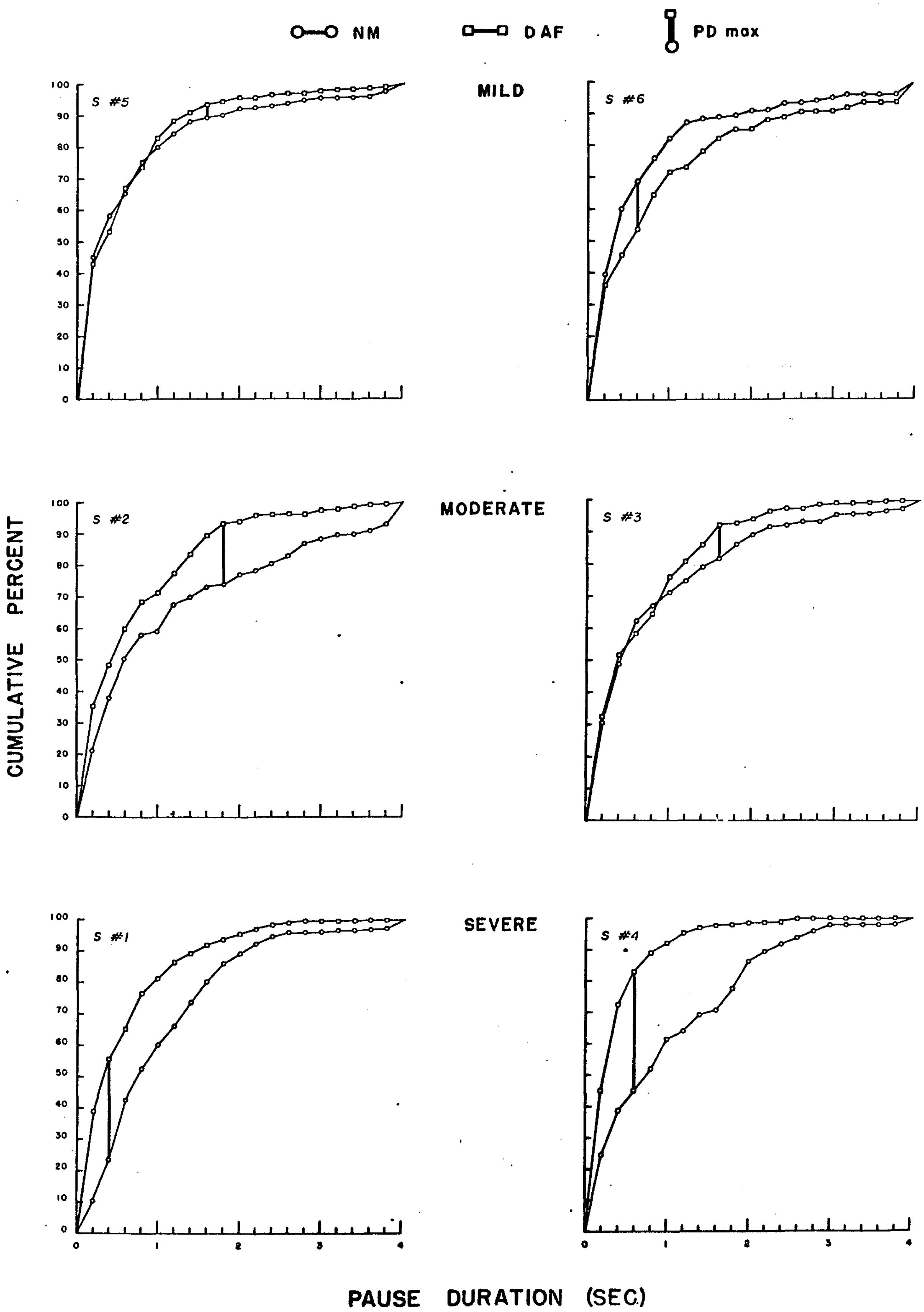
[7]A median chi-square test (Siegel, 1956) employed to test for the independence of the pause and vocalization distributions showed non-significance (i.e., independence) for all 6 Ss. Also, the DAF distributions in Table 1 did not exhibit the decreasing monotonic property of the decaying exponential function.

[8]It should be noted that regardless of the underlying distribution, the following relationships hold, MPT = $(1/q_0) \times (.2 \text{ sec.})$; MVT = $(1/(1-q_1)) \times (.2 \text{ sec.})$; and TPT = $((1-q_1)/(1+q_0-q_1)) \times$ (duration of speech sample = 300 sec.).

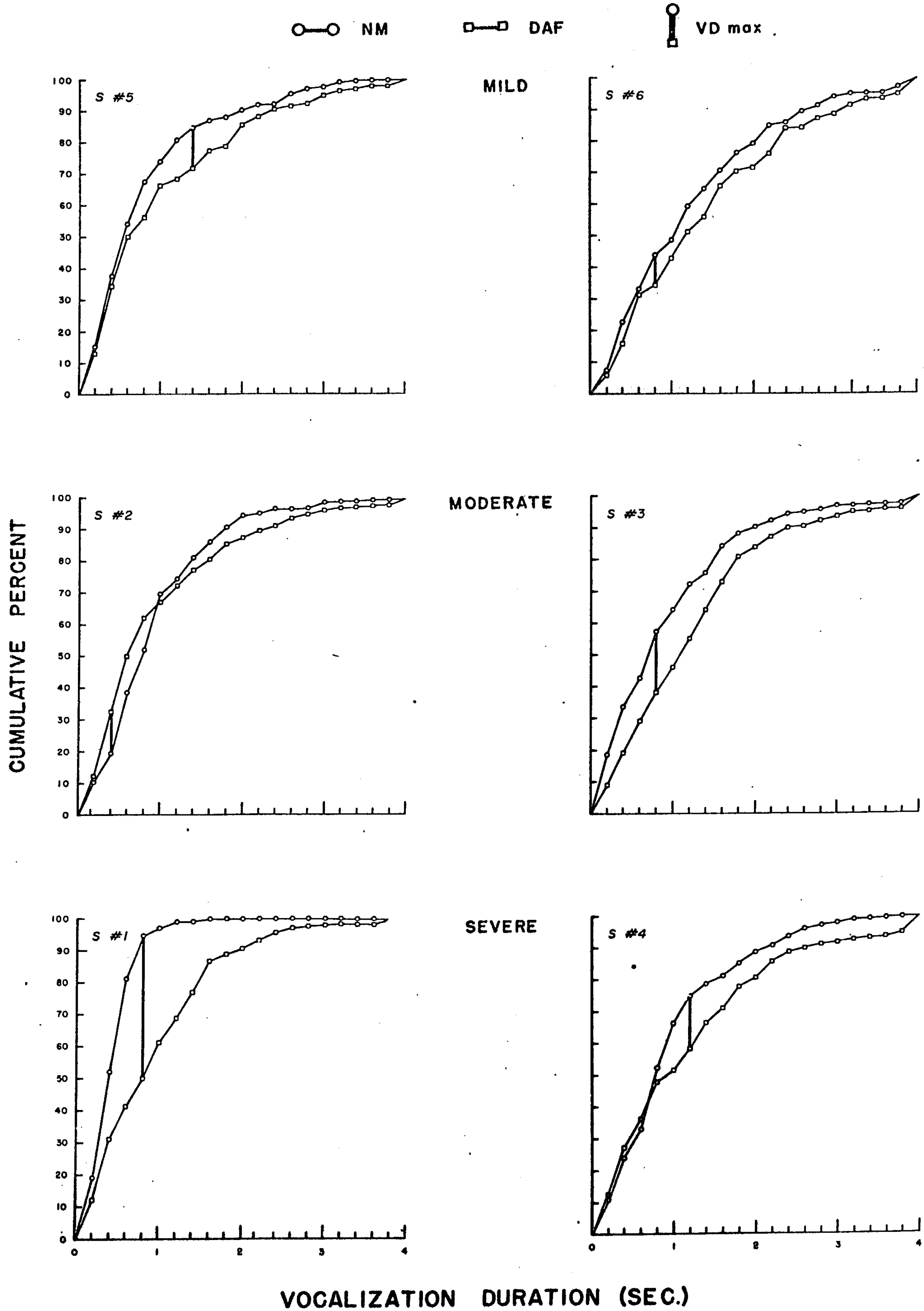
FIGURE CAPTIONS

Figure 1. Cumulative percentage function of increasing pause duration for the 6 _Ss_ under NM and DAF conditions. PDmax is shown as the maximum displacement between NM and DAF distributions.

Figure 2. Cumulative percentage function of increasing vocalization duration for the 6 _Ss_ under NM and DAF conditions. VDmax is shown as the maximum displacement between NM and DAF distributions.



NM
DAF
PD max
MILD
S #5
S #6
MODERATE
S #2
S #3
SEVERE
S #1
S #4
CUMULATIVE PERCENT
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
PAUSE DURATION (SEC)


NM
DAF
VD max
MILD
S #5
S #6
MODERATE
S #2
S #3
SEVERE
S #1
S #4
CUMULATIVE PERCENT
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
VOCALIZATION DURATION (SEC.)

APPENDIX F

SAMPLE COMPUTER PRINTOUT FROM AVTA

Pause Distribution

+35.00000	+17.00000	+12.00000	+7.00000	+10.00000
+7.00000	+12.00000	+3.00000	+3.00000	+4.00000
+3.00000	+1.00000	+2.00000	+1.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
+1.00000	+0.00000	+0.00000	+0.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
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+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000

Vocalization Distribution

+6.00000	+9.00000	+14.00000	+13.00000	+7.00000
+13.00000	+5.00000	+9.00000	+8.00000	+5.00000
+5.00000	+3.00000	+4.00000	+1.00000	+3.00000
+3.00000	+4.00000	+0.00000	+0.00000	+0.00000
+0.00000	+3.00000	+0.00000	+1.00000	+0.00000
+0.00000	+0.00000	+0.00000	+1.00000	+0.00000
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+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000
+0.00000	+0.00000	+0.00000	+0.00000	+0.00000

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AUTOBIOGRAPHICAL STATEMENT

I was born in Brooklyn on January 28, 1943 and was raised, from the age of five, in Queens. In June 1959 I was graduated from Flushing High School and in June 1963 I was graduated from Rensselaer Polytechnic Institute with a BS in Mathematics. I had become interested in the insurance business, and upon graduation from college worked for one and one half years at New York Life Insurance Company as an Actuarial Trainee. In February 1965 I entered Queens College as a non-matriculated student, taking undergraduate courses in psychology, and in February 1966 I was matriculated into the Master's degree program.

In March 1966 I entered the New York State National Guard, and commenced six months of active duty in the United States Army in June of that year. I returned to graduate study in February 1967 and was matriculated into the Ph.D program in September 1967. I was awarded the MA in Psychology in February 1969.

Currently, I work full-time as an Associate Research Scientist at New York State Psychiatric Institute, and part-time as a Psychologist in Training at the Independent Bronx Consultation Center. I am an Associate Member of the APA, and during the course of my graduate study, I have authored or co-authored sixteen articles in psychological journals. I was married on September 20, 1969.