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PAUSIMETRIC ANALYSIS OF SPEECH PRODUCTION IN CHILDREN
WITH CONSISTENT MISARTICULATIONS
VERSUS CHILDREN WITH NO CONSISTENT MISARTICULATIONS

presented by

Paul N. Deputy

has been accepted towards fulfillment
of the requirements for
Doctor of Philosophy degree in Audiology and Speech Sciences

Major professor
Oscar Tosi, Ph.D., Sc.D.

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by

Paul N. Deputy

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ABSTRACT

PAUSIMETRIC ANALYSIS OF SPEECH PRODUCTION IN CHILDREN
WITH CONSISTENT MISARTICULATIONS
VERSUS CHILDREN WITH NO CONSISTENT MISARTICULATIONS

By

Paul N. Deputy

The purpose of this research project was to compare measures of the duration of pauses and frequency of occurrence of pauses between the speech of children with two or more consistent misarticulations as opposed to children with no consistent misarticulations. The two groups were compared on three levels of speech sample types: paraphrased speech, spontaneous speech, and conversation. The two groups were also compared on three levels of duration categories with respect to the duration of pauses. The first duration category was 10 to 50 msec; the pauses in this category were considered to be articulation pauses only. Articulatory pauses are related to the process of producing sequences of phonemes which include the processes of respiration, phonation and articulation. The second duration category was 51 to 250 msec. The pauses in this category were considered to be a mixture of articulatory pauses and hesitation pauses. Hesitation pauses have been related to the internal cognitive process of speech formulation.

The third duration category was 251 to 3000 msec; and the pauses in this category were considered to be hesitation pauses only. Additionally, it was the purpose of this study to compare differences in the duration of pauses and frequency of occurrence of pauses between the three speech sample types and to compare the frequency of occurrence of pauses between the three duration categories.

Thirty children participated in the study. Fifteen of the children had two or more consistent misarticulations, no language disorder, no organic or structural defect, normal hearing and no previous speech therapy. The second group of children consisted of children matched by age, sex and mental maturity.

According to an analysis of the data obtained in this study, there was no difference in duration of pauses of frequency of occurrence of pauses between the two groups of subjects on any level of speech sample types or duration categories. There was a difference between the speech sample types in terms of duration of pauses. Spontaneous speech produced higher duration values and conversational speech produced lower duration values. There was no difference between the speech sample types in terms of the frequency of occurrence of pauses. There was a difference in the frequency of occurrence of pauses between the duration categories. There were more pauses in the 51-250 msec category. The fewest number of pauses occurred in the 10 to 50 msec category.

It was concluded that children with two or more consistent misarticulations have no more difficulty with the internal language formulation process than children without misarticulations. It was concluded that spontaneous speech was harder to formulate and conversational speech was easier to produce. It was also concluded that there was a valid division of pauses at the 250 msec point. It was recommended that research be conducted to continue studying pauses using speakers with communication disorders and that articulatory pauses and hesitation pauses be further studied and classified to form stronger relationships between the articulatory and speech production process and the occurrence of pauses.

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CHAPTER I

INTRODUCTION

Much of the literature dealing with speech production has focused on the "filled" aspects of speech. Man's perception of speech as an on-going, "sound-filled" phenomenon has probably contributed to this focus. However, within the speech signal are numerous pauses of varying duration. These pauses amount to between 4 and 54 percent of the utterances produced in a speech sample (Goldman-Eisler, 1968). The general purpose of this investigation is to study the pauses that occur in the speech of children with consistent misarticulations as compared to children without consistent misarticulations.

In the speech science and psycholinguistic literature to date, pauses occurring in speech have not been uniformly described or defined. Authors identify different types of pauses under different experimental perspectives. Tosi (1974) alluded to this fact, stating that the dictionary definitions of pauses are inadequate when considering instrumentation for measuring pauses in speech. He proposed an operational definition of a pause in order to provide a more uniform definition that would still encompass different experimental perspectives. Based on this definition, instrumentation could be constructed that would facilitate electronic detection and measurement. With a more precise definition of pauses there is potential that pauses occurring during speech production can serve as a valuable dependent variable in the study of normal and disordered speech production. Tosi suggested measurements involving duration and frequency of occurrence of pauses as parameters in testing significant differences between different types or conditions of talkers. Levin and Silverman (1965) stated that pauses are a significant variable to use in studying speech production. They cite the pause as an important variable in the study of speech production.

Definition of Pause

In reviewing the literature, it was evident that several different terms have been used to refer to pauses that occur in speech production. This lack of uniformity when reviewing literature on pauses added to the confusion and created difficulty in correlating conclusions from different experiments. To supersede this heterogeneity Tosi (1965, 1974) proposed an operational definition of pause as follows:

> A pause is a flow of acoustic energy of which the relative amplitudes remain below a predetermined value of a parameter called 'pause maximum amplitude, L_p,' provided the duration of such levels of amplitudes is more than a predetermined amount of time, indicated by another parameter called 'pause-minimum duration, T_p.' The parameter L_p is expressed as a percentage of dB ratio with respect to the average peak amplitudes (pressure or voltage) of the rectified waves of the sample of sound analyzed. The parameter T_p is expressed in milliseconds (p. 134).

Thus, this operational definition introduces two standard parameters to quantitatively define a pause. These parameters can be set according to the experimenter's interests. Using an operational definition with standard parameters facilitates the use of electronic instrumentation for measurement purposes. It also allows the experimenters to define a pause according to their perspective, whether it is psychological, linguistic, phonetic or musical (Tosi, 1974). For example, Love and Jeffress (1971) considered brief pauses below 150 msec to be nonsignificant between stutterers and non-stutterers. Therefore, they defined a significant pause as beginning at 150 msec or longer. Their reasoning was that pauses below 150 msec in duration were associated with low intensity fricatives, plosives or vocal fold movement. Using Tosi's (1974) operational definition, the above authors could have set the lower limit of a pause as 150 msec. Goldman-Eisler (1968) has studied pauses above 250 msec in duration. Her reasoning was that only pauses above 250 msec reflect the internal speech formulation process. These authors have arbitrary definitions according to their experimental perspective, yet their research needs in terms of an explicit definition for measurement, can be met by the operational definition.

Most authors refer to pauses as silent pauses (Rochester, 1976). Tosi (1974) stated that acoustic energy is always present in a pause. The human perceptual system may not perceive this acoustic energy and interpret a pause as having only silence. However, this is not adequate when determining criteria to which electronic equipment must respond. For this reason, pause-maximum amplitude (L_p) is needed to define the upper limit of intensity acceptable in order for a segment of a speech sample to be considered a pause.

In the present study, Tosi's (1974) phonetic content concept is used. In other words, when the acoustic energy within the pauses is amplified and played back, a pause occurs when there is no phonetic content, according to a listeners perceptual judgment. This energy, when played back, should sound like a series of hisses, clicks or other non-phonemic noises. Laboratory work at Michigan State University has indicated that a L_p value of 95% of the average peak amplitude eliminates all phonetic content of the pauses when amplified and played back. This level was used by Tanner (1976), Tosi, Fischer and Rockey (1968) and Black, Tosi, Singh and Takefuta (1966).

The second parameter necessary for an operational definition of pause is the smallest amount of time in which L_p can be present in order for the segment to be considered a pause. This parameter is called pause-minimum duration, T_p. The need for this parameter arises because of the presence of intrawave gaps in complex waveforms. Tosi (1974) pointed out that complex sound waves have moments of relatively little amplitude near the point where the wave form passes from positive to negative. These small points of relatively less amplitude would be considered pauses and would be detected by fast acting electronic detectors. The duration of the intrawave gap depends upon the fundamental frequency. Tosi (1974) stated that it is reasonable to assume that a signal with a fundamental frequency of 100 Hz would have an intrawave gap of 10 msec, whereas a signal with fundamental frequency of 150 Hz has an intrawave gap of 6.6 Hz. Therefore, if children, none of whom had a fundamental frequency of 100 Hz or below, were used in a study, then a lower limit for T_p of 10 msec would eliminate detection of an intrawave gap. This was the rationale used in setting T_p = 10 msec for purposes of this study.

In summary, the operational definition of pauses as proposed by Tosi (1974) was used to provide explicit criteria for electronic detection and measurement of pauses. The pause-maximum amplitude was set at 95% of the average peak amplitudes (L_p = 95%), in which no phonetic content would be detected from an amplified playback of the pauses. The pause-minimum duration was set at 10 msec to avoid an interwave gap.

Two types of pauses that occur during spontaneous speaking were considered in this study: the hesitation pause (Goldman-Eisler, 1968) and the articulatory pause (Goldman-Eisler, 1968; Tosi, 1974; and Rochester, 1976). The hesitation pause is a pause that occurs in speech and is usually associated with some type of cognitive decision-making during speech production. The hesitation pause was not considered to be a result of the articulatory process. On the other hand, the articulatory pause is associated with peripheral events occurring in the vocal tract during speech production. These pauses can be caused by respiratory, phonatory or articulatory processes (Tosi, 1974). Even though the two major divisions of pauses have evolved through research and discussion, the exact parameters of these pauses are still not precisely known. Goldman-Eisler (1968) has set an arbitrary lower limit of hesitation pauses at 250 msec. She acknowledges some loss of data because of this limit; but when considering pauses as a variable, the limit insures that only hesitation pauses will be considered. This lower limit may be an artifact of measurement techniques and may not represent a true division between articulatory and hesitation pauses. Rochester (1976) stated that the upper limit of a hesitation pause is 3000 msec. Her review of the literature revealed that 99% of hesitation pauses are under three seconds.

For the purposes of this study, a hesitation pause was considered to be a segment of speech at or below L_p with durations between 251 and 3000 msec. An articulatory pause was considered to be a segment of the speech sample at or below the intensity L_p with durations between T_p = 10 msec to 250 msec. Since the 250 msec limit is arbitrary, it is possible that there are pauses below 250 msec that are related to the cognitive aspects of language formulation and not to peripheral articulatory events. For purposes of this study, articulatory pauses are divided into two categories of duration. The first category (10 to 50 msec) was considered purely articulatory pauses. The second category (51 to 250 msec) was considered to be a mixtrue of articulatory and hesitation pauses. This division of pauses into duration categories allowed experimental comparison of articulatory and hesitation pauses. These divisions were created to allow more insight into differences in pauses with respect to children with misarticulations.

The Function of Pauses

The study of pauses has taken diverse directions. In most studies pauses longer than 250 msec in duration are considered to be one of several hesitation variables. Articulatory pauses are usually not considered in the literature. For this reason the research regarding the function of pauses pertains to hesitation pauses, or pauses above 250 msec in duration. Tosi (1974), Tosi, Fischer, and Rockey (1968), and Black, Tosi, Singh, and Takefuta (1966) included articulatory pauses as one of several articulation parameters. For the above reasons the following discussion on the function of pauses will refer to hesitation pauses.

Research regarding this aspect of pauses often includes hesitation variables. A discussion of some of these hesitation variables and how they are related to pauses was warranted before reviewing conclusions about the function of pauses.

Rochester and Gill (1973) distinguished between silent pauses and filled pauses. Both types of pauses were classified, under the general term "hesitation." Silent pauses were pauses that occurred in speech with little acoustic energy. The word "pause" in this report will always refer to what is commonly called the silent pause. Filled pauses included interjections such as 'er', 'ah', or 'uh' or some other nonmeaningful syllable. Also included under the rubric of hesitations were other types of speech errors such as phoneme reversal, repetitions and "slips of the tongue." Levin and Silverman (1965) classified thirteen types of hesitation variables including the unfilled pause.

Goldman-Eisler (1968) studied the relationship between filled and unfilled pauses and concluded that the two phenomena were related and both increased in frequency and duration as the complexity of the speech act increased. Kowal, O'Connell and Sabin (1975) summarized a number of studies and stated that "...all studies seem to have in common the basic assumption that UP's (unfilled pauses) and FP's (filled pauses) are functional for the speaker and can be related to emotional states and/or cognitive processes underlying his production of speech" (p. 195).

Mental operations cannot be seen during speech production, and inferences must be made about the processes of speech production on the basis of some characteristic of the utterances. Pauses and other hesitations in speech production have been established as indications of some kind of decision-making process during sentence production. Since pauses serve as a means of studying the internal speech formulation process, they contribute to the study of the relationship between thought and language (Goldman-Eisler, 1968; Levin, Silverman and Ford, 1967; and Kowal, O'Connell and Sabin, 1975). However, one of the problems that occur in studying pauses was the difficulty in acoustically differentiating between hesitation pauses and other types of pauses. For example, Fodor, Bever, and Garrett (1974) pointed out that some pauses may be syntactically conditioned and not reflect language formulation processes. Boomer (1965) tried to eliminate pauses due to juncture by only considering pauses associated with filled pauses. Hawkins (1971) and Fodor, Bever, and Garrett (1974) question this approach because of possible loss of data. These difficulties gave rise to questions about the methodology and conclusions of some of the studies on pauses. Nevertheless, Fodor, Bever, and Garrett (1974) concluded from their review of the literature that, in general, pauses "...have face validity as indicants of sentence planning activity" (p. 420).

Therefore, it is a general conclusion inferred by most studies regarding pauses in speech production that some type of internal decision making or cognitive processing was related causally to pauses. An additional causal factor cited by Levin and Silverman (1965) and Kowal, O'Connell, and Sabin (1975) was the emotional state during the act of speaking.

Studies have shown that the more complex the cognitive task, the greater the total frequency and mean duration of pauses found in speech. Levin, Silverman, and Ford (1967) studied the spontaneous productions of children and concluded that pauses are inversely related to the "automaticity of the cognitive process" (p. 564). Thus, according to these authors, there will be more pauses when children are producing speech with greater requirements on cognitive processing. Kowal, O'Connell, and Sabin (1975) have studied pauses across a wide range of ages in children. They concluded that younger children with less language experience had additional trouble expressing specific concepts and exhibit a greater number of pauses in their utterances with a greater mean duration. Goldman-Eisler (1968) summarized over a decade of her research on pauses. The general purpose of this research was to learn more about the generative system of speech. Her overall conclusion was that pauses were a direct result of formulating speech, which increased with the difficulty of the speech act. In other words, new verbal constructions, explanations, and interpretations, and other variables added complexity to the speech act, thus, increasing the total frequency and mean duration of pauses in an individual's utterances. Rochester and Gill (1973) stated that speech disruptions increased as the difficulty of the cognitive task increased. Taylor (1969) states, "It is reasonable to assume that these latencies and hesitations reflect the amount of conceptualizing for the sentences to be produced" (p. 170).

Although the general conclusion was that pauses are related to internal cognitive processes during speech production, a question that has been asked is what type of mental processes are associated with pauses. One of the issues in the literature concerning disruptions in speech was whether pauses and hesitations indicate syntactic or semantic planning. Goldman-Eisler (1968) proposed that pauses are related to lexical uncertainty and not a search for semantic relations between elements of a phrase. Most authors conclude that Goldman-Eisler has a syntactic perspective on the function of pauses. This was reflected in Goldman-Eisler (1972) where she concluded that different syntactic structures are reflected in the pause patterns during spontaneous speaking. However, Maclay and Osgood (1959), while agreeing with Goldman-Eisler about lexical uncertainty being related causally to pauses, pointed out that it is content words which are related most to speech errors. Thus, these authors expressed a semantic perspective in regard to the function of pauses. Rochester and Gill (1973) studied sentences produced in dialogues and monologues. They analyzed the speech samples syntactically and found that pauses were related to specific syntactic structures. They acknowledged the possibility of semantic concepts being related to pauses causally; however, they concluded from their data that pauses are related to syntactic structure. It is their conclusion that a structural or syntactic hypothesis was tenable and was at least a partial cause of increased pauses in speech samples. They also noted that dialogues contained shorter sentences with fewer pauses than monologues. Cook, Smith, and Lalljee (1974) found that filled pauses were related to longer than average clauses and concluded that these hesitations reflected syntactic planning at the clause level. Hawkins (1971) studied the narratives of children and concluded that two-thirds of all pauses and three-forths of all pause time were related to the clause as a planning unit. However, Hawkins also found that pauses within clauses were related to groupings of words within a clause. He interpreted his results to mean that there is an overall planning at the clause level. Boomer (1965) studied the occurrence of filled and unfilled pauses in the spontaneous speech of adults. He pointed out that individual words did not cause pauses and that there was a larger planning unit. According to his conclusion, the phonemic clause was the unit of planning. A phonemic clause was defined linguistically as having one area of primary stress with a terminal intonation contour. Hawkins (1971) concluded that the syntactic clause and the phonemic clause were similar. Taylor (1969) negates structural factors and concludes that decisions about content are the crucial factors causing pauses and speech errors. According to Taylor, decisions about structure were irrelevant. The question was what to say, not how to say it. Butterworth (1975) analyzed the overall pattern of pauses rather than measuring the frequency and duration of pauses. He concluded that semantic components or the location of idea boundaries coincided with syntactic boundaries. In his conclusions, he placed emphasis on semantic operations since patterns of pausing occurred in cycles that related to the sequence of ideas presented in spontaneous speech.

Pauses and Different Types or Conditions of Speakers

Most of the studies on pauses have used adult speakers or children with no outstanding characteristics. They have used subjects considered "normal speakers." Linguistic variables have been manipulated for the purpose of testing a hypothesis about sentence production. Many of these studies were reviewed in the last section. A few studies have used pauses as a measure to compare different talking conditions or different types of speakers. From these studies it is possible to learn whether different characteristics of the groups or conditions were associated with differences in pause measures. Historically, different types of speakers, especially those with communication disorders, have been used to gain insight into the language process. Aphasia is an example of a disorder that has contributed to the knowledge and understanding of language processing. Since the present study used two different types of speakers, the purpose of this section is to review the studies that compare various measures of pauses between two different groups of speakers.

Mahl (1956) was one of the first to study pauses in two different groups. His original intention was to gain more information about psychiatric patients during interviews. He found significant differences between schizophrenic and normal speakers. Rochester, Thurston, and Rupp (1977) compared two different types of schizophrenic patients and "normal" speakers. One group of schizophrenics were considered to be thought-disordered. In other words, their flow of thoughts was disassociated. Their speech was characterized with well-constructed phrases both with poor association between the ideas expressed by each individual clause or phrase. The other group of schizophrenics did not possess this thought disordered characteristic. The authors reasoned that there would be a significant difference in pauses between phrases but not within phrases. Their results indicated that there was a significant difference of the pause durations that initiated a clause between the two groups. There was not a difference between the two groups in terms of frequency of pauses. There were smaller differences between the groups within clauses. Rochester et al. used three different types of speaking samples. One type of speech sample was an interview. The other two were description and explanation of cartoons. There were significant differences between all groups in the frequency of occurrence and mean duration of pauses. Contrary to Goldman-Eisler's (1968) finding, there was more pause time during description of cartoons than interpretation of the cartoons. The authors could not explain the difference between the two studies. According to them, it was possible that a difference in methodology could be responsible.

A few studies have varied talker's conditions. Two of these studies have investigated the effects of drugs on pauses in speech. Tosi, Fischer, and Rockey (1968) and Goldman-

Eisler (1965) found differences when "normal" speakers spoke under normal conditions and when they were under the effects of drugs. Black, Tosi, Singh, and Takefuta (1966) studied the differences of pauses in three groups of foreign speakers. The different groups were Hindi, Spanish and Japanese. In turn, these groups were divided into proficient and less proficient in English according to a test of aural comprehension of English. Using median duration as a dependent variable, they found significant differences between readings in native language versus English in the less proficient group. The less proficient individuals had a higher median duration of pauses. There were no significant differences between the three groups of speakers when reading in their native language.

Several studies looked at the difference in pauses between subjects with a communication disorder and normal speakers. Canter (1963) studied pauses occurring in the speech of individuals with Parkinson's disease. He compared these individuals with normal speakers. He found no significant difference between the two groups on measures of pause frequency and mean duration; but the Parkinsonian group displayed more variability in terms of the range of pause durations. Tosi and Tanner (1977) also measured pause duration occurring in the speech of Parkinsonian patients and matched normals. They reported an unexpected trend toward shorter pauses in the Parkinsonian patients. Also, the patients were divided into categories of mild, moderate, and severe. There was a significant difference at the 0.10 level of confidence between the severe Parkinsonian patients and the mild and moderate patients. According to Tosi and Tanner, shorter pauses in Parkinsonian patients are possibly a result of an acceleration phenomenon sometimes observed in Parkinson's disease. This acceleration phenomenon was associated with the rapid speech that occurs periodically during the speech of Parkinsonian patients. Tosi and Tanner reasoned that the overall rate of speech in Parkinsonian patients could be faster and be reflected in the shorter duration of pauses.

Pauses have been cited as an index of fluent speech behavior (Hawkins, 1971; and Rochester, Thurston, and Rupp, 1977). That is, the fewer the pauses, the more fluent the speaker. This may not necessarily be true, but it provided good reason to study speakers with fluency disorders. Love and Jeffress (1971) have compared the fluent speech of stutterers with that of non-stutterers. They found that pauses below 150 msec were not significantly different between the groups. However, stutterers had in their fluent speech significantly more pauses between 150 and 700 msec. According to the analysis of these data, the number of pauses between 150 and 250 msec showed the most differences between the two groups. In their discussion, the authors implied that the stutterer does something different from the normal speakers in producing speech. This difference can be perceived by listeners. They cite this as a possible explanation in the ability of judges to reliably identify stutterers by listening to samples of their fluent speech. However, an electronic count of pauses was more reliable than listener judgment and was suggested as a method of evaluation of stutterers. Following up on this idea, Love, Starbuck, and Christensen (1972) found a significant reduction of pauses in the 200 to 250 msec ranges as a result of six weeks of intensive therapy in a resident clinic. Hutchinson and Burk (1973) used total duration of perceived pause time as a dependent variable when studying the effects of temporal alterations in auditory feedback between stutterers and clutterers. In a pilot study, they found that pauses above 300 msec could be perceived reliably by listeners. Thus, they measured pauses above 300 msec using a graphic level recording. They found that stutterers exhibited a significantly greater total perceived pause time than clutterers. These results could possibly have related to Tanner's (1976) results since both Parkinsonian patients and clutterers have organic involvement and tend to speak at a more rapid rate (Darley, Aronson, and Brown, 1975; Weiss, 1964). The results of Hutchinson and Burk (1973) concurred with the earlier results of Rieber, Breskin, and Jaffe (1972), who used mean pause time as a measure to differentiate between stutterers and clutterers. They found significant differences with the stutterers displaying a higher mean duration of pauses. The recommended measurements of pause time as a diagnostic procedure in differentiating between stutterers and clutterers.

Finally, a recent study reflects the current interest in the aged. Gordon, Hutchinson, and Allen (1976) compared several measures of speech production between the spontaneous speech of young adults and geriatric adults. Two of the measures were frequency and location of pauses and the number of interjections (filled pauses). They found that older speakers exhibited significantly more interjections. The results indicated a trend towards more pauses in the geriatric group, but this difference failed to reach significance at the 0.10 level of confidence.

In conclusion, there was a small body of literature reporting differences between different types of speakers, or speaking conditions on various measures of pauses. Significant differences were found in some groups and not in others. However, as a literature review indicates, more work was needed in this area and studies exploring other communication disorders may be warranted.

Pauses and the Speech of Children

Most of the studies on pauses cited up to this point have used adults as subjects. There are four studies in the literature that measure pauses in the speech of children. Levin and Silverman (1965) studied the spontaneous speech of children ages ten to twelve. They knew of no other study concerned with pauses in the speech of children. The purpose of their study was to provide normative data on several hesitation and fluency variables that occur during spontaneous speech. They included pauses in with the hesitation variables. They considered pauses to be the most important and frequent variable.

Each child told a story under two conditions. The first condition was with an audience of four adults, and the second condition was telling a story in a room with only recording equipment. The children returned at least a week later to repeat the procedure. To equalize the samples, Levin and Silverman used ratios with the number of words as the divisor. The concluded that the subjects were consistent in terms of the hesitation variables from story to story and between the two sessions. However, the pause was the most variable measure. They concluded that pauses were sensitive to personality and environmental influences. Levin, Silverman, and Ford (1967) studied the pause behavior of children on two different types of tasks, description and explanation. The childrens' ages ranged from five to twelve. They were required to describe and then explain physical tasks that were surprising. For example, two clear liquids that turned a vivid color when combined were observed. The dependent variables were pauses and the hesitation variables used by Levin and Silverman (1965). There were significantly more pauses with longer durations when children were required to explain the demonstrations as opposed to describing them. The authors related this to the greater cognitive task involved in explaning the situations as opposed to describing them. It was also reported that twelve of the children in the study spontaneously produced explanations of the situations after they had been questioned. These verbalizations were shorter with fewer pauses. Levin, Silverman, and Ford implied that since these verbalizations were voluntary, they were more available to the speakers; thus, they planned and executed them more efficiently. In both of the above studies, the authors concluded that rate and number of words are stable variables across tasks and sessions. Hawkins (1971) in a more linguistically oriented study investigated the pauses in children respective to the syntactic location of hesitation pauses. The children were between the ages of six and seven and one-half. Spontaneous speech tasks during an interview and story were analyzed. Hawkins concluded that two-thirds of all pauses which amounted to three-quarters of all pause time were found to occur at boundaries between clauses. From their analysis, they concluded that most of the planning for utterances occurred at clause boundaries. They did not view it as an issue whether these clause boundaries were considered syntactic or phonemic. The pauses that occurred within clauses seemed to occur before word groupings. Hawkins reasoned that these pauses may be related to lexical selection. Finally, Kowal, O'Connell and Sabin (1975) studied pauses across a wide range of ages in children. Their basic assumption in the study was that pauses were related to filled pauses and that they reflect emotional and/or cognitive variables. They hypothesized that older children would have fewer pauses. The children ranged in age from five to eighteen. There were twelve children in each of seven age levels. One-hundred and sixty-eight children in all talked about a cartoon sequence. The authors were able to identify a definite developmental trend and concluded that the frequency and duration of pauses decreased as children grew older. This decline leveled off at age fifteen. They theorized that adults have built up sufficient language experience and, because of overlearning, are able to express themselves more fluently. Thus, they have fewer pauses and other types of hesitations. The authors identified several developmental transition points in which there seemed to be a change of pause patterns. There seemed to be a change between kindergarten and the second grade. According to them, this coincides with developmental information in terms of linguistic and cognitive development.

Statement of the Problem

The complexity of the speech act is self-evident. Goldman-Eisler (1968) expressed this well, as follows:

> The complete speech act is a dynamic process demanding the mobilization in proper sequence of a series of complex procedures and is the temporal integration of serial phenomena. It is a most articulate and finely graded external projection of internal processes organized and integrated in time (p. 6).

It was obvious in the study of speech production that inferences must be drawn from external evidence upon the complex internal process of speech production. The pause has been established as such an external characteristic of an internal process. Although there is much more to learn and full understanding of the relationship of pauses to speech production is not at hand, the study of pauses as a dependent variable is considered a reasonable method of studying the internal process of speech production. In the present study, pauses were used to compare two different types of speakers.

Therefore, the general purpose of this study was to describe and compare the pauses that occur in the speech of children who consistently misarticulate two or more sounds as opposed to children who have no consistent misarticulations. The pauses considered were articulatory and hesitation pauses. The subjects produced speech in three different speaking situations. The three speech samples were common to techniques used to elicit speech. The first type was called paraphrased speech. This was essentially repeating back or paraphrasing a short story presented to the child. The second sample was called spontaneous speech and is formulation of a story on the basis of a sequence of pictures. The third speech sample was natural conversation with no structural requirement. The comparison was made in order to gain more information and insight into the speech production process of children with misarticulations and to compare pauses between the three types of speech tasks. Measures of the frequency of occurrence and duration of pauses was used to compare the groups. The misarticulations of these children, particularly those without any perceived structural or organic defects, were considered to be external symptoms of an internal, possibly disordered, process. There was evidence that the phonological system is not the only linguistic level affected in the children with articulation disorders. Shriner, Holloway, and Daniloff (1969) studied the syntactic complexity of children with articulation disorders with no observed organic problem. They compared the performance of these children with normally speaking children. Their conclusion was that children with articulation disorders with no observed organic problem displayed slightly underdeveloped syntactical structures. Their study supported previous research. One possible explanation of this finding was that there are difficulties in producing speech in higher, less obvious processes of language production. An alternative explanation was that children with misarticulations have equal internal processes in terms of planning speech production but do not pay attention to detail in producing speech. If it can be assumed that more pauses with greater mean duration reflect greater weight on the cognitive aspects of language formulation, then it is reasonable to explore the pause patterns of children with misarticulations versus children with no misarticulations. Also differences in articulatory pauses may indicate a difference in the processes related to articulation.

In order to address this issue the following experimental questions were asked.

1. Do differences exist, in terms of duration of pauses and frequency of occurrence of pauses between children with two or more consistent misarticulations and children with no consistent misarticulations in their speech?

   a. Do differences exist in terms of duration of pauses and frequency of occurrence of pauses between the groups on any level of speech sample types; paraphrases speech, spontaneous speech and conversation?

b. Do differences exist between the groups in terms of duration of pause and frequency of occurrence of pause on any level of three duration categories; 10 to 50 msec (articulatory pauses), 51 to 250 msec (mixed articulatory and hesitation pauses), or 251 to 3000 msec (hesitation pauses)?

2. Do differences exist in terms of duration of pauses and frequency of occurrence of pauses between the speech sample types, paraphrased speech, spontaneous speech and conversation?

3. Do differences exist in terms of frequency of occurrence of pauses between the duration categories, 10 to 50 msec, 51 to 250 msec and 251 to 3000 msec?

CHAPTER II

EXPERIMENTAL PROCEDURES

Subject Description and Procedures

Thirty children of kindergarten age participated in the study. The ages ranged from 4-6 to 6-4. Fifteen of the children exhibited two or more misarticulations which were confirmed by traditional diagnostic procedures. The other fifteen had no misarticulations and their speech was judged to be free of any consistent misarticulations, by their teacher, mother, and the experimenter. These two groups were matched by sex and age. The ages matched ± 1 month with the exception of one subject pair which was different in age by 2 months. In other words, a 5-8 male was matched with a 5-7, 5-8, or 5-9 male, and so forth. The mean age for both groups was 5-8.

This age was of interest to the experimenter for several reasons. At this age children are not passing through any major transition in terms of social, linguistic or cognitive development (Kowal, O'Connell, and Sabin, 1965). It is a common age for a child with misarticulations to be identified and possibly enrolled in therapy. Information obtained from a study of children at this age would be applicable to children at the beginning of therapy. Further, by this age a child's phonological and language system are well developed (Dale, 1976). Finally, children of this age are mature enough to cooperate and perform the experimental tasks.

Several diagnostic measures were administered in order to qualify the misarticulation group and more accurately describe and compare the two groups. The misarticulation group had to meet several criteria. In order to be included in the sample, they had to have two or more consistent misarticulations, no perceived structural or organic defect, no language disorder, and normal hearing. The subjects were also equated in terms of mental maturity. Furthermore, the subjects with misarticulations had not previously been enrolled in therapy.

An oral peripheral examination performed with each subject revealed that all subjects had normal structures for articulation. According to the clinical judgment of the experimenter, oral motor ability in the misarticulation group was slightly lower than the normal group. This observation was made on the basis of ratings of various tongue and lip movements. However, the misarticulation group had oral motor ability within normal limits, and no observed motor ability was low enough to impair articulation.

The misarticulation sample exhibited two or more misarticulations as measured by three separate tests of articulation. The Riley Articulation and Language Test (RALT; Riley, 1972) was designed as a screening test for early elementary school children. The articulation section of the RALT samples the four sounds most discriminatory in identifying children with articulation disorders (Riley, 1972). It samples these sounds in two positions. The scoring system takes into account six factors that relate to articulatory development. These factors are the degree of similarity of the misarticulated sound to the target sound, stimulability, number of defective sounds, error consistency, frequency of occurrence of the sound in English, and developmental expectancy. A functional articulation score obtained from the scoring procedure can be compared to norms. The Goldman-Fristoe Test of Articulation (Goldman and Fristoe, 1969) has a sounds-in-words subtest. This subtest samples the consonants of English in three positions in words; the initial position, medial position and final position. Exceptions are the English consonants which are not represented by three positions. The responses are elicited through the use of pictures. The test serves as the traditional articulation inventory. The sound-in-sentences subtest was also administered as one of the methods of obtaining a speech sample. The McDonald Deep Screening Test of Articulation (McDonald, 1964) combines the nine most misarticulated sounds according to research and presents each phoneme in ten different phonemic contexts. Thus, a percentage of correct or incorrect productions can be computed. Each child in the misarticulation group misarticulated two or more consonants on all three articulation tests. In addition, on the McDonald Deep Screening Test of Articulation the misarticulations had to be incorrect at least sixty percent of the time.

The three measures were selected as a check because it is possible to miss a single item on one articulation test yet produce that consonant accurately. The misarticulations were also observed to be present in spontaneous speech, although no formal scoring was completed.

According to the McDonald Deep Screening Test of Articulation the range of misarticulations which were incorrect sixty percent or more was from 2 to 6 consistent misarticulations. The mean consistent misarticulations for the misarticulation group was 3.3. According to the Goldman-Fristoe Test of Articulation the range of errors was from 2 to 12 with a mean of 5.0.

The misarticulation group did not exhibit any language disorders as evidenced by their ability to produce spontaneous utterances and engage in conversation. Subjects who failed to respond to probing, who possessed telegraphic speech, or who responded with consistently short utterances were not included in the sample. Two experienced speech pathologists made a clinical judgment that no language disorder existed and that the primary characteristic of each subject in the misarticulation group was misarticulation of two or more sounds. In addition, each utterance of all of the subjects was judged individually in terms of grammatical and syntactical form. All subjects exhibited definite ability to produce well formed, complex sentences. Although grammatical and syntactical errors were noted within both groups, they were the kind of errors that may be expected of a child their age.

No utterance contained errors deviant enough, nor were the errors frequent enough, to be considered characteristic of a language disorder. Errors consisted of misuse of pronouns and inappropriate use of the "-ed" ending in words such as "sneaked" and "hided". Some of the misarticulation subjects failed to pluralize using the /s/ or /z/ endings. However, this might have been an artifact of their articulation problem. The amount of verbalization was determined by measuring the total duration of the utterances for all of the samples. The amount of verbalization according to this measure was equal between both groups (t = .95).

The language subtest of the RALT was given to each of the subjects. This subtest includes six sentences of increasing length. There are two trials allowed. According to Riley (1974), a sentence repetition task requires adequate perception, imagery, symbolization, conceptualization, and expressive organization. The mean for the misarticulation group was 83. This compares with the mean for the normative group (83) used in obtain the test norms. The mean for the normal group in this study was 95 which was above the mean for the normative group.

In order to obtain a measure of mental maturity, the Columbia Mental Maturity Scale (CMMS; Burgemeister, Blum, and Lorge, 1972) was administered to both groups of subjects. This test consists of a series of plates with three to five items on each plate. The child is instructed to pick out the item that is somehow different from the rest. The plates become increasingly complex, and the child is required to formulate the rule that organizes the pictures in such a way as to exclude just one. Except for several basic items based on perceptual differences, no two plates contain exactly the same rule for organizing the pictures. Thus, each plate requires new thinking to solve the item. The responses require no verbalization. Except for comprehension of the instructions, this is considered a non-verbal test. The authors state that the CMMS is a measure of general reasoning ability and reflects to some degree experience in handling educational tasks. The norms were carefully constructed using 2600 children in 25 states controlled to "ensure that a representative national sample of 200 children was tested at each age level" (p. 9). This included proportionate sampling of occupation, race, geographic, and urban considerations. A standardized score is obtained from the scoring procedure; this score can be converted into percentile rankings and age level. The mean for the misarticulation group in terms of percentile ranking was 53.3 as opposed to 63.7 for the normal group. The means for each group in terms of the standardized score was 102.6 and 106.7 respectively. There were no significant differences between the groups for either set of means (percentile means, $t = 1.40$; standardized score means, $t = 1.08$).

Normal hearing was determined by a bilateral hearing screening at 25 dB HTL at octave frequencies from 250 through 6000 Hz (re ANSI; 1969). All subjects passed the hearing screening except for two, one from each group. Each of these children failed in one ear and currently had a medically confirmed middle ear infection. The parents of both children had never questioned or suspected hearing problems. It was assumed that these children had normal hearing.

Parents were questioned at the end of the session on the basis of a short questionnaire completed during the testing session. No parent reported any major developmental or functional problems.

Procedures

Subjects were obtained through referral by the public school speech pathologists in the Pocatello, Idaho area. A letter was sent explaining the project with a request that the parents be given a letter if their children were potential subjects. The parent letter explained the project and requested permission for their name and telephone number. To ensure confidentiality, no names were given until permission was obtained through a signed permission slip. The parents who gave permission were called and their children were scheduled for an evaluation.

The evaluation procedures and collection of the speech samples lasted approximately one and one-half hours for each subject. There were two phases. The first phase included administration of the oral peripheral examination, the *RALT*, *McDonald Deep Screening Test of Articulation*, and *CMMS*. This took place in a typical university clinic therapy room that was free from distraction and had a table and chairs of appropriate size for children of that age. The second phase involved hearing screening and collection of the three types of speech samples. Since the Goldman-Fristoe Test of Articulation was used for the paraphrased speech sample, the sounds-in-words portion was administered during this phase.

Instructions and comments pertaining to each procedure were read to each subject in a natural conversational manner. All of the procedures occurred in the same order. Every attempt was made to keep each session the same for each subject. The procedures occurred in the following order: 1) introduction to the session; 2) RALT; 3) oral peripheral examination; 4) McDonald Deep Screening Test of Articulation; 5) CMMS; 6) change to IAC 1600 sound suite; 7) hearing screening; 8) sounds-in-words subtest of the Goldman-Fristoe Test of Articulation; 9) paraphrased speech sample; 10) spontaneous speech sample; 11) conversation; 12) follow-up parent interview.

The following procedures were used to obtain the three speech samples. The paraphrased speech sample was obtained by administration of the sounds-in-sentences subtest of the Goldman-Fristoe Test of Articulation. This subtest contains two small stories. A sequence of pictures is shown to each child. Three or four sentences explain each picture. The child then is instructed to tell the entire story as he is shown the appropriate picture. This speech sample is not considered to be spontaneous speech because the entire speech sample is modeled for them. The rationale of this task is to set the pattern for the less structured spontaneous speech tasks. Levin and Silverman (1965) found it more effective to provide their subjects with an example of a story before they formulated one of their own. Another rationale for the use of this sample was its common use as a technique for eliciting speech during articulation therapy. All of the subjects responded well to this task and were able to repeat both stories well.

The picture/story task is also a common technique used in articulation therapy and in obtaining spontaneous speech samples. This task consists of showing a child a sequence of pictures and asking him to tell a story about them. The pictures used were the Travis Story Pictures (1971). The pictures are designed to be ambiguous, thereby facilitating a wide variety of interpretations. Two sets of five pictures were laid on the table before the child. The pictures were sequenced in such a manner as to form a logical sequence of activity. The child was requested to tell a whole story. Prompts were used sparingly but only as necessary.

After completion of the paraphrased speech and spontaneous speech samples, the subjects were told that they had to wait until the equipment turned itself off before they could go. The situation of waiting, effectively defused the structure of the present task-response situation. At this time, non-directive statements of interest to the child were used to elicit natural conversation. The child was not probed or asked to tell about anything. Questions were strictly avoided until the child began talking naturally. When the children were participating in the conversation, non-threatening questions about the subjects being discussed or school trips, pets, toys, etc. were asked naturally and unobtrusively. This was done in order to continue the conversation and obtain an adequate speech sample. This sample was considered a more natural and less restrictive form of spontaneous speech (Hubbell, 1977). All of the subjects responded to this method of eliciting conversation and produced enough utterances for each subject to be included in the analysis.

Equipment and Measurement

To collect the speech samples, a Realistic omni-directional electret condenser microphone (33-1044A) was placed on the table approximately fifteen inches from each subject's mouth. The microphone was routed through from the examination side of the sound suite to the control booth. A Crown 800 reel-to-reel tape recorder was in the control booth to record the samples. An assistant turned the recorder on or off at the experimenter's signal. The samples were collected using Maxell 50-60 sound recording tape. The tape was 1.5 mil and reels of 1200 feet were used. The samples were recorded at a speed of 7½ feet per second.

The original tapes also included experimenter prompts and other interruptions of the subject's spontaneous speech. In preparation for processing, the original tapes were edited to eliminate all but the child's utterances. The output from the Crown 800 was fed into a Crown 700 reel-to-reel tape recorder. Only the subjects utterances were recorded onto the edited tapes. For the purpose of editing, an utterance was defined as a segment of the speech sample in which there are no stoppages or breaks in speech production lasting more than three seconds. Experimenter prompts, interruptions, or stoppages longer than three seconds for any reason defined the boundaries of an utterance. An utterance had to be composed of two or more syllables; however, it may or may not have been a complete syntactic unit. Utterances were separated on the edited tape by four to five seconds using a stopwatch. Thus, experimenter prompts and interruptions were not present in the edited tapes. The different types of speech samples were separated by ten seconds on the edited tapes. The end product consisted of a tape which contained three speech samples. The utterances were separated by four to five seconds and the samples were separated by ten seconds. This spacing gave clear indication of the utterance and sample boundaries; thus, there was no confusion between longer pauses near three seconds and utterance or sample separations.

The edited tapes were processed by a set of instruments designed for detecting and measuring the duration of pauses in speech. This set of instruments was designed by Tosi (1965). It was later described by Tosi (1974) and proposed as a method for studying the speech of different types of speakers. The instruments that make up the pausimeter are divided into three blocks. Block I contains an amplifier, attenuator, and rectifier. Block II contains three Schmitt trigger circuits. Block III consists of an electronic switch. For the purpose of measuring pauses, the input signal is fed into Block I. In this case, the edited tapes were played into Block I of the pausimeter with an Ampex AG600 reel-to-reel tape recorder. The output of Block I is amplified or attenuated such that the average peak amplitudes of the speech signal remain approximately fourteen volts. This adjustment is made by adjusting a dial and reading the voltmeter built into the panel of the pausimeter. Thus, the output of Block I and the input to Block II is a rectified speech wave with the average peak amplitudes approximately at the level of 14 volts. For measuring pauses, two of the three Schmitt trigger circuits are used. The first unit, S_c, is active only when the relative amplitudes of the rectified input are greater than the L_p value specified by the experimenter. As will be recalled, L_p is the value of the intensity parameter specified in the operational definition of a pause (Tosi, 1974). It is the maximum amount of acoustic energy that can be present in a segment of a speech sample and still be considered a pause. This value is selected by means of a decade dial on the panel of the pausimeter. Setting the dial at 95 sets L_p as 95% of the average peak amplitudes of the speech signal. The second circuit, S_p, is activated at a fixed time indicated by T_p. Again, T_p is the amount of time that has to pass with values under L_p in order for a segment to be considered a pause. T_p relates to the time parameter of the operational definition and exists to prevent detection of an intrawave gap. Values of T_p are introduced by selecting a slope of a RC integrator through a panel dial. Setting the dial at 10 sets the lower limit on pauses measured. The output of the S_c circuit is a train of square waves which occur when the signal amplitude is above L_p. Thus, the square waves are as long in duration as the portions of the signal above L_p. When there are no square waves coming from the S_c circuit, values of the signal are less than L_p. Thus, with the time parameter T_p, the pausimeter responds to the two parameters described in the operational definition of a pause. When there are no square waves coming from the S_c circuit, the slope selected by the RC integrator dial intercepts the S_p fixed triggering level after T_p msec's of no square wave from S_c. At this instant, S_p is activated emitting a 10 volt DC pulse. This pulse is deactivated T_p seconds after square waves are emitted by S_c. Therefore, the output of Block II is a 10 volt DC pulse. It occurs for the duration that the intensity value of the signal is lower than L_p. This duration corresponds to the duration of a pause. The output of Block II effectively activates Block III which is an electronic switch. This switch is on as long as a pause is present and is off when the signal is present. The electronic switch in turn allows an 8000 Hz pure tone to pass through into a Hewlett-Packard 5320B timer-counter which counts the durations of the 8000 Hz tones. These durations correspond to the durations of the pauses. A Mohawk Data Sciences Corp. (Model 1200) high speed digital printer then prints the durations on a strip of paper.

The output of the pausimeter is in the form of pause durations printed in the order of occurrence on strips of paper. In addition, the output from the S_c circuit of Block II was fed into a Bruel and Kjaer Graphic Level Recorder (2305). Since the output of S_c is a square wave with a duration that corresponds with the signal above the value of L_p, the graphic level recording indicated when the signal was present and when a pause was present. Pauses were indicated on the graphic recording as a return to baseline. Because of mechanical inertia, it is difficult to measure pauses accurately below 300 msec with graphic level recordings. Even pauses above 300 msec are difficult to measure within 40 msec. However, used in conjunction with the durations printed by the pausimeter, the graphic level recording can be used to indicate the presence of a pause. It also serves as a check of accuracy of the printer. The paper strip with the printed durations and the graphic level recordings were checked against each other, pause by pause, for accuracy. There were only a few minor discrepancies out of approximately 10,000 measured pauses. These discrepancies were assumed to be caused by random failings of the printer or recorder due to the constant requirement for rapid response. To be consistent in dealing with these discrepancies, when a pause duration was missing on the printed tape but present on the graphic level recording, it was added by hand to the tape. Conversely, when a pause was missing on the graphic level recording and present on the printed tape, it was added to the graphic level recording. The discrepancies were so few that there was a negligible effect on the data. As a further check, the utterance separations which showed up as a pause of about four to five seconds were measured by hand and checked against the printed duration. The measured durations from the graphic level recordings correlated perfectly with the printed durations coming from the pausimeter.

Data Analysis

Data reduction consisted of organizing and manipulating approximately 10,000 pause durations and deriving four values that served as dependent variables. The four values were as follows: A frequency ratio (FR) was used as a measure of the frequency of occurrence of pauses. The FR was derived by dividing the total length of the utterances in a sample by the number of pauses in that sample. The FR is an indication of how much speaking time, on the average, passes before an occurrence of a pause. In many other studies, standard reading samples were used which allowed for a direct comparison of the number of pauses. The FR effectively equates speech samples that vary in length from subject to subject. The next three measures, mean duration of pauses (MP), variability of duration of pauses (VP), and percentage of pause time with respect to utterance duration (PP), were values derived from the pause duration. The PP was computed by dividing the total duration of pauses by the total utterance lengths of the sample.

The VP was the standard deviation of the pause durations.

The data were handled by an IBM 370-125 computer using a standard data reduction program. The output of the computer program provided the four values needed for analysis as well as other information such as utterance length and overall values across speech samples. The printout also listed the pauses by category. The printout was checked against the raw data for errors.

The four dependent variables were FR, MP, VP, and PP. There were three independent variables. The first variable is a grouping factor with two levels, misarticulation and normal. The second factor was speech sample types with three levels: paraphrased speech, spontaneous speech, and conversation. The third independent variable was duration categories; 10-50, 51-250, 251-3000 msec. Four three way ANOVA's with fixed effects and repeated measures were computed (Winer, 1972).

CHAPTER III

RESULTS

Overview of the Results

The basic questions addressed in this study concerned the differences in four derived measures of pauses between two types of speakers. The first group of speakers were children with two or more consistent misarticulations. These speakers were compared to children without any consistent misarticulations. The experimental questions asked whether there were any differences between groups in terms of the four derived measures of pauses. The first three derived measures related to the duration of pauses. They were (MP), mean duration of pauses; (PP), percentage of pause time with respect to total duration of utterances; and (VP), variability of pause duration. The variability of pause time was the standard deviations of the pause durations. This value was considered to be a value of variability of pauses. The last derived measure related to the frequency of occurrence of pauses. It was a ratio between the total length of the utterances in a speech sample and the number of pauses in that sample. The frequency ratio (FR) effectively equated the samples between the subjects so that frequency of occurrence of pauses can be compared between groups.

These derived measures were compared between the groups using three different types of speech samples; paraphrased speech, spontaneous speech, and conversation. Pauses were measured in three duration categories; 10-50 msec, 51-250 msec and 251-3000 msec. The first duration category was considered to be purely articulatory pauses. The second category was considered to be a mixture of articulatory pauses and hesitation pauses. The third category was considered to be hesitation pauses.

In general, the results showed that there was no difference between the two groups in terms of the derived measure MP, PP, VP, and FR. There was a significant difference between speech sample types for the derived measures related to duration, MP, PP, and VP. There was not a significant difference for FR between the speech sample types. There was a significant difference between duration categories for the FR measures.

Spontaneous speech accounted for most of the variance and had the highest MP, PP and VP values. There was an interaction between speech sample types and duration categories on all four measures. There was an increase in the duration measure during conversational speech for the duration category 251-3000 msec. The pauses in this category were considered to be hesitation pauses. For the FR measure there was a trend toward a decrease in longer pauses (251-3000 msec) and an increase in shorter pauses (10-50 msec; and 51-250 msec) during conversation.

Duration Measures

Mean Duration of Pauses, MP. The significance of these results was determined by four three-way analysis of variance (ANOVA's) with repeated measures and fixed effects. Table 1 presents the ANOVA for the derived measure MP. There were no significant differences between the two groups in terms of mean duration of pauses. There was a significant difference at the 0.01 level of significance between speech sample types. A Newman-Keuls' test of main effects indicated that spontaneous speech differed significantly ($p \leq 0.05$) from paraphrased speech and conversation. However, paraphrased speech and conversation did not differ in terms of the MP measure. An interaction was found (0.01 level of significance) between speech sample types and duration. Figure 1 illustrates this interaction. It can be seen that the mean duration of pauses was higher during spontaneous speech for hesitation pauses, or pauses between 251 and 3000 msec.

Table 2 presents the mean duration of pauses for the two groups. The values are presented for each speech sample type and each duration category within that speech sample type. A visual inspection of the table indicates the similarity of mean durations for the two groups. Between the speaking samples it will be noted that the mean durations for spontaneous speech in the 251 to 3000 msec duration category have higher values.

Table 1. Analysis of variance for the derived measure MP

Source	d/f	Sums of Squares	Mean Square	F
Groups (G)	1	23154.94	23154.94	1.11
Error	28	585815.06	20921.96	
Speech Types (S)	2	179757.69	89878.81	9.20*
S x G	2	7639.62	3819.81	.39
Error	56	546877.06	9765.66	
Duration Categories (D)	2	32229760.00	16114880.00	780.87*
D x G	2	54257.00	27128.50	1.31
Error	56	1155675.00	20637.05	
S x D	4	368958.00	92239.50	9.09*
S x D x G	4	13043.00	3260.75	0.32
Error	112	1136043.00	10143.23828	

*Significant at the 0.01 level of significance.

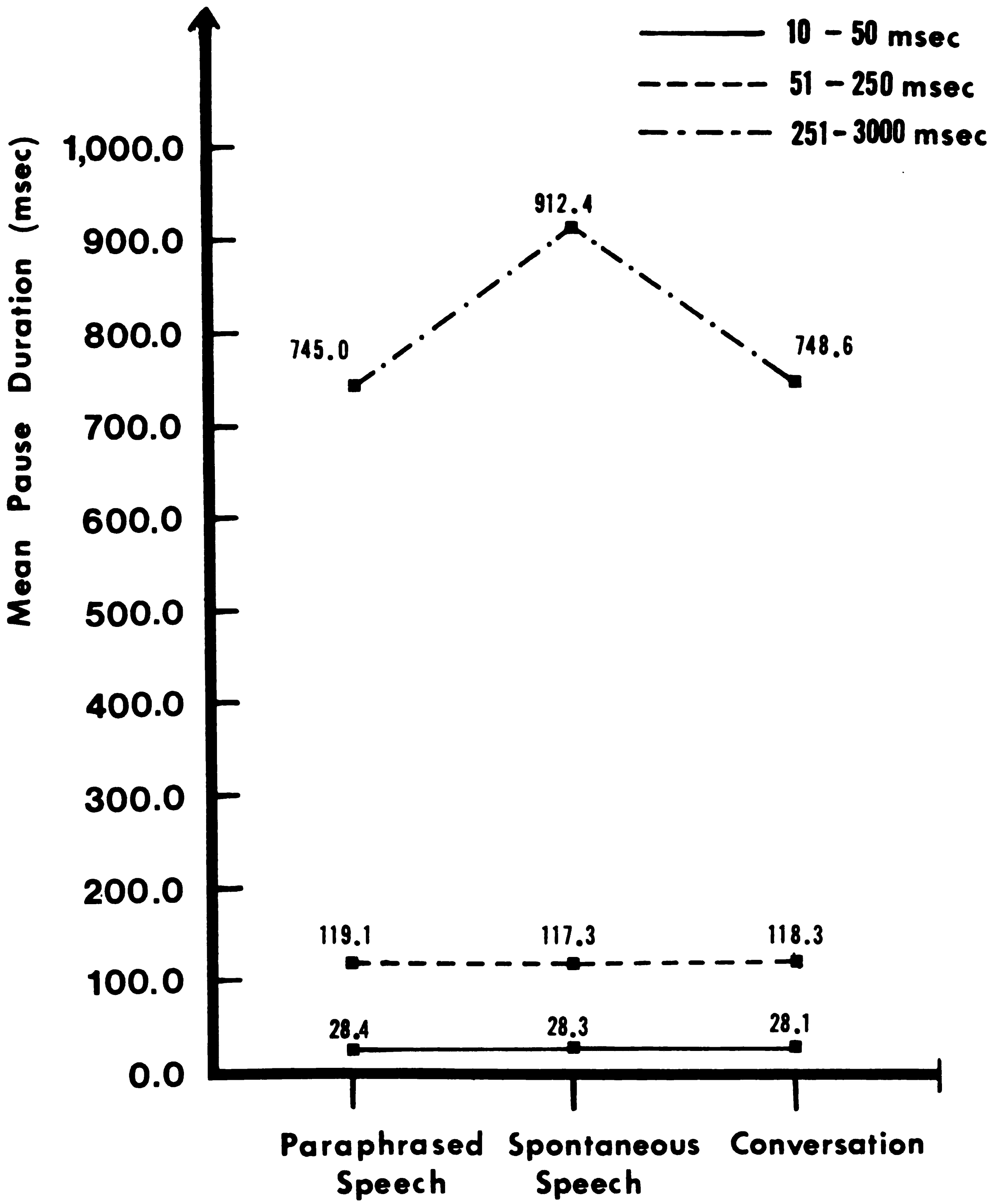

Figure 1. Interaction for MP between speech sample types and duration categories.

Table 2. Group means for the derived measure MP

Sample Type	Duration Category		Misarticulation	Non-Misarticulation
Paraphrased Speech	10-50 msec	$\bar{X}$	28.4	28.4
		SD	2.7	2.1
	51-250 msec	$\bar{X}$	121.5	116.8
		SD	6.8	13.0
	251-3000 msec	$\bar{X}$	735.7	754.8
		SD	129.4	86.6
Spontaneous Speech	10-50 msec	$\bar{X}$	27.8	28.7
		SD	4.2	1.9
	51-250 msec	$\bar{X}$	119.9	114.8
		SD	7.7	16.8
	251-3000 msec	$\bar{X}$	879.8	945.1
		SD	241.9	215.7
Conversation	10-50 msec	$\bar{X}$	28.5	27.8
		SD	2.9	2.6
	51-250 msec	$\bar{X}$	118.1	118.6
		SD	9.7	15.92
	251-300 msec	$\bar{X}$	702.8	794.5
		SD	227.0	250.7

Percentage of Pause Time with respect to Utterance Duration, PP. Table 3 presents the ANOVA for the derived value PP. There were no significant differences between the groups in any level of duration category or speech type. There was a significant difference ($p \leq 0.01$) between speech sample types. A Newman-Keuls' test of main effects ($p \leq 0.05$) indicated that the percentage of pause time with respect to utterance duration was significantly different between spontaneous speech and paraphrased speech and conversation and between conversation and paraphrased speech. There was a higher value for PP in spontaneous speech followed by paraphrased speech and then conversation. An interaction was found (significant at the 0.01 level) between speech sample types and duration categories. Figure 2 illustrates this interaction. For spontaneous speech there was a higher percentage of pause time with respect to utterance duration in the duration category of 251 to 3000 msec. In this same duration category there was a lower percentage of pauses with respect to utterance duration during conversation.

Table 4 presents the PP values for the two groups. A visual inspection of this table indicates that there was a low PP value in the first duration category for each speech sample type. Rounded to two places the PP value in each speech sample type in the 10 to 50 millisecond category was 1% with respect to utterance duration. The percentage of pause time with respect to utterance duration in the second duration category of 51-250 msec was 4 to 6%. The percentage

Table 3. Analysis of variance for the derived measure PP.

Source	d/f	Sums of Squares	Mean Square	F
Groups (G)	1	0.01000	0.01000	2.11
Error	28	0.13271	0.00474	
Speech Types (S)	2	0.09453	0.04726	38.47*
S x G	2	0.00540	0.00270	2.20
Error	56	0.06881	0.00123	
Duration Categories (D)	2	4.96820	2.48410	383.12*
D x G	2	0.00591	0.00296	.46
Error	56	0.36310	0.00648	
S x D	4	.21881	.05470	36.84*
S x D x G	4	.00792	.00198	1.33
Error	112	.16630	.00148	

*Significant at the 0.01 level of significance.

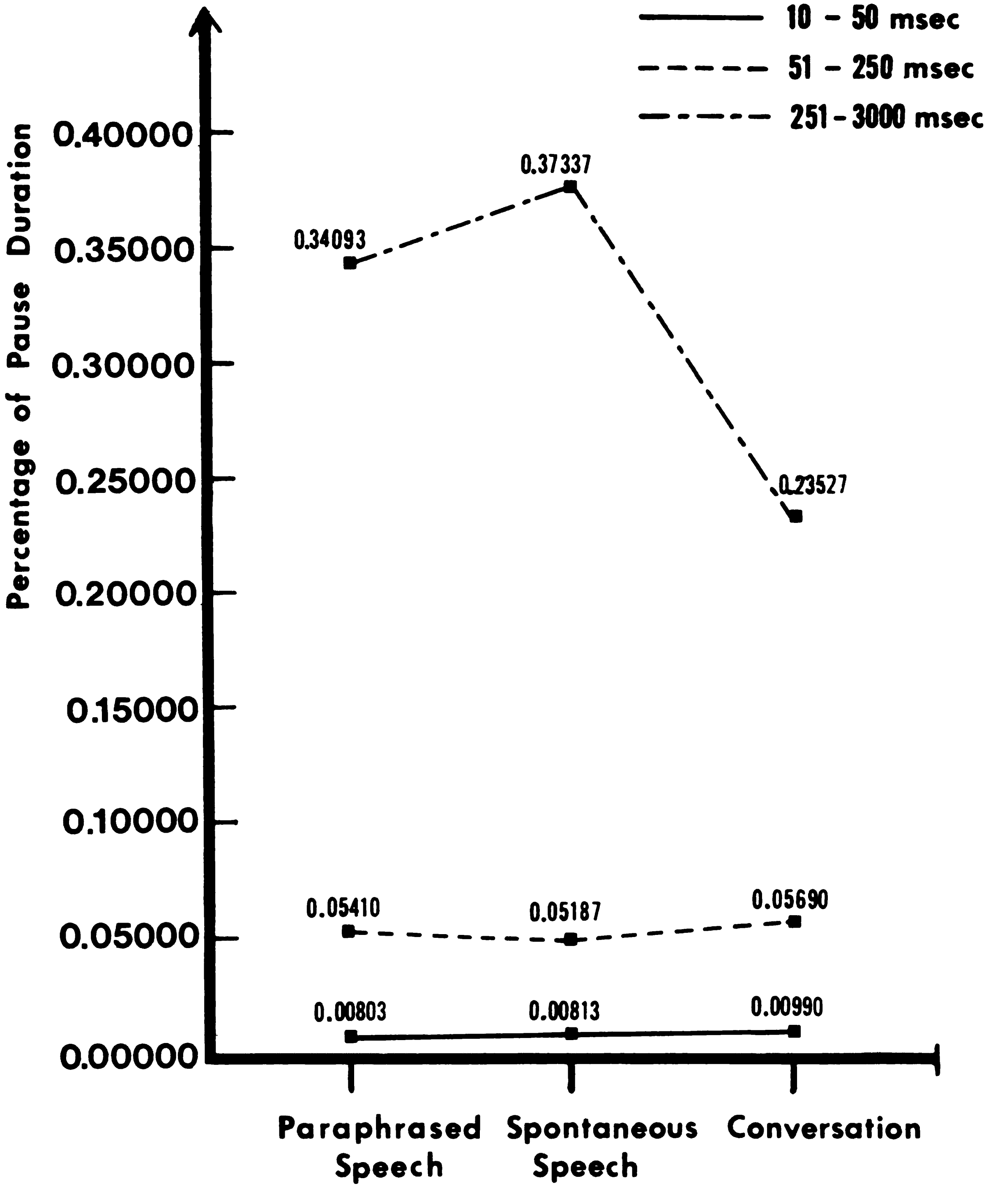

Figure 2. Interaction for PP between speech sample types and duration categories.

Table 4. Group means for the derived measure PP.

Sample Type	Duration Category		Misarticulation	Non-Misarticulation
Paraphrased Speech	10-50 msec	$\overline{X}$	.00767	.00840
		SD	.00315	.00304
	51-250 msec	$\overline{X}$	.06327	.04493
		SD	.01780	.01001
	251-3000 msec	$\overline{X}$	.36773	.31413
		SD	.09528	.07074
Spontaneous Speech	10-50 msec	$\overline{X}$	.00800	.00827
		SD	.00344	.00287
	51-250 msec	$\overline{X}$	.05980	.04393
		SD	.02243	.02069
	251-3000 msec	$\overline{X}$	.38180	.36493
		SD	.10692	.09114
Conversation	10-50 msec	$\overline{X}$	.00967	.01013
		SD	.00356	.00366
	51-250 msec	$\overline{X}$	.06253	.05127
		SD	.01291	.01721
	251-3000 msec	$\overline{X}$	.23280	.23773
		SD	.09996	.08076

of pause time with respect to utterance duration in the hesitation pause or 251-3000 msec category ranges from 23 to 38%. The percentage of pause time with respect to utterance duration in this category went up during spontaneous speech and down during conversation.

Variability of Pause Duration, VP. The standard deviation of pause duration was used as score data to indicate variability in pause duration. Table 5 presents the ANOVA for the derived measure VP. There were no significant differences between groups in terms of VP. There was significnat difference at the 0.01 level of significance between speech sample types. A Newman-Keuls' test of main effects indicated that spontaneous speech differed significantly ($p \leq 0.05$) from paraphrased speech and conversation and that conversation differed from paraphrased speech. According to the Newman-Keuls' ranking, conversation displayed the least variability of pause duration followed by paraphrased speech. Spontaneous speech displayed the most variability of pause duration. An interaction was found between speech sample types and duration categories. Figure 3 illustrates this interaction. The variability of pause duration increased during spontaneous speech and decreased during conversation for the duration category of 251 to 3000 msec. Table 6 presents the standard deviations for the two groups. The values are presented for each speech sample type and each duration category. Visual inspection confirms the statistical analysis.

Table 5. Analysis of variance for the derived measure VP.

Source	d/f	Sums of Squares	Mean Square	F
Groups (G)	1	10237.88	10237.88	.88
Error	28	326870.62	11673.95	
Speech Types (S)	2	100455.50	50227.75	7.46*
S x G	2	2709.62	1354.81	.20
Error	56	377284.69	6737.23	
Duration Categories (D)	2	14533162.00	7266581.00	599.62*
D x G	2	22604.81	11302.41	.93
Error	56	678644.88	12118.66	
S x D	4	195796.44	48949.11	7.49*
S x D x G	4	6355.00	1588.75	.24
Error	112	731471.50	6530.99	

*Significant at the 0.01 level of significance.

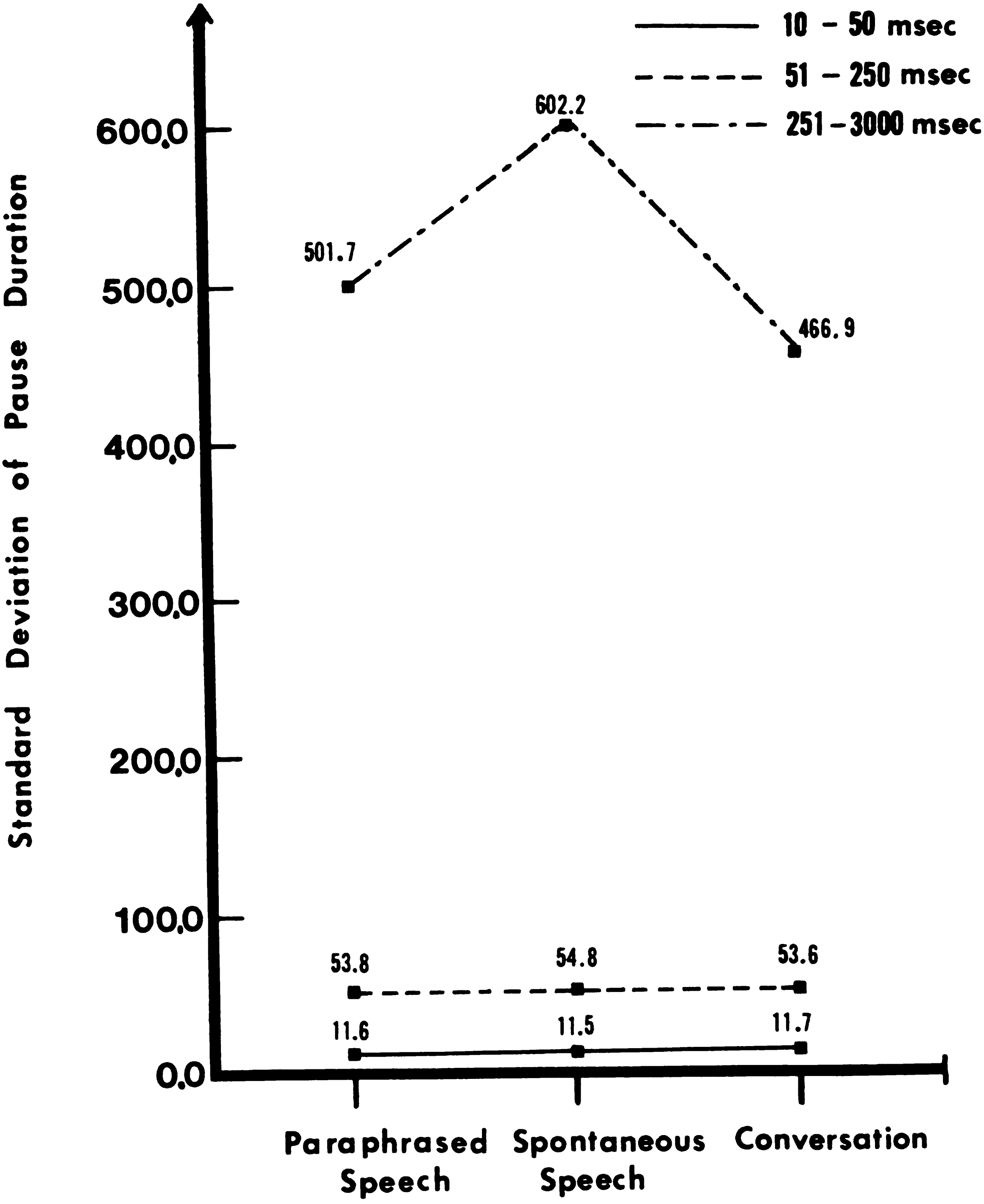

Figure 3. Interaction for VP between speech sample types and duration categories.

Table 6. Group means for the derived measure VP.

Sample Type	Duration Category		Misarticulation	Non-Misarticulation
Paraphrased Speech	10-50 msec	$\bar{X}$	11.65833	11.52199
		SD	.90418	1.15763
	51-250 msec	$\bar{X}$	54.06339	53.52692
		SD	3.52032	9.57310
	251-3000 msec	$\bar{X}$	494.75342	508.59790
		SD	124.57178	80.10886
Spontaneous Speech	10-50 msec	$\bar{X}$	11.61992	11.46333
		SD	1.10054	1.92996
	51-250 msec	$\bar{X}$	56.35536	53.30351
		SD	5.77231	8.96697
	251-3000 msec	$\bar{X}$	570.78125	633.68638
		SD	170.86725	160.16838
Conversation	10-50 msec	$\bar{X}$	11.45753	11.91659
		SD	1.82098	1.72767
	51-250 msec	$\bar{X}$	53.70525	53.41472
		SD	6.44296	14.66292
	251-3000 msec	$\bar{X}$	448.04297	485.83911
		SD	199.59419	184.14407

Frequency Measure

Frequency Ratio. Table 7 presents the ANOVA for the FR derived measure. This is the only measure having to do with the frequency of occurrence of pauses. There were no significant differences between the two groups in terms of the derived measure FR. There were also no significant differences between the speech sample types. This was a different result than the derived measures relating to duration. There was a significant difference ($p \leq 0.05$) between duration categories. A Newman-Keuls' test of main effects indicated that the most pauses occurred in the 51 to 250 msec duration category. This was followed by the 251 to 3000 msec category. The least number of pauses was in the 10 to 50 msec category. All duration categories were significantly different from each other. An interaction was found between speech sample types and duration categories ($p \leq 0.05$ level of significance). Figure 4 illustrates this interaction. Apparently, the number of pauses tended to decrease in frequency of occurrence in the 251 to 3000 msec duration category during conversation; and the number of pauses in the shorter duration categories of 10 to 50 msec and 51 to 250 msec tended to increase in frequency of occurrence.

Table 8 presents the frequency ratios for each speech sample type and duration category. The mean ratios for each group appeared to have no general pattern except that there were fewer pauses for the 10 to 50 msec category barring an overlap during conversation between the 10 to 50 msec and 51

Table 7. Analysis of variance for the derived measure FR.

Source	d/f	Sums of Squares	Mean Square	F
Groups (G)	1	7584.00	7584.00	.00
Error	28	216449376.00	7730334.00	
Speech Types (S)	2	12060496.00	6030248.00	1.50
S x G	2	2030144.00	1015072.00	.25
Error	56	225511984.00	4026999.00	
Duration Categories (D)	2	148416256.00	74208128.00	9.49*
D x G	2	34881792.00	17440896.00	2.23
Error	56	437936896.00	7820301.00	
S x D	4	51671552.00	12917888.00	3.15**
S x D x G	4	9096704.00	2274176.00	.55
Error	112			

*Significant at the 0.01 level of significance.
**Significant at the 0.05 level of significance.

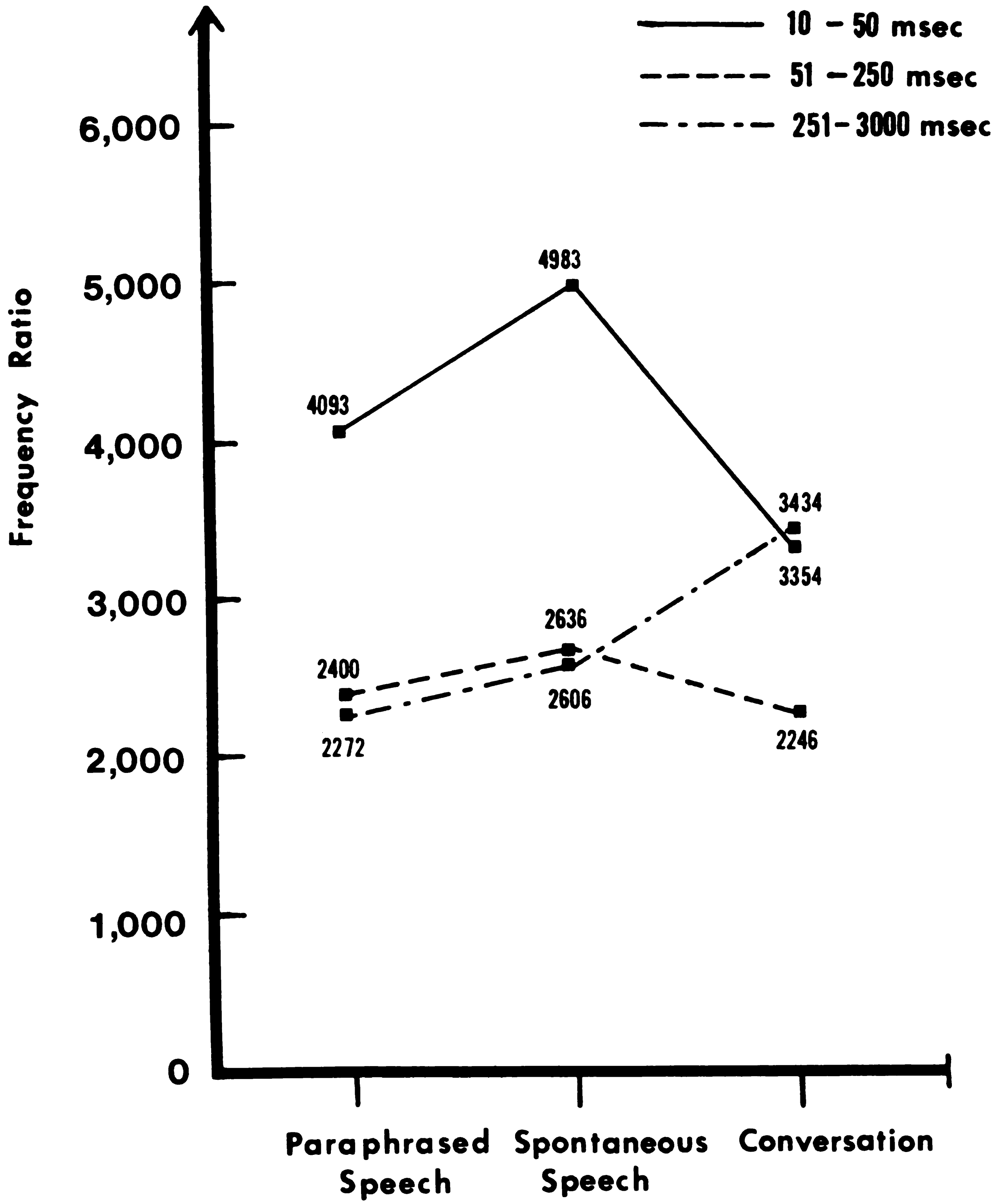

Figure 4. Interaction for FR between speech sample types and duration categories.

Table 8. Group means for the derived measure FR.

Sample Type	Duration Category		Misarticulation	Non-Misarticulation
Paraphrased Speech	10-50 msec	$\overline{X}$	4347.1	3840.0
		SD	1810.66	1531.35
	51-250 msec	$\overline{X}$	2102.9	2697.3
		SD	723.67	572.02
	251-3000 msec	$\overline{X}$	2053.4	2493.6
		SD	313.34	477.47
Spontaneous Speech	10-50 msec	$\overline{X}$	5966.2	4001.3
		SD	8462.66	1540.12
	51-250 msec	$\overline{X}$	2242.7	3029.4
		SD	724.75	1281.03
	251-3000 msec	$\overline{X}$	2360.6	2851.5
		SD	510.50	1625.46
Conversation	10-50 msec	$\overline{X}$	3610.8	3097.6
		SD	2205.38	1148.79
	51-250 msec	$\overline{X}$	1973.8	2519.9
		SD	502.20	775.63
	251-3000 msec	$\overline{X}$	3323.1	3546.5
		SD	1082.73	1256.93

250 msec duration categories. The means between the groups appeared to be more variable than the duration derived measures, and the direction of the difference varied between the groups.

<u>Summary of the Results</u>

In summary, the results show that there was no difference in the frequency of occurrence or pause duration according to four derived measures of pauses between children with two or more consistent misarticulations and children without consistent misarticulations. There was a significant difference between speech sample types in terms of the derived measures related to duration. For the variable MP, spontaneous speech differed from paraphrased speech and conversation. However, conversation did not differ from paraphrased speech. For the variables PP and VP, spontaneous speech differed from paraphrased speech and conversation; and conversation differed from paraphrased speech. For the derived measure related to frequency of occurrence of pauses, there was no difference between the groups although there was variability in both directions between groups. There was also no difference between speech sample types. According to the analysis, there were significant differences in frequency of occurrence of pauses between each duration category. The 10 to 50 msec category had the fewest pauses, followed by the 251 to 3000 msec category. Overall, the 51 to 250 msec category had the most pauses; but this varied within speech sample types and between groups. There was an interaction on all four derived measures between speech sample types and duration categories. For the most part, the duration measures increased during spontaneous speech for the 251 to 3000 msec category. For the frequency measure there was a decrease in pauses in the above category and an increase in pauses for the shorter 10 to 50 msec and 51 to 250 msec duration categories.

CHAPTER IV

DISCUSSION AND CONCLUSIONS

Summary of the Results

The purpose of this research was to study the pauses that occur in the speech of children with two or more consistent misarticulations versus children with no consistent misarticulations. This study was unique since very few researchers have studied pauses in speakers with any kind of a communication problem. Also, only two authors, Tosi (1974) and Goldman-Eisler (1968) have delt with articulation pauses to any extent.

The question was asked, do differences exist between the two groups of children in terms of four derived measures of pauses: mean pause duration, MP; percentage of pause time with respect to utterance duration, PP; variability of pause duration (standard deviation of pause duration), VP; and number of pauses, frequency ratio, FR? According to the results of this study, the answer was that there are no differences between the two groups in terms of these derived measures of pauses.

The question was also asked, do differences exist between different types of speech samples? The speech sample types were paraphrased speech, spontaneous speech, and conversation.

In this study it was found that differences in pause measures do exist between speech sample types. For the measure MP there was a difference between spontaneous speech and paraphrased and conversational speech but not between paraphrased speech and conversation. For the measures PP and VP, there was a difference between spontaneous speech and paraphrased speech and conversation and between paraphrased speech and conversation. For the measure FR no difference between speech sample types was found.

Finally the question was asked, are there differences between the groups in terms of three duration categories of pauses? There was an interest in determining differences between groups on articulatory pauses since one of the groups consisted of children with consistent misarticulations. The first duration category, 10 to 50 msec, was considered to consist of articulatory pauses only. The third duration category 251 to 3000 msec was considered to consist of hesitation pauses. The 51 to 250 msec duration category was considered to have a mixture of hesitation and articulatory pauses. These categories were formed to see whether there were any differences between the two groups on the four derived measures in terms of articulatory pauses or hesitation pauses. There were no differences found between groups. It was found that there were significant differences in the frequency of occurrence of pauses between the duration categories. The first category (10-50 msec) had the fewest pauses, the second category (51-250 msec) had the most, and the third category (251-3000 msec) was between the first and second duration categories.

On all four of the derived measures of pauses there was an interaction between speech sample types and duration categories. For the measures related to duration, the interaction was between the 251 to 3000 msec duration category and spontaneous speech and conversation. All of the values increased during spontaneous speech. For PP and VP, the values decreased during conversational speech. There was no interaction in the first two duration categories across speech sample types. For the derived measure related to frequency of occurrence, FR, the interaction was more complicated; however, in general it appears that there was a trend toward longer pauses becoming less frequent and shorter pauses becoming more frequent during conversation.

Interpretation of the Results

It is the purpose of the following section to discuss the meaning of these results further. They will first be discussed in terms of the duration measures, main effects, and interaction between the main for the measures MP, PP, and VP. Then the measure related to frequency, FR will be discussed in terms of the main effects and the interaction between the main effects. Finally research and clinical implications will be discussed.

Duration Measures, MP, PP, and VP. Most studies regarding pauses use some type of measure of duration of pauses (Levin and Silverman, 1965; Levin, Silverman and Ford, 1967; Goldman-Eisler, 1968; Kowal, O'Connell and Sabin, 1975; and Hawkins, 1971). Percentage of pause time with respect to total speaking time is not used as often as mean duration of pauses. The variability of pause duration, VP, has not previously been used as a dependent variable, but Canter (1963) discusses the variability of pauses in his Parkinsonian subjects. Variability of pause time was actually the standard deviations of pause durations and was a value representing the average range of pause durations; thus it was called variability of pause duration. The general conclusion in these studies has been that an increase in the duration of pauses reflects upon the internal organizing process of speech production. If the duration values were higher, then it was usually concluded that speaking tasks are more difficult.

The fact that there was no difference between the two groups in this study in terms of the MP, PP, and VP measures indicates that children with consistent misarticulations do not take longer to formulate speech than children without misarticulations. Thus, in spite of consistent errors in speech production, they do not have more difficulty with the internal process of formulating speech. Thus, if increased duration of pauses reflects increased complexity of sentence formulation, then it can be assumed that children with consistent misarticulations are not making errors in their speech because of increased difficulty in formulating speech. This conclusion may be evidence that misarticulations occur because of a more surface level of processing such as motor planning or attention to detail in motor execution.

In this project the misarticulation group was assumed to be a homogeneous group. However, the range of misarticulations was from 2 to 12 errors. There may be a difference between groups if they were divided in terms of number of consistent misarticulations. Differences in pause patterns depending on severity of misarticulations may affect the above general conclusion which was the group as a whole.

The results of this study do show that there were differences between the speech sample types with respect to the derived measures of pause duration. Spontaneous speech produces the highest values on all three derived measures relating to duration. These higher values occur only in the duration category 251 to 3000 msec. The spontaneous speech task required each subject to look at a sequence of pictures and explain the actions in the pictures in the form of a story. The conclusion based on the results of this study is that spontaneous speech is a more diffcult speech task than paraphrased speech or conversation because it places greater weight on the internal speech production process.

This finding correlates with the findings of other studies. Goldman-Eisler (1968) concluded that explanation of cartoons produced higher mean duration than did description. Her reasoning was that features for description were more available to the speaker, thus easing the speech formulation process. In the explanation task, speakers had to first formulate relationships between the features of the cartoon and express these. Paraphrased speech may relate to description in that the features are more readily available. Since the story is provided for the children during the paraphrased speech task, they do not have to formulate new ideas about the pictures. If paraphrased speech can be said to relate to description in that the features are more readily available and if spontaneous speech relates to explanation in that they both involve formulation of ideas, then the results of Goldman-Eisler and this study are similar. Levin, Silverman, and Ford (1967) concluded from their results that describing physical demonstrations was easier than explaining them. Thet based this conclusion on measures of the duration of pauses as well as other hesitation variables included in their study. Kowal, O'Connell and Sabin (1975) used a spontaneous speech task to study pauses across a wide range of ages in children. The subjects told stories from a cartoon sequence. They compared their results with a previous study using reading samples. Their conclusion was that there was a higher mean duration of pauses during spontaneous speech. Rochester, Thurston and Rupp (1977) were the only authors that did not find higher duration values for explanation of cartoons as opposed to description.

During conversation there was a marked reduction in duration measures in comparison with spontaneous speech. The MP value was equal with paraphrased speech, but the PP and VP values are lower than the other two speech sample types. It was reasoned that during conversation the utterances were produced with no structured request or requirement for speech production. This reduction could relate to the conclusion by Levin and Silverman and Ford (1967) that the duration of pauses is related to the automaticity or availability of speech. Since conversational utterances were voluntary, children expressed the thoughts that occurred to them. A case can be made that these thoughts are more readily available and more easily converted to the spoken word. Rochester and Gill (1973) used dialogue and monologue as speech samples. They found that dialogue produced a lower percentage of pause time also. This result indicates that speech production during conversation takes less time and is easier to formulate. Levin, Silverman and Ford (1967) noted that when children produced utterances voluntarily after the required task, there was less pause duration. They attributed this to the fact that voluntary utterances were more readily available to the children and therefore were easier to produce.

For all three derived measures of duration there was a significant interaction between speech sample types and duration categories. According to analysis, the interaction was between the duration category of 251 to 3000 msec and the three speech sample types. In the duration categories 10 to 50 msec and 51 to 250 msec the values of the derived duration measures remained constant. This indicates that there is a division in terms of the function of pauses between the first two duration categories and hesitation pauses. This supports Goldman-Eisler's (1968) lower limit of 250 msec for hesitation pauses.

Frequency Measure, FR. FR was the only derived measure related to frequency of occurrence of pauses used in this study. According to an analysis of this measure there was no difference between groups. There were no significant differences in the number of pauses that occur between speech sample types. This places more importance on the duration measures for finding differences between speech sample types. It also establishes some degree of independence between the duration and frequency measures. In other words, duration measures may vary significantly across speech samples, whereas the number of pauses that occur does not. There was a significant difference for FR between duration categories. Significance was found between any combination of the duration categories. The most pauses occurred in the 51 to 250 msec duration category. Fewer pauses occurred in the hesitation pause category 251 to 3000 msec, and the fewest number of pauses occurred in the 10 to 50 msec category. The interesting point of this analysis is not the order of the duration categories in terms of FR but the significant interaction between speech sample types and duration categories. It appears that there was a trend towards more short pauses (10 to 50 msec and 51 to 250 msec) and fewer long pauses (251 to 3000 msec) during conversation. This result could relate to the decrease of PP and VP during conversation. Again, conversational utterances are probably more available and take less time to produce. Thus, there are long pauses and more short pauses. This trade off, in turn, caused the number of pauses to be equal between the speech sample types.

It is possible that the analysis used in this research artifactually reduced the FR value. The FR ratio was formed by dividing the total utterance duration by the number of pauses. The total utterance length includes pauses in other duration categories. This could have possibly introduced a bias into the analysis in terms of the FR measure. Further analysis is recommended to determine the validity of this alternative to the FR measure.

Research and Clinical Implications. More questions were generated during the process of this project than were answered. Pauses are a valuable dependent variable and can add much to the description of speech production. Since articulatory pauses have not been studied extensively, more work should be done to classify these pauses and to relate them to the speech production process. Generally, articulatory pauses are thought to be a result of plosives, low intensity fricatives or vocal fold vibrations (Love and Jeffress, 1971). However, this may not be the whole story. For example, why was there a trend towards more short pauses during conversation? Does this mean there were more plosives, low intensity fricatives or voice breaks during conversation? To the author's knowledge, no research has addressed this question.

More work is needed in discovering and differentiating other types of pauses. A conclusion of this study was that there was a valid division between pauses above 250 msec and pauses below 250 msec. However, there may be further divisions and types of pauses within these categories.

One possible division is the syntactic pause, which is mentioned in Fodor, Bever and Garrett (1974). The state of the act is not to the point where syntactic pauses can be separated from hesitation or articulatory pauses. With new techniques regarding analysis of the location of pause, it may be possible to sort out which pauses serve to disambiguate a sequence of morphemes.

The trend in studying children and different types of speakers should be continued. For example, pauses may differentiate children with a primary problem of articulation from children with a primary problem of language. Preliminary work has already been able to differentiate stutterers from clutterers (Hutchinson and Burke, 1973; and Rieber, Breskin and Jaffe, 1972); fluent speakers from stutterers (Love and Jeffress, 1971); and stutterers before and after therapy (Love, Starbuck and Christensen, 1971). It is also possible that children and adults with voice problems have voice breaks that would show up as pauses.

The use of different types of speaking situations may also provide useful information. Caution is suggested in using reading samples only. Several types of speaking situations should be used in collecting normative data, since all of the research indicates that there is a difference in pause measurements depending on the type of speaking sample. Since younger children can't read, reading samples can't be used. However, reading samples are useful for providing equated samples using adults. If reading samples could be shown to be related to paraphrased speech or sentence repetition, then research using reading samples used for adults or adolescents could be related to research using connected samples for children.

Another possible area of research is correlation of speech with other types of hesitations phenomena such as filled pauses or phoneme reversals. Some authors have found correlations between pauses and these hesitation variables; but this correlation may not be always true. Children with misarticulations may have more filled pauses than children without misarticulations. The correlation between pauses on hesitation variables found in adults may break down in children with misarticulations because of more difficulty in motor planning or attention to detail during motor execution.

On the basis of these results, implications for direct clinical application are less apparent than implications for research. However, the eventual goal of this line of research is clinical application. At this point there are only ideas not definite suggestions. More information is needed before definite suggestions are proposed for application. In the future, if differences are found, pauses may be used as a diagnostic tool (Love and Jeffress, 1971; Rieber, Breskin and Jaffee, 1972). As electronic equipment becomes increasingly more sophisticated, there is an increasing possibility that a computer-based device could be developed that would provide quick and definitive analysis of pauses for diagnostic purposes. Future clinical applications may come from research on types of speech tasks. For example, it may be advantageous to use paraphrased speech in articulation therapy before attempting carry over into spontaneous speech, since spontaneous speech is more difficult to produce.

Summary of the Research Project

The experimental questions asked in this study were as follows:

1. Do differences exist, in terms of duration of pauses and frequency of occurrence of pauses between children with two or more consistent misarticulations and children with no consistent misarticulations in their speech?

   a. Do differences exist in terms of duration of pauses and frequency of occurrence of pauses between the groups on any level of speech sample types; paraphrased speech, spontaneous speech and conversation?

   b. Do differences exist between the groups in terms of duration of pauses and frequency of occurrence of pauses on any level of three duration categories: 10 to 50 msec (articulatory pauses), 51 to 250 msec (mixed articulatory and hesitation pauses), or 251 to 3000 msec (hesitation pauses)?

2. Do differences exist in terms of duration of pauses and frequency of occurrence of pauses between the speech sample types, paraphrased speech, spontaneous speech and conversation?

3. Do differences exist in terms of frequency of occurrence between the duration categories: 10 to 50 msec, 51 to

250 msec and 251 to 3000 msec?

According to an analysis of the data obtained in this study:

1. There were no differences in terms of duration of frequency of pauses between children with two or more consistent misarticulations and children with no consistent misarticulations on any level of speech sample type or duration category.

2. There were differences between speech sample types in terms of duration but not in terms of frequency. Generally the duration of pauses increases during spontaneous speech and decreases during conversation.

3. There were differences between duration categories in terms of the frequency of occurrence of pauses. The most pauses occur in the 51 to 250 msec category followed by the 251 to 3000 msec category with the fewest pauses in the 10 to 50 msec duration category.

4. There was a significant interaction in terms of duration and frequency of occurrence of pauses between speech sample types and duration categories. Generally, the interaction was between the 251 to 3000 msec duration category and spontaneous speech and conversation. In terms of frequency of occurrence, there was a reduction of longer pauses and an increase of shorter pauses during conversation.

The conclusions made on the basis of the results are as follows:

1. Children with two or more consistent misarticulations do not have more difficulty with the internal process of speech formulation than children with no consistent misarticulations.

2. Children with consistent misarticulations are not producing errors due to difficulty with the internal process of formulating speech.

3. Spontaneous speech takes longer and is harder to formulate than paraphrased speech or conversation.

4. Conversation requires the least time and is the easiest to produce.

5. In terms of duration measures, there is a general division between pauses above 250 msec and pauses below 250 msec.

The following recommendations are made in regard to future research:

1. Continue work comparing pauses in children with and without communication disorders.

   a. Develop the measurement of pauses as a diagnostic tool.

   b. Develop hierarchies of speech tasks for use in remediation programs.

2. Increase the control in studying articulatory and hesitation pauses to obtain more definitive classifications of these pauses and to obtain clearer relationships between them and characteristics of the articulatory process and the speech production process.

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APPENDICES

APPENDIX A

LETTER TO PARENTS OF CHILDREN WITH MISARTICULATIONS

Dear Parents:

I am an assistant professor of speech pathology at Idaho State University. I am interested in studying speech in children and finding out why some children need help in learning a few of their speech sounds. I would like to learn how to help these children as efficiently as possible. In order to do this, I am conducting a research project in which I will obtain taped samples of childrens' speech when they are repeating a story, telling a story from pictures, and during normal conversation. These children will also receive a speech and language evaluation. The whole procedure lasts about one and one-half hours and is usually enjoyable and interesting to children. The tape recordings will be analyzed with special equipment at Michigan State University. This equipment will measure extremely short pauses in the speech samples. Analysis of these pauses will help us learn more about the nature of speech production in children who have problems producing all of their sounds.

I firmly believe that research such as this will lead to more understanding of the speech process and more efficient procedures for helping children with articulation problems. Your cooperation and assistance will be greatly appreciated. As a service for your cooperation, a report of my observations, my impressions and recommendations formulated during the speech and language evaluation will be written and available to the parents and speech therapists serving the school that the child attends. A research report will also be sent to participants upon completion of the research.

I have asked the speech therapist serving your child's school to contact the parents of children between four and six years of age who still need to learn two or more speech sounds. To insure confidentiality I will not receive your name or number until you give your permission. Enclosed is a form giving the speech therapist permission to supply me with your name and phone number. If you grant your permission, please return the form with your signature to the speech therapist or mail it directly to me. I will then contact you, and answer all questions. After the telephone conversation, if you wish for your child to participate in the study, I will then schedule an appointment at your convenience. If there are any questions or concerns, please feel free to call me at 236-3295 or 236-2852.

Sincerely,

Paul N. Deputy
Assistant Professor
Speech Pathology

APPENDIX B

LETTER TO PARENTS WITH CHILDREN WITH NO MISARTICULATIONS

Pocatello, Idaho
April 19, 1978

Dear Parents:

I am an assistant professor of speech pathology at Idaho State University. I am interested in studying speech in children and finding out why some children need help in learning a few of their speech sounds. I would also like to learn how to help these children as efficiently as possible. In order to do this, I am conducting a research project in which I will obtain taped samples of children's speech when they are repeating a story, telling a story from pictures and during normal conversation. These children will also receive a speech and language evaluation. The whole procedure lasts about one hour and fifteen minutes, is enjoyable and interesting to children. The tape recordings will be analyzed with special equipment at Michigan State University. This equipment will measure extremely short pauses in the speech samples. Analysis of these pauses will help us learn more about the nature of speech production in children who have problems producing all of their sounds.

I have already seen a group of children with two or more consistent articulation errors. I am now looking for children between the ages of four-and-one-half and six-and-one-half with clear speech as a comparison group. I am identifying these children through friends and acquaintances rather than advertisement or formal announcement through school districts. I have asked these people to pass this letter on to you for your consideration. If you have a child within the above age range and are willing to participate in the study, please fill out information below and return it to me or call me at 236-3495.

I firmly believe that research such as this will lead to more understanding of the speech process and more efficient procedures for helping children with articulation problems. Your cooperation and assistance will be greatly appreciated. Parents have found this project enlightening as they can observe the entire testing procedure through a one-way mirror and discuss their child's performance with me after the session. If I receive your name and telephone number you are not obligated to participate nor will you be pressured. I will call you to see if you have any questions and inquire about your interest. If you have interest at this time you will be scheduled for an appointment. I am scheduling appointments from 8:00am to 7:00 pm Monday through Friday and all day Saturday.

Sincerely,

Paul N. Deputy
Assistant Professor, Speech Pathology

Name of Child______________________________male female Age_________

Date of Birth______________________________Phone Number______________

____
Signature of Parent

APPENDIX C

PARENT PERMISSION FORM

______________________________, speech therapist, has my permission to supply Paul N. Deputy, assistant professor of speech pathology, with my name and telephone number. I understand that Mr. Deputy will contact me regarding my child's participation in a research project. I also understand that I am under no obligation to participate in the study.

____
Signature

APPENDIX D

PARENT PERMISSION FORM

In order to participate in this project, your child will receive a speech and language evaluation. This will include an oral peripheral examination, an articulation test, a language test, a test of mental maturity and a hearing screening. Also samples of your childs' speech will be tape recorded while telling a story and during normal conversation. You may observe the proceedings if you would like through a two-way mirror. All information gained during the study will remain absolutely confidential. If your child has any speech or language problems a report of the speech and language evaluation will be sent to the appropriate agency upon your approval. Results from the study may be published in a research report but the report will report cumulative data and in no way identify any child participating in the study.

I approve a report being sent (if necessary) to the appropriate agency.

YES________ NO________

I approve of my child receiving a candy reward for participating in the study.

YES________ NO________

I ________________________________, give my child _____________ permission to participate in the study under the conditions stated and marked above.

____
Signature

____
Date

APPENDIX E

NEWMAN-KEULS FOR SIGNIFICANT SPEECH TYPES MAIN EFFECT; MEAN DURATION OF PAUSES MP

	Paraphrased 26,778.75	Conversation 26,854.97	Spontaneous 31,742.60	r	Critical Value
Paraphrased 26,778.75	---	76.22	4,963.85*	3	1301.28
Conversation 26,854.97		---	4,887.63*	2	1083.14
Spontaneous 31,742.60			---		

$*p \leq 0.05$

APPENDIX F

NEWMAN-KEULS FOR SIGNIFICANT SPEECH TYPES MAIN EFFECT; PERCENTAGE OF PAUSE TIME WITH RESPECT TO DURATION OF UTTERANCES, PP

	Conversation 9.06210	Paraphrased 12.09180	Spontaneous 13.00110	r	Critical Value
Conversation 9.06210	---	3.03*	3.94*	3	.46182
Paraphrased 12.09180		---	.91*	2	.38440
Spontaneous 13.00110			---		

*$p \leq 0.05$

APPENDIX G

NEWMAN-KEULS FOR SIGNIFICANT SPEECH TYPES MAIN EFFECT; VARIABILITY OF PAUSE DURATION, VP

	Conversation 15965.62	Paraphrased 17011.82	Spontaneous 20058.13	r	Critical Value
Conversation 15965.62	---	1046.20*	4092.51*	3	1080.85
Paraphrased 17011.82		---	3046.31*	2	899.65
Spontaneous 20058.13			---		

*$p \leq 0.05$

APPENDIX H

NEWMAN-KEULS FOR SIGNIFICANT DURATION CATEGORIES MAIN EFFECT; FREQUENCY RATIO, FR

	(51-250 msec) 218491.20	(250-3000 msec) 249414.30	(10-50 msec) 372944.40	r	Critical Value
(51-250 msec) 218491.20	---	30923.10*	154453.20*	3	36824.45
(251-3000 msec) 249414.30		---	123530.10*	2	30650.95
(10-50 msec) 372944.40			---		

*$p \leq 0.05$