A STUDY OF VOCAL INTENSITY IN DYADIC INTERACTION

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PREFACE

This thesis is concerned with the formal and process characteristics of vocal interaction. The approach is one which heretofore has received only minimal recognition in the literature. Of immediate concern is the desire to develop a quantitative methodology for the analysis of dyadic interaction. Much of the research in this area has attempted qualitative techniques including clinical impression and description and interview and questionnaire. The primary disadvantage of the former is the lack of agreement among observers regarding phenomena under consideration. The major disadvantage of the latter is the consistently poor fit for action-process phenomena. Consequently, the current research effort has channeled its energy in the direction of a quantitative analysis – that is, written and taped records of interaction.

The ensuing quantitative approach involves a detailed assessment of the various properties of the social interaction process. In this approach, each communication act is evaluated and coded along a number of dimensions derived from conceptual frameworks considered to be significant in the study of interaction. Henry Lennard and Arnold Bernstein in their book, <u>Patterns in Human Interaction</u>, point out that numerical data in this form can be summarized and manipulated in a variety of ways designed to elucidate the structure and evolution of interactional phenomena. Lennard and Bernstein also cite two distinct advantages of this approach. One can subject the same interactional data to repeated examination. Thus, one may examine and re-examine, organize and re-organize, and process and re-process. Second, quantitative analysis may be accelerated or decelerated and the unit under analysis may be increased or decreased in size.[1]

I would like to take this opportunity to thank Dr. Donald Allen for his valuable instruction and advice. His counsel, suggestions, and untiring interest and concern for the project have been of immeasurable value.

I would also like to thank Dr. Ivan Chapman, Dr. Donald Fromme, and Dr. Richard Dodder for serving on my Advisory Committee.

Special thanks are extended to Velda Davis who deciphered my codes and excellently typed the manuscript.

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[1] Henry Lennard and Arnold Bernstein, Patterns in Human Interaction (San Francisco, 1969), p. 51.

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CHAPTER I

INTRODUCTION

The process of verbal communication has been identified by different names in different eras: rhetoric in ancient times, elocution in the past two centuries, and public speaking in the twentieth century. In recent decades, this field of inquiry has become the concern of a vast number of disciplines, including sociology, psychology, and even mathematics. Though the scope of these studies has been wide and varied, for the most part, they have been attempts to describe the communication phenomena based primarily on external factors. The purpose of this research effort differs considerably from the more traditional approaches. The proposed research is an attempt to develop an internal view of the communication process and then to relate the various internal factors to relevant external components. The basic research effort is to look for and to identify, if possible, regularity in patterns of vocal emissions. Primarily, this will be approached by attempting to develop a mathematical description of the sequencing of vocal outputs as measured by intensity variation.

The ensuing research focuses on the most elementary form of communication: dyadic vocal interaction. Two individuals are engaged in spontaneous speech which results in a kind of communal free association between the two parties concerned. The phenomena of speech being measured are not those represented by an extensive list of alphabetized words in a dictionary, nor those represented by pages of paradigms and syntatical rules in grammar. They are rather the phenomena of speech in the process of being uttered. They represent the stream of speech that may appropriately be viewed as a succession or a continuum of communicative pulses, produced by the vocal organs occurring in arrangements that are essentially permutations.

It is readily recognizable that interaction between two individuals can be viewed on a variety of dimensions. One can, for example, study the content of the interaction or the kinesic behavior of the dyadic contact. However, research which attempts analysis from these perspectives displays a variety of techniques and methods. The diversity of the approaches illustrates the lack of consensus among researchers concerning what is being measured, suggesting that both approaches are vulnerable to subjectivity.

Perception of interaction in terms of vocal intensity offers a mathematically precise means of analyzing dyadic interaction primarily because the concept deals with two indices, both having ratio scales. Intensity, which refers to loudness variation, is measured in terms of volts. Time, the second interval scale, allows one to view intensity in its temporal sequence. The concept of action in a time sequence is a potentially valuable concept. Social action relative to its temporal occurrence offers both description and understanding for behavioral patterns. Consequently, this research effort attempted a descriptive analysis of vocal conversation by developing indices defined in terms of these two concepts.

From a conceptual point of view, vocal interaction refers to a bonding or transfer of information between two individuals. The research question is concerned with this bonding process. What are the characteristics of the bond? How complete or incomplete is the bonding process? Is bonding more complete in the heterogeneous or homogeneous dyad structure? Are certain indices descriptive of bonding and others descriptive of a lack of bonding? The research under consideration gives considerable attention to these questions and others.

When one steps into the real world to examine a theoretical model, a giant step must be taken. At the time this is accomplished, the researcher may not be sure that he has taken the best possible step. And as in this case, when the research is novel, the question of interpretation is even more difficult to judge. The current research project is not unique in this respect. The empirical model discussed in Chapter IV is conceived as one means of operationalizing the theoretical model cited in Chapter III. The indices selected, slope, amplitude, wave length, area, density, and the number of points per mesowave, were selected because of the objectivity which they afford in data manipulation. It is conceded that these indices afford a single perspective for viewing the interactional contact. However, it is also thought that the information gained through the use of these indices is both descriptive of the vocal interaction and valuable in terms of analysis.

Data manipulation and data analysis for the current research effort has been handled primarily by use of computer facilities. Without the computer, the methodology employed would be practically impossible. However, employment of such a methodology in the social sciences often raises concern for the dehumanization of man. The extensive use of the computers and the attempt to gain mathematically precise descriptions of man's behavior is in no way an attempt to reduce man to that which is inhuman. The methodology should be viewed as a technique used primarily to gain a high degree of accuracy and precision. It is nothing more than this. The research does not suggest that vocal interaction is a series of wave-like formations. Instead, it suggests that vocal interaction can be studied and analyzed by looking at these wave-like formations. They, themselves, are simply tools of precision.

This research effort will revolve around vocal dyadic interaction as perceived in terms of vocal intensity. Emphasis will be placed upon the meaning of vocal intensity relative to the conversational bond. The model examines three dyad structures: male-male, male-female, and female-female. Examination of the intensity property will be in terms of these three dyad structures. Special attention will also be given to each unique actor and to the temporal distribution of vocal patterns.

The need and importance of such basic research is readily recognizable. Keltner writes, "Much contemporary cultural and social lag relative to our technological advancement stems from our grossly inadequate mastery of the face-to-face speech communication process."[1] Joyce Hertzler indicates that all social processes depend on communication as a social technique.

> Moreover, communication is necessary in order to establish all social ties, to conduct action with or against others. Without it - and in sufficient quantity, quality, and range - there can be no interstimulation and reciprocal response, no establishment of common meaningful conceptualizations, no informative, instructional, provocative invitations, or directive action, no invention, no recording, accumulation, and transmission of knowledge, no social organization, no planning and reorganization.[2]

Greenberg writes,

> We may isolate phonology as a largely autonomous aspect of descriptive linguistics. Its distinctiveness is unquestionable and must be taken into account in any over-all theory of descriptive linguistics. Indeed, the sound system of a language seems to involve a practically autonomous set of habits of articulation and perception.[3]

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[1] John Keltner, Interpersonal Speech-Communication. (Belmont, California, 1970), p. Preface.

[2] Joyce Hertzler, A Sociology of Language (New York, 1965), pp. 26-27.

[3] Joseph Greenberg, Anthropological Linguistics (New York, 1968), p. 50.

The need for a workable methodological approach to the study of vocal interaction is certainly needed. As indicated earlier, verbal communication has been studied for many centuries and from many perspectives. Lack of knowledge and understanding with regard to the interaction process is quite apparent, suggesting inefficient techniques for analysis. Claims are not being made for the proposed empirical model. It is a unique approach and it is hoped that the reader will recognize its merits and value. Using this methodology, the research will attempt to explore objectively the nature of the reciprocal bond between people which facilitates the communication process.

CHAPTER II

REVIEW OF LITERATURE

The area of communication research, historically speaking, has received considerable attention from the field of linguistics. Recent decades, though, have witnessed a growing interest in the field of social psychology for communication research. For the most part, it appears that the work in each of these two disciplines has progressed independently. Serge Moscovici, in his article, "Communication Processes and the Properties of Language," examines the positions of each of these two disciplines and then raises the question "What relations exist between linguistics and social psychology?"[1] The relevancy of the question becomes most apparent when one examines the dominant orientations in each discipline regarding the communicative function, which is the essential function of language.

Moscovici asserts that the linguist's consideration of the communication process results in an abstraction. The physical and physiological nature of communication receives privileged treatment. For example, in linguistic textbooks,

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[1] Serge Moscovici, "Communication Processes and the Properties of Language," Advances in Experimental Social Psychology, Leonard Berkowitz, ed. (New York, 1967), pp. 225-230.

the main emphasis is put on the speaker's biological capacities including minute descriptions of the organs of speech, and the anatomy and physiology of the ear. The point is that such works show a relative indifference to the social and psychological attributes of the persons concerned. Moscovici offers an excellent description of the linguist's approach:

> The classic distinction between langue - a stable system of relationships among lexical units - and parole - an ensemble of uses of this sytem by the members of a community - has permitted the severing of linguistic phenomena from their extralinguistic foundations. Consequently, emitters, receivers, and their relations are depicted as ideal, universal types. In wanting to make language an autonomous and purely formal entity, linguistics has forgotten the speaking subject and has created a mirror image, equally formal and autonomous, of communication.[2]

An examination of the position of social psychology as it relates to communication research reveals a somewhat different picture. Within the discipline of social psychology, one can identify theoretical and experimental studies of classes of speakers and listeners, their intentions and actions, the circulation of information, and the function of persuading. Moscovici notes that studies of this nature have not been used to understand linguistic behavior. In fact, they have not really taken serious account of linguistic behavioral qualities and specificity.

The social psychologist who has come as close as any in recognizing the linguistic approach to the study of

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[2] Ibid., p. 227.

communication is Roger Brown. In discussing the concept of communication, Brown begins by describing the physical apparatus necessary for the production of sounds. Basically, speech sounds can be described as a set of modulations of the stream of air produced through a function of its passage through the oral, nasal, and pharyngeal cavity. The study of language, Brown asserts, can be viewed on two levels: the phonological and the grammatical. Brown stipulates that all languages are built around the phonemic principle. By the phonemic principle, Brown has reference to an elementary stock of sounds which in and of themselves are meaningless or semantically empty. For the most part, they are vowels and consonants which correspond roughly to the letters of an alphabetic writing system. No language uses many of these, the range being from fifteen to eighty-five with English using around eighty-five. By combining phonemes larger units called morphemes can be constructed. These are similar to but not the same as words. Morphemes are not semantically empty; each one has meaning.[3]

The second level at which language is viewed by Brown is the grammatical level. Brown asserts that any linguistic utterance is a sequence of individually meaningless phonemes, but it is also, simultaneously, a sequence of meaningful morphemes. A sentence is a string of vowels and consonants spoken at different pitches with varying degrees

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[3] Roger Brown, Social Psychology (New York, 1965), p. 247.

of stress. At the grammatical level, the morpheme is the element or unit and grammar is the set of rules for combining morphemes to make words and sentences. Grammar is conventionally divided into morphology and syntax; the former being rules for building words and the latter rules for building sentences. Brown summarizes the communication system as follows:

> Fewer than 100 sounds which are individually meaningless are compounded, not in all possible ways, to produce some hundreds of thousands of meaningful morphemes, which have meaning that are arbitrarily assigned, and these morphemes are combined by rule to yield an infinite set of sentences, having meaning that can be derived. All of the systems of communication called languages have these design features.[4]

Attempting to synthesize the linguistic approach with the social psychological approach, it would seem reasonable to assert that social psychology is especially interested in the production or generation of linguistic signs, rules, and events. For the social psychologist, the linguistic sign appears in two forms. First, it is an index of the rapport between individuals or groups, of their position in a social scale, of their desire to obey or to command, and so on. Secondly, the chain of linguistic signs seems to constitute a medium, a field of social interaction, to the extent to which their properties - from the point of view of redundance or from the grammatical point of view - are utilized

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[4] Ibid., p. 248.

to contribute precisely to a particular effect.[5] A synthesizing of these two approaches would appear to be particularly advantageous to social psychology.

Literature in the area of communications reveals both theoretical and empirical contributions. Theoretical developments can be seen as early as the writings of Adam Smith. In discussing the concept of social interaction, Smith asserts that an individual should be concerned with making his feelings and interests maximally usable by others as a source of appropriate involvement. This major obiligation of an individual is balanced by his right to expect that others present will be motivated to respond to his involvement. The speaker, in scaling down his experiences, and the listener, in scaling up his interests, each with respect to the other, form the bridge that people build to one another, allowing them to meet for a moment of talk in a <u>communion of reciprocally sustained involvement</u>.[6] (Emphasis added by this author.)

Social psychologist George Herbert Mead, in his writings, described certain mechanisms of communications as the central basis of mind, self, and society. For Mead, all group life is primarily a matter of cooperative behavior. But a distinction must be made between infrahuman society and human society. In infrahuman societies, cooperation is

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[5] Serge Moscovici, p. 231.

[6] Adam Smith, <u>Adam Smith's Moral and Political Philosophy</u> (New York, 1948).

physiologically determined. In human societies, on the other hand, such is not the case. Human cooperation involves responding to the intentions of others and responding on the basis of that intention. The intentions to which Mead had reference were the meanings of gestures. Thus, the gesture becomes a symbol to be interpreted. It becomes something which in the imaginations of the participants, stands for an entire act.[7]

According to Mead, each human being has the ability to respond to his own gestures. Thus, it is possible for the responding individual to have the same meaning for the gestures as the other person. This ability to stimulate oneself as one stimulates another and to respond to oneself as another does, Mead ascribes largely to man's vocal-auditory mechanism. (The ability to hear oneself implies at least the potentiality for responding to oneself.) When a gesture has a shared common meaning, <u>when it is a linguistic element</u>, one can designate it as a significant symbol. Mead summarizes his position in this way:

> The development of communication is not simply a matter of abstract ideas, but it is a process of putting oneself in the place of the other person's attitude communicating through significant symbols. Remember that what is essential to a significant symbol is that the gesture which affects others should affect the individual himself in the same way. It is only when the stimulus which one gives another arouses in himself the same or like response that the symbol is a significant symbol. Human communication takes place through

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[7] George H. Mead, <u>Mind, Self, and Society</u> (Chicago, 1934).

> such significant symbols, and the problem is one of organizing a community which makes this possible. If that system of communication could be made theoretically perfect, the individual would affect himself as he affects others in every way. That would be the ideal of communication, an ideal attained in logical discourse wherever it is understood. The meaning of that which is said is here the same to one as it is to everybody else.[8]

In the course of conversation, then, there is a "meeting of minds." Each individual assimilates the other's experience with that of his own.[9]

Erving Goffman's theoretical view of conversational exchange between two or more individuals is that of an interaction ritual. Goffman conceptualizes the interaction ritual as a system in equilibrium in which the individuals involved are primarily concerned with saving face.

In a conversational encounter, flow of information and business is parcelled out into relatively closed ritual units an interchange at a time. The structural aspect of talk arises from the fact that when a person volunteers a statement or message, however trivial or commonplace, he commits himself and those he addresses. In a sense, he places everyone present in jeopardy. In essence, the speaker becomes vulnerable to the possibility that the intended recipients will affront him by not listening or will think him forward, foolish, or offensive in what he has said. If this reception is made manifest, he will find

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[8] Ibid., p. 327.

[9] Ibid., p. 51.

himself committed to the necessity of taking face-saving action against them.[10]

Thus, when one person volunteers a message, he contributes what might easily be interpreted as a threat to the ritual equilibrium. Consequently, someone else present is obliged to show that the message has been received and that its content is acceptable to all concerned or can be acceptably countered.

With respect to the length of the interaction contact, Goffman suggests that once individuals enter a converation, they are obliged to continue it until they have the kind of basis for withdrawing that will neutralize the potentially offensive implications of taking leave of others. While they are interacting, they need to have subjects at hand to talk about that fit the occasion and yet provide content enough to keep the talk going. Goffman labels this small talk. When individuals use up their small talk, they find themselves officially lodged in a state of talk but with nothing to talk about. When this happens, according to Goffman, interaction-consciousness, experienced as a painful silence, is the typical consequence.

Goffman further indicates that when conversation fails to capture the spontaneous involvement of an individual who is obliged to participate in it, uneasiness results. A fundamental requirement of many social encounters seems to be

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[10] Erving Goffman, Interaction Ritual (Garden City, New York, 1967).

the spontaneous involvement of the participants. When this requirement exists and is fulfilled, the interaction "comes off". When the encounter fails to capture the attention of the participants, but does not release them from the obligation of involving themselves in it, then persons present are likely to feel uneasy. For them the interaction fails to "come off". A person who chronically makes himself or others uneasy in conversation and perpetually kills encounters is a faulty interactant.

A final theoretical framework for the study of interaction has been suggested by Thibaut and Kelly.[11] Thibaut and Kelly view verbal interaction in terms of exchange theory. The consequences of interaction can be described in terms of the rewards received or the costs incurred. By rewards, the authors have reference to the "pleasures, satisfactions, and gratifications the person enjoys." By costs, the authors mean, "any factors that operate to inhibit or deter the performance of a sequence of behavior."[12] The assumption made is that rewards and costs can be measured on a common psychological scale. The result of the rewards received and costs incurred is the consequence or outcome for an individual participant of any interaction. The authors, basically, are suggesting that the more rewards offered, the higher the quality of response. Excessive

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[11] John W. Thibaut and Harold H. Kelley, The Social Psychology of Groups (Chicago, Illinois, 1959).

[12] Ibid., p. 12.

costs, on the other hand, result in producing a deterioration in the quality of responses made.

Turning to the experimental or empirical point of view, it is possible to identify a variety of approaches to the study of communication in the literature. One typical approach to the study of the communications process appears to be an examination of the growth and development of speech parallel to the growth and development of the human being. Some of the earliest research on the importance of speech was conducted by Swiss psychologist, Piaget, who took this approach and studied the function of speech in children. Piaget distinguished two functions of speech for the child: the social and the egocentric. In social speech, the child addresses his hearer, considers his point of view, tries to influence him or actually exchanges ideas with him.[13] In other words, in socialized speech, the child does attempt an exchange with others - he begs, commands, threatens, conveys information, asks questions. In egocentric speech, the child does not bother to know to whom he is speaking, nor whether he is being listened to. He talks either for himself for the pleasure of associating anyone who happens to be there with the activity of the moment.[14] Piaget contends, in egocentric speech, the child talks only about himself, taking no interest in the other. He does not try

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[13] Jean Piaget, Language and Thought of the Child (New York, 1926).

[14] Ibid.

to communicate, expects no answers, and often does not even care whether anyone listens to him. It is similar to a monologue in a play: the child is thinking aloud, keeping up a running accompaniment, as it were, to whatever he may be doing.

Piaget's experiments showed that by far the greater part of the preschool child's talk is egocentric. He found that from 44 to 47 per cent of the total recorded talk of children in their seventh year was egocentric in nature. This figure, he contends, must be considerably increased in the case of younger children. Piaget's further investigation with six and seven year olds proved that even socialized speech at that age is not entirely free of egocentric thinking. When at the age of seven or eight, the desire to work with others manifests itself, egocentric talk subsides.[15]

Repetition of Piaget's study by other investigators has not always confirmed his findings. Miller, who has summarized these investigations, concludes that the bulk of the child's speech - approximately 90 per cent - is social.[16]

The Russian psychiatrist, Vygotsky, suggests that even the so-called "egocentric" monologues described by Piaget are really directed toward others. When Vygotsky placed a child whose speech showed all the characteristics of

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[15] Semenovich Vygotsky, Thought and Language (Cambridge, Mass., 1962), p. 15.

[16] G. A. Miller, Language and Communication (New York, 1951).

egocentric speech - babbling, short, and incomplete sentences - among deaf and dumb children, in isolation, or in a very noisy room, the amount of the child's talk dropped off considerably. Vygotsky interpreted this as indicating that the child believes his babbling speech is understood by others, and when external conditions make communication impossible or difficult, he stops speaking.[17]

The development of speech parallel to physical growth and development has also been studied with the aid of a spectrograph. Spectrographic studies of sound during the first few months of infancy indicate that vocal behavior is very unstable. The speech organs are employed in breathing, eating, crying, or gurgling. The cortex is immature and speech-like sounds which do occur show extreme fluctuations and defy analysis by the ordinary phonetic classifications applicable to speech under more stable control.[18]

The most striking change in speech during the child's first months, according to Ervin and Miller, appears to be the acquisition of increasing control over volume, pitch, and articulatory position and type, a control manifested by continuity or repetition of these features. Ervin and Miller report a study conducted by Tischler concerning this

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[17] Lev Semenovich Vygotsky, "Thought and Speech," Psychiatry, II (1939), pp. 29-54.

[18] A. W. Lynip, "The Use of Magnetic Devices in the Collection and Analyses of the Preverbal Utterances of an Infant," Genetic Psychological Monographs, XLIV (1951), pp. 221-262.

phase of development. In a study of seventeen children in contrasted social situations, he noted that there was a gradual increase in the frequency of vocalization. It reached a peak at eight or ten months of age, then declined. Between the eighth and twelfth months, almost all conceivable sounds occur, including some not in the adult language.[19]

Mowrer has offered a note-worthy theory regarding changes in the prelinguistic stage. He suggests that there is a secondary reinforcement in hearing oneself speak as the rewarding parent speaks. This suggestion would account for both increasing quantity of sound and increasing approximation to adult sounds.[20] There are few data to test this theory. However, the theory is somewhat supported by the finding that the prelinguistic sounds of deaf and hearing children are indistinguishable in the first three months, but there is a gradual decrease in the range of sounds uttered by the deaf after the age of six months with each child specializing idiosyncratically. Thus, the hearing of a variety of speech sounds may increase the range of sounds used by the child, but it is not known if the hearing of a

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[19] Susan M. Ervin and Wick R. Miller, "Language Development," Readings in the Sociology of Language, Fishmen ed. (Netherlands, 1968), p. 70.

[20] O. H. Mowrer, Learning Theory and the Symbolic Processes (New York, 1960).

particular range of sounds influences the particular range used by the child.[21]

Communication research has also been approached from the perspective of role sets. In spite of variation within each role set, communication is so affected by the nature of a role set that one can often predict, just from a prediction of a dyadic event, the basic behavior patterns, and even communicative content of that event. For example, the role of courtroom judge is better established than is that of judged (unbalanced role set). Therefore, more judges communicate in the same form and even in the same manner of expression than do any given number of defendents, whose position is sketchy indeed. The person in the less stylized position has more flexibility in communicating about the business at hand than does his stylized partner. But he also has fewer roles to guide his behavior and less influence on the dyadic communication system in which he behaves if he behaves congruently with the set.[22]

As used by Sarbin and others, a role is a sequence of learned actions performed by a person in an interaction situation. On the basis of behavior of the other person, the latter is assigned to a 'position' or set of anticipated actions. This is simply a form of social perception. Each person takes a role in response to his perception of the

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[21] Ervin and Miller, p. 70.

[22] Borden, Gregg, Grove, p. 119.

other, the latter confirming or correcting the expectation of the former. A person is said to be able to "take the role of the other" if he can act their part or predict their behavior correctly, a concept borrowed from Mead.[23]

This approach has led to a number of experiments on the perception of self and other among which is included Weinstein's, Wiley's, and DeVaughn's study of "Role and Interpersonal Style as Components of Social Interaction."[24] Basically this study explores the usefulness of placing others into a role type as a conceptual approach to the analysis of social interaction. This study views interactive behavior as efforts by one actor to control the responses of others to him. The authors contend that one of the main ways people attempt to influence how others behave toward them is to project an identity for the others to assume in the situation; an identity which is congruent with ones own purposes. This process is labeled altercasting - casting alter (other) into an identity or role type. Rather than emphasizing the content of acts or the implications of the act for the motivation of the actor, any given act or sequence is viewed on the basis of its potential consequences for shaping the responses of the other.

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[23] T. R. Sarbin, "Role Theory," Handbook of Social Psychology, Lindzey, ed. (Reading, Mass., 1954), chap. vi.

[24] Eugene A. Weinstein, Mary Glenn Wiley, and William DeVaughn, "Role and Interpersonal Style as Components of Social Interaction," Social Forces, XLV (December, 1966), pp. 210-216.

Utilizing the concept of role sets, T. O. Beidelman conducted a study in which he was interested in terms of address as clues to social relationships. Informants, speaking fourteen different languages were interviewed by Beidelman. His results indicate a consistent cross-cultural tendency for the terms used to vary directly with the roles and social relationships of the partner involved. For example, he noted a general tendency toward the use of formal terms when addressing strangers or members of the opposite sex. When informants were asked to explain the reason for the formal usage with the strangers, they indicated a "reluctance to be familiar with those about whom one knows almost nothing."[25]

Although the theoretical and empirical approaches to communication research appear to follow no uniform pattern, one common denominator can be identified. Primarily, they all treat communications in a qualitative manner. As has been indicated, qualitative methods are not totally adequate for specifying the regularities of the communication process with any degree of precision. The result is that quantitative approaches to the study of communication are becoming more prevalent.

One of the most significant variables in a quantitative approach to the study of communication is time.

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[25] T. O. Beidelman, "Terms of Address as Clues to Social Relationships," Modern Sociology, A. W. Gouldner and H. P. Gouldner (New York, 1963), p. 312.

Goldman-Eisler, in her book, Psycholinguistics: Experiments in Spontaneous Speech, writes:

> Speech is a serial phenomenon, an activity spread out in time. It does not, however, fill time continuously, particularly when it is spontaneous, but it comes in fits and starts with intermittent periods of non-speech. A passage of speech extending in time consists of two sorts of time: time of vocal action and time of silence.[26]

Goldman-Eisler further asserts:

> We treat time as a thing at our disposal - we have time, we lose time - not as something of which we are a part. But in conversation, in speech, which is spread over time, we become subject to it again; we must operate in time and we must adjust to the time of our partner. In spontaneous conversation, man's way of handling time is revealed and by studying his speech behavior under these conditions we may comprehend his attitudes when time is his master, when, whatever else the wider purpose of the interlocutors may be, their primary inescapable object must be to participate in, if not to take possession of, time, without which speech cannot take place. In conversation, time is a quantity to be shared between partners and the more spontaneous it is, the more open is left the manner in which their time for talking will be distributed between them.[27]

The importance of the concept of time has also been noted by Colin Cherry:

> Speech is bound to a time continuum; we must receive it as it comes, instant by instant. For the purpose of observing speech and making scientific analysis, we record it and examine segments in a search for structure.[28]

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[26] F. Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech (New York, 1968), p. 11.

[27] Ibid., pp. 3-4.

[28] Colin Cherry, On Human Communication (New York, 1957), pp. 77-78.

Andre Martinet writes:

> Every language is manifested in the linear form of utterance which represents what is sometimes called the 'spoken chain.' This linear form of spoken language derives in the last resort from its vocal character: vocal utterances are necessarily produced in time and are necessarily perceived by the ear in succession.[29]

The concept of time in the communication process perhaps has been most seriously considered by Chapple who proposed the study of purely temporal aspects of interaction - the length and frequency of verbal contributions, silences, interruptions. Chapple was interested in an objective description of interaction. Thus, he selected as his variable, the duration of periods of speech and silence in interviews and their interaction. Chapple and his associates have developed an observation procedure which is concerned exclusively with the measurement of the time aspects of interpersonal relationships. This time record provides several kinds of information. It is possible to note how much each person talked or acted and also characteristics of their interaction: whether they interrupted each other, whether there were or were not delays between the action of one and the action of the other.[30]

Chapple and his associates have developed an observation procedure which is concerned exclusively with the

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[29] Andre Martinet, Elements of General Linguistics (Chicago, 1960), Preface.

[30] E. D. Chapple, "Measuring Human Relations: An Introduction to the Study of the Interaction of Individuals," Genetic Psychological Monographs, XXII (1940), pp. 1-147.

measurement of the time aspects of interpersonal relationships. They have developed an elaborate machine called the Interaction Chronograph which records the data required by the system. Chapple has described and labeled many of the scores that can be obtained:

Tempo - how often a person starts to act

Activity or Energy - how much longer he talks or responds than is silent and unresponsive

Adjustment - the length of his interruptions against his failure to respond

Initiative - the frequency with which one person takes the initiative as against the other

Dominance - the frequency with which one person outtalks or out acts the other when there has been an interruption

Synchronization - the frequency with which one person interrupts or fails to respond.[31]

With the exception of Chapple, the theoretical and empirical literature cited to this point can primarily be described as attempts to gain precision in control through prediction. Chapple's work, on the other hand, is an attempt to approach the study of communication from a more basic and elementary level. The proposed research effort follows an approach similar to Chapple. Basic concern is with describing the generative process involved in the description of speech. The research proposes a graphic and digital representation of vocal sound sequences in an

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[31] E. D. Chapple, "The Interaction Chronograph: Its Evolution and Present Application," Personnel, XXV (1949), pp. 295-307.

attempt to determine if there are stable patterns.

Although the literature in this area is somewhat exiguous, there have been a few research efforts which lend support. At the level of sound patterns, the output of energy can be viewed from two perspectives: intonation and volume. One research tool for dealing with sound patterns is the spectrograph. The Haskins Laboratory, for many years, has been working out the distinctive acoustic features of the various phonemes of English. The research makes use of the sound spectrograph, a device which transforms speech sound into visible patterns, and the pattern playback, a device which makes the reverse transformation. The pictures produced by the spectrograph are called spectrograms. On a spectrogram, time appears on the horizontal axis and acoustic frequencies on the vertical axis. The relative concentration of acoustic energy at particular frequencies is represented by the darkness of the lines at that level of the spectrogram. The spectrogram provides a large amount of acoustic detail for each syllable and suggests the characteristic features of each vowel. In order to find out if some feature is actually an important one for recognition of a vowel, the Haskins people would use the pattern playback. The acoustics characteristics can be painted on paper in an idealized form, and the playback will transform into sound. This makes it possible to determine whether or not the sound is recognizable as one or another

English vowel.[32] It should be kept in mind though that the spectrograph approach is not meant to include social variables. It is simply an effort to abstract speech regardless of emitters or situation.

At the level of sound patterns, there have been few attempts to deal experimentally with the concept of communication. One such experiment was conducted by Lieberman in which he was primarily concerned with the concept of intonation. By intonation, Leiberman had reference to the entire ensemble of pitch and stress levels that occur when a sentence is spoken. The author was particularly concerned with the Trager-Smith transcriptions, a technique for describing the pitch and stress levels of an utterance. The object of the experiment was to test whether the linguists using Trager-Smith notation does in fact employ an 'objective' procedure in which he considers the physically present acoustic signal. The results of this experiment demonstrate that the linguist often considers his 'subjective' judgment and fills in the Trager-Smith pitch notation that is appropriate to the structure.[33]

R. Jakobson and M. Halle deal with energy outputs in terms of loudness variation where loudness variation refers to the utterance of consonants or vowels. These authors write that the labial stop presents a momentary burst of

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[32] Roger Brown, p. 248.

[33] P. Lieberman, "On the Acoustic Basis of the Perception of Intonation by Linguists," Word, XXI (1965), pp. 40-54.

sound without any great concentration of energy in a frequency band, whereas in a vowel there is no strict limitation of time, and the energy is concentrated in a relatively narrow region of maximum aural sensitivity. In the first constituent, there is an extreme limitation in the time domain, whereas the second constituent showed no obstensible limitation in the time domain. Consequently, the diffuse stop with its maximal reduction in the energy outputs offers the closest approach to silence, while the open vowel represents the highest energy output of which the human vocal apparatus is capable.[34]

The generative process of communication can be described not only in terms of energy, but also in terms of speech hesitation and speech rates. Goldman-Eisler states:

> The stable element in the pattern of conversations of individuals is to be found, not so much in those measures which are concerned with their active behavior, as in those belonging to the intervals of intensity between periods of action.[35]

D. S. Boomer conducted a study in which he concerned himself with two varieties of hesitations in spontaneous English speech: silent pause and filled pause (uh/ah/a/um). His data concerned the location of these hesitations in extended utterances, but his basic issue was the nature of the grammatical encoding process in speech. Basically his

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[34] R. Jakobson and M. Halle. "Phonemic Patterning," _Psycholinguistics: A Book of Readings_ (New York, 1961).

[35] F. Goldman-Eisler, _Psycholinguistics: Experiments in Spontaneous Speech_ (New York, 1968), p. 4.

hypothesis was that hesitations in spontaneous speech occur at points where decisions and choices are being made. On this basis, Boomer believed the patterning of hesitations should provide clues as to the size and nature of the encoding units which are operative.[36]

Boomer believed that if the encoding units were single words, then hesitations should occur more frequently before those words which involve a difficult decision, i.e., a choice among many alternatives. If the encoding unit was a sequence of several words, then the hesitation should predominate at the beginnings of such sequences, rather than occurring randomly wherever a difficult word choice occurred. Boomer found that both types of hesitation were most frequent after the first word in a clause regardless of the length.[37]

Goldman-Eisler also conducted a series of experiments which were designed to examine the function of hesitation pauses in speech. Specifically pauses were conceived of as anticipating increase of information in subsequent speech and as involving acts of choice. In other words, hesitation pauses in speech represent the act of choice in selecting the suitable word from among the possible alternative words. The hypothesis was formulated as follows: "Hesitation pauses correspond to the points of highest statistical

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[36] D. S. Boomer, "Hesitation and Grammatical Encoding," <u>Language and Speech</u>, VIII (1965), pp. 148-158.

[37] Ibid.

uncertainty in the sequencing of units in any given order." To test this hypothesis, the incidents of pauses within sentences were related to the transition probabilities of the words constituting them. Estimates of these probabilities were obtained experimentally by an adoption of Shannon's guessing technique and were based on reverse as well as forward guessing. The hypothesis was born out by the facts: hesitancy in speech was shown to be closely related to uncertainty of prediction and fluency of utterance to redundancy.[38]

Henderson, in an examination of spontaneous speech and hesitation, found that 55 per cent of pauses occurred at grammatical junctures while 45 per cent occurred in non-grammatical places.[39] A grammatical juncture refers to a place where a grammatical decision must be made.

The generative process of communication can also be described in terms of speech rates. In discussing the concept of speech rates, Goldman-Eisler writes:

> The rate of speech production expressed by the number of speech units, usually words or syllables, per total time of utterance is frequently used as a variable supposed to measure the speed of talking and as such brought in relation to other variables. It is therefore important that it is understood which aspect of speech production is in fact measured by speed, rate, etc.[40]

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[38] Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech, pp. 33-37.

[39] A. Henderson, F. Goldman-Eisler, and A. Skarbek, "Sequential Temporal Patterns in Spontaneous Speech," Language and Speech, IX (1966), pp. 207-216.

[40] Goldman-Eisler, Psycholinguistics, p. 23.

Goldman-Eisler defines speech rate or speed of talking as the number of syllables per minute. In her experiments, she found:

> (1) The range of speech rate is relatively great for short utterances, but narrows as utterances grow longer.
>
> (2) Stability is gained at a length of about 100 syllables. Speech rate for utterances longer than that are confined within a narrow range of central position.
>
> (3) Relatively fast speech rates occur rarely at lengths above 100 syllables.
>
> (4) Means and standard deviations of speech rates for utterances of different lengths decreased with increasing length of utterance: the stablization of speed in talking gaining stability as it slows down.[41]

The fact that on no occasion were longer utterances spoken at high speeds suggested that a physical as well as psychological factor might be operating as an impediment; the high rates of speech output sometimes achieved in bursts seemed on this basis physically impossible to maintain for any length of time. Short utterances were not necessarily always faster than longer ones; in the case of the former, the range of speed was wider from very slow (60 syllables per minute) to very fast (600 syllables per minute).[42]

Phoneticians have investigated the limits in speed of articulation and have found it to vary between 6.7 and 8.2 syllables per second. Miller conducted a series of

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[41] Ibid.

[42] Ibid.

experiments dealing with this phenomenon. These investigations were carried out by asking subjects to repeat (as fast as they could) simple syllables in rhythmic groups. Thus, tat, tat, tat was used to measure the speed of articulatory movements made with the tip of the tongue which produced 8.2 syllables per second, whereas only 6.7 syllables per second could be produced with the back of the tongue.[43]

Goldman-Eisler conducted an experiment in which rates of articulation were based on three conditions of speech production: (1) the description of cartoon stories, (2) the interpretation of their meanings, and (3) speech uttered after several repetitions, when descriptions and interpretations were well-practiced. Rates of articulation were calculated in terms of words per second. Goldman-Eisler found no difference between the two highly distinctive cognitive operations of describing and interpreting pictures stories. In both situations, the articulation rate was 3.7 words per second.[44]

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[43] G. A. Miller, Language and Communication (New York, 1951).

[44] Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech, p. 25.

CHAPTER III

THE THEORETICAL MODEL

Blalock, in his book, Social Statistics, writes that the ultimate goal of science is prediction.[1] This is not to imply that the scientist has only secondary interest in understanding why two or more variables are interrelated as they are. Ideally, if understanding were more complete, perfect prediction would be possible. Unfortunately, perfect understanding is not easily attained due, in part, to a lack of adequate descriptive information.

In essence, man is concerned with scientific inquiry because he wants to understand the milieu in which he finds himself. He wants to engineer and control as much of his environment as possible to sustain, propagate, and enrich his life. Following this path, the goal of science is to gain a reliable description of phenomena which allows accurate prediction (within certain limits) of behavior as a function of an ever-changing environment.

In this quest for understanding and its utilization, "models" or "visualizations" of the phenomena are generated

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[1] Hubert Blalock, Social Statistics (New York, 1960), p. 274.

which are vehicles by which fuller understanding is gained.[2]

The proposed research is an effort aimed primarily at describing the communication process. The literature review undertaken has recognized both theoretical and empirical developments within the area of communication. The proposed model is an eclectic approach to communication. It is an attempt to abstract from the literature, both theoretical and empirical, those elements which deal descriptively with communication. The model attempts to synthesize the linguistic and social psychological approaches. At the same time, effort is put forth to step beyond the present status of the literature in an attempt to discover new approaches.

The concept of communication implies the flow of information between two or more persons. It might be said that an interaction situation commences whenever two or more people come under the immediate influence of one another. It lasts as long as the participants continue to be influenced by one another without shifts of interest away from immediate contact. It is terminated when the contact is broken and the interest of those involved shifts to another situation.[3]

The proposed research is an effort to analyze the

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[2] Robert Pittenger, Charles Hockett, and John Daneby, The First Five Minutes (Ithaca, New York, 1960), p. 212.

[3] David Dressler, Sociology: The Study of Human Interaction (New York, 1969), p. 441.

conversational bond in natural face-to-face interaction. In a sociological context, the conversational bond can be viewed as a continuing mental union between two actors arising from a variably integrated series of verbal exchanges. The bond consists of a complex integration of vocal sequences which incorporate a variety of simpler elements. The simplest vocal element in natural conversation is the vocalized syllable which provides a standard unit for analysis. Vocalized syllables are emitted in discrete strings denoted by relatively short intervals between syllables within a string and by longer intervals between strings. In general, the syllable string is the basic unit of communication.

Bonding, viewed as the core construct in dyadic interaction, occurs at three levels:

1. The prime level of bonding is the pulse-by-pulse linkage between emitter and receiver in the vocalization and hearing processes. It depends on the vocal emissions, syllable by syllable.
2. The second level of bonding is the integration of vocal pulse strings into messages so that there is a replicate ordering of thoughts between partners. It is the natural sequencing of vocalized syllables as they are emitted.
3. The tertiary level of bonding is in a

> generalized consensus or communal residue of the conversational contact. The third level refers to an understanding of that information which has been transferred in the contact.

In any interaction event, there exists an interactional context or larger situation within which that event occurs. Any interaction between persons is a part of an ongoing sequence of interactions which possess formal configural properties, independent of the content of the communication. The approach of the research under consideration indicates that the interactional context heretofore, has not received the attention it deserves. Thus, the proposed theoretical model identifies properties of the conversational bond which can be quantitatively measured.

The basic research question is this: How does the variation in energy, defined in terms of loudness variation, and its temporal distribution relate to the core properties of the conversational bond? There are six recognized core properties which will be discussed in the following paragraphs. The recognized core properties include (1) the bonding or interlock between conversational partners, (2) the reciprocity in emergent action sequences, (3) interaction equilibrium and its stabilizing mechanisms, (4) cycling and periodicity in emission sequences, (5) information replication, and (6) the affective increment. Since these core properties are parts of a single process of conversational interchange, it should be recognized that the core properties are analytical abstractions which are related to each other.

From the sociological viewpoint, bonding is the prime characteristic of the conversational tie because it represents the primitive cement of social union between individuals. The bonding concept can be generalized from a number of discrete components in the conversational action stream. The most important bonding component lies in the nearly simultaneous emission - and - intake of syllable strings where the vocalized thought of one partner becomes the nearly identical thought of the other, a concept borrowed from Mead. The tightness of bonding depends on how well the vocal emission survives the listening process. Reception depends, in part, on the characteristics of the syllable string, including loudness, articulation, density, redundancy, and, in part, the attention and concentration of the receiver. If bonding is successful on the first level, the level of syllable string replication, cumulative bonding in a more general sense can be inferred because increments of knowledge are built up from a collection of piece-meal items developed from a coherent succession of syllable strings.

Reciprocity in emergent action sequences involves oscillation of vocal emission strings between dyadic partners, and coherence between adjacent emissions. Over-all measures of reciprocity indicate the pattern of investments by two partners in the conversational union in which each actor stimulates and sustains vocal chaining by himself and by his partner. One thesis of the theoretical model is that intervals, miscues, failure to respond, and energy reduction reduce reciprocity.

The equilibrium concept incorporates the assumed tendency to restore the balance between two actors in terms of engagement, emission, and participation, as well as a tendency to maintain a steady state in the emission stream. Equilibrium is measured by the ratio of less - to - greater outputs. It is believed that the equilibrium concept applies to all properties of the conversational contact and is implicit in the bipolar nature of the system.

Cycling and periodicity in syllable emission sequences result from the oscillatory character of the two-person conversational relation and from the limited range within which the syllable stress points can vary. The cycling and periodicity being referenced is that created by the shifting pattern of intensity levels. Cycling and periodicity is a function of loudness variation. The oscillation of the actor emission stream is expected to establish measurable regularity. The research effort holds that vocalized syllable strings range with considerable regularity over some span of loudness levels. These periodic phenomena display a wave-like character which can be mathematically analyzed.

Information replication is a two-part process in which a syllable string is emitted in a connected series of pulse-like vocalized syllables, and is almost simultaneously replicated in the mind of the partner. As successive waves of syllable strings are generated on one side and replicated on the other, the receiver experiences the expressed thoughts of the emitter in the same order and pattern as the emitter experiences them. Thus, the receiver quite literally shares the emitter's vocalized thoughts in their original sequence and in a very similar way.

A minute affect increment is incorporated in each vocalized syllable which is also perceived in the mind of the receiver as a part of the vocal sequence. This is not to suggest that the affective increment is imposed on the sound waves, but rather that it is built into the vocalization pattern due to its influence on the emitter, and that this part, along with the other characteristics of the string, are more or less perfectly replicated through the listening process. The affect increment reflects the interest or excitement of the emitter in the content of his own outputs. The receiver may not replicate the full degree of affect generated by the emitter, but the affective direction is evident to the receiver, and additional vocal sequences in the same direction may develop equivalent interest in the receiver. The result of the accumulation of affective increments may be generalized as enjoyment of the contact for positive increments and this is a source for the development of affect in the same direction toward the emitter. Homans suggests that evidence of a change in the affective component includes changes in the loudness range and in syllable density.[4]

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[4] George C. Homans, The Human Group (New York, 1950).

CHAPTER IV

INDICES OF THE CONVERSATIONAL BOND

In the history of research on the interview, many investigators have found formal noncontent variables to be remarkably reliable, valid, and consistent. This interest in reliability and validity, so characteristic of the research investigator, is markedly different from Freudian writings on the interview. American investigators, influenced by Freud, have stressed content, giving it various levels of interpretation, in contrast to other cultures, such as the oriental, which have been more concerned with form and structure. Because formal, noncontent variables strongly affect interview behavior, it is imperative that the clinician become as interested in this aspect of his own behavior as he is in the interpretation of the content. Pauses, speed of response, interruptions, and length of speeches are important bits of behavior that the therapist can deliberately utilize once he realizes their importance.

The formal characteristics of speech are important determinants of how an individual carries out his social role. Such characteristics of speech, pitch, rate, density, length, pauses, and silence are aspects of social roles to which other individuals react. Changing these characteristics may systematically affect the reception an individual receives from the audience of his peers and significant others. It is often not what an individual says but the way in which he says it that influences how his peers react to him.[1]

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[1] J. D. Matarazzo, A. N. Wiens, and G. Saslow, "Studies in Interview Speech Behavior," Research in Behavior Modification: New Developments and Their Clinical Implications, Krasner and Ullman, eds. (New York, 1965), pp. 179-180.

This is the argument of Matarazzo concerning the importance of noncontent variables in the study of the communication process. The writer shares Matarazzo's assessment. The mathematical indices of the conversational bond are graphically portrayed in the wave-like formations produced in Phase II of the computer analysis (see Figure 1).

As shown in Figure 1, loudness levels are represented on the vertical axis and time is represented on the horizontal axis. All mathematical indices are descriptive of either loudness, time, or some joint function of these two factors. The purpose of this chapter is to delineate the various indices and their function or utility in the conversational contact.

The first distinction to be made is that between loudness and intensity. Carl B. Cass, in discussing the concept, suggests that intensity applies to sound waves while loudness applies only to sound. The intensity of a sound wave refers to the amount of energy used to initiate the sound wave or more specifically the amount of energy needed to force movement of the sound wave through the air.[2] Loudness, on the other hand, may be defined as the subjective evaluation of tones ranging from loud to soft. The listener's perceptive evaluation is determined by the intensity of the sound waves, or energy of the exhaled air stream.

Weaver and Strausbaugh argue the value of loudness in

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[2] Carl B. Cass, A Manner of Speaking (New York, 1961), p. 52.

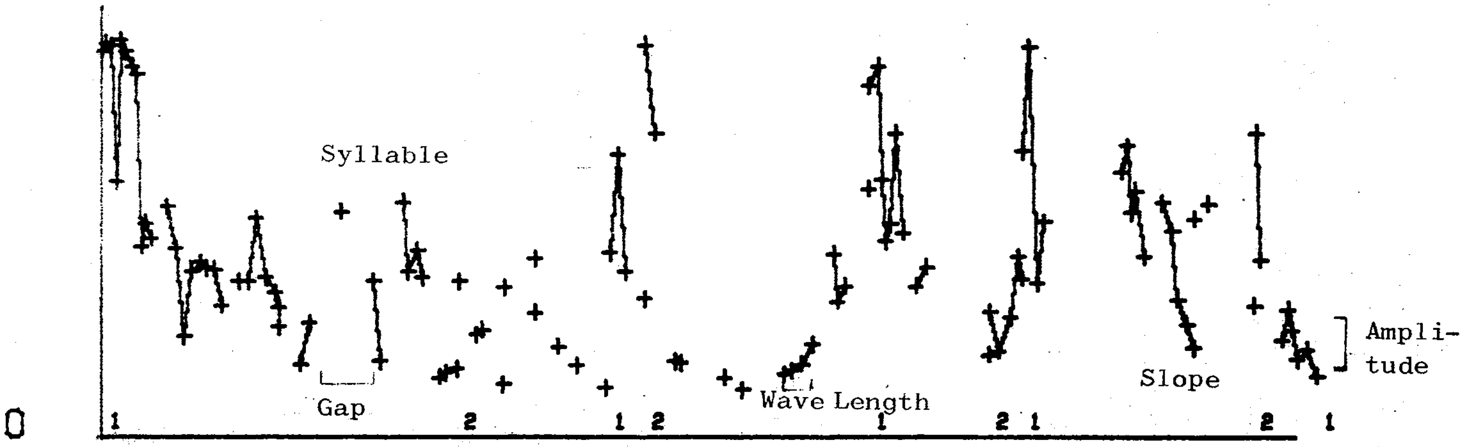

Figure 1. Mathematical Indices for Mesowave Analysis

the following terms:

> Loudness may be used as subtly as pitch and time to vary the carrier signal when we talk. A word said more or less loudly than other words will be emphasized that is, made to stand out from others so that it will be noticed. Loudness can be varied within a word or syllable. It is primarily loudness that accents a syllable in a multisyllabic word. The infinite opportunity to vary the loudness of the speech from one instant to another contains all the opportunities for adding vocal cues as pitch and time.[3]

Closely related to the concept of loudness and intensity is the concept of amplitude. Cass defines the amplitude of a sound wave as the measure of distance of vibration. Thus, a sound wave of strong intensity will have a relatively large amplitude close to its source. An increase in the intensity of a sound wave is accompanied by an increase in the amplitude of the vibration, and, consequently, a louder sound. Ecroyd, Halfond, and Towne, in their book, Voice and Articulation, recognize that there does exist a relationship between loudness, intensity, and amplitude, though its exact nature is not clear.[4] The current research effort will attempt to describe and examine this relationship. Although the relationship between these factors is somewhat ambiguous, the importance of these three factors within the conversational bond has been recognized and should not be overlooked. Keltner gives considerable

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[3] Carl H. Weaver and Warren L. Strausbaugh, Fundamentals of Speech Communication (New York, 1964), p. 292.

[4] Donald H. Ecroyd, Murray M. Halfond, and Carol C. Towne, Voice and Articulation (Glenview, Ill., 1966), pp. 52-53.

recognition to the concepts. He suggests that intensity in vocal communication will vary within tolerable limits. If intensity exceeds these limits in either direction, the communication message may be destroyed. Vocal communication which is too loud, for example, may cause the listener to focus on the volume and, consequently, lose the message. In other words, the receiver simply does not perceive much of the information which is transmitted with too much intensity by the speaker.[5] Keltner not only concerns himself with excessive intensity, but also inadequate intensity as this also can create serious problems. Low intensity or a seeming lack of basic energy can result in a communication breakdown.[6]

The indices recognized to this point, intensity, loudness, and amplitude have been concerned with vocalization. Alternatively, as Goldman-Eisler suggests, another extremely important index descriptive of the conversational bond is the absence of vocalization referred to as silence or a pause. Pause can be defined as the interruption between syllables (which may also be between words, phrases, or sentences) even though it may be no more than a slight break in sound continuity rather than an actually discernible period of silence.[7]

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[5] John Keltner, Interpersonal Speech-Communication (Belmont, California, 1970), pp. 168-169.

[6] Ibid.

[7] Cass, p. 321.

In this research design, the index descriptive of this phenomenon has been identified as gap as it refers to both silence and pauses. The concept is extremely valuable in describing the process of information transfer. Its importance is further stressed by Keltner who writes that the occurrence of a pause in conversation can also be related to withdrawing from the interaction situation by choosing not to listen. When this occurs in the dyadic or two-person contact, breakdown is almost inevitable.[8]

Keltner also suggests that gaps or pauses between messages are among the most serious problems in a communication system. The passage of time following any vocal utterance deteriorates the substance and meaning of a message. Communication interactions take place in real time and that time cannot be re-experienced. The farther away the message is from its origin, the greater the likelihood of that message losing more and more of its meaning.[9]

Goldman-Eisler, in discussing the concept of silence or pause, writes that much of an interaction sequence is made up of pauses or silence. She questions the utility of pauses in the communication structure.

> What seems clear is that a large proportion of pauses in spontaneous speech does not fit in with the linguistic structure and does not seem to serve communication, indeed it may at times impede rather than facilitate decoding.[10]

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[8] Keltner, p. 177.

[9] Ibid., p. 188.

[10] Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech, p. 14.

Thus, from the literature it would seem that silence or pause is often dysfunctional to the bonding process. Rather than facilitating conversational bonding, it may impede the bonding process.

The interdependency of vocalization with time can be referred to in terms of speech-rate, another important index descriptive of the conversational bond. The rate of speech has been referred to by many names: speech-rate, speech tempo, and density. It simply refers to the speed of talking. The term can be formally defined as the number of words (or some other designated unit) spoken in a given unit of time (such as a second or a minute). Ecroyd, Halfond, and Towne suggest that people tend to evaluate speech of less than 150 words per minute as too slow in conversation, and speech above 185 words per minute as too fast.[11] They write: "Most individuals will do well to try to speak within the range of 150 to 185 words per minute."[12] Goldman-Eisler, in her research on speech rate, found the actual rate of articulation to occupy a range between 4.4 and 5.9 syllables per second.[13] Keltner also comments on the value of density. "The rate at which we speak, move, and gesture tells of our inner intensity of feeling. Each of us seems to have an inherent basic rhythm which is uniquely his."[14]

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[11] Ecroyd, Halfond, and Towne, p. 110.

[12] Ibid.

[13] Goldman-Eisler, p. 117.

[14] Keltner, pp. 172-173.

Thus density, or the syllable rate per second as it is defined in the proposed research, is an extremely valuable index for describing the conversational bond. The bonding element, for example, can be affected by speech that is too fast and also by speech that is too slow. Keltner reviews both of these possibilities. Generally, an individual can listen to vocal communication about three times faster than he can produce meaningful vocalization. However, at times the communicator may attempt to send messages faster than the listener can receive them. At this point, the system becomes vulnerable to a breakdown. Breakdown can also result from too little information being transmitted. This can cause the listener to lose the thread of the presentation, and once lost, he may never be able to recapture it.[15]

Goldman-Eisler suggests that a second meaningful measure of the relationship between speech and pauses is hesitancy defined as the ratio of pause time to speech time. In discussing the meaning of hesitation, Goldman-Eisler writes that the measure is an indicator of the internal act of generating information rather than of the statistical predictability of the linguistic expression. Consequently, once an expression becomes habituated, the link between hesitation and information disappears.[16]

The interrupt index is another measure related to the

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[15] Ibid., pp. 172-173.

[16] Goldman-Eisler, Psycholinguistics, p. 57.

conversational bond. In regard to the concept, Keltner writes, "Any interruption of the flow of messages and feedback in a speech-communication interaction causes a breakdown, however minor it may be in communication."[17] Mishler and Waxler, in their study on interaction in schizophrenic and normal families believe that the interruption index offers valuable information regarding the interaction process. They further reduce the index to two types of interruptions: successful and unsuccessful. In the first instance, a speaker stops when interrupted, leaving his idea incomplete. In the second instance, the interrupted person continues to talk so that the two persons are talking simultaneously. Mischler and Waxler treat the rate of interruptions and simultaneous speech as an indicator of fragmented or disrupted communication similar in function to repetition, incomplete sentences, fragments, and laughter.[18]

Farina's treatment of the concept of interruption is similar to that of Keltner and Mishler and Waxler. In his study comparing two types of schizophrenic parents with parents of tuberculosis patients, he suggests that total interruption rate may stand as indicators of family conflict.[19] Interruptions, then, seem to break the flow of communication. They function as static within the channels.

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[17] Keltner, p. 185.

[18] Elliot G. Mishler and Nancy E. Waxler, Interaction in Families (New York, 1968), p. 40.

[19] A. Farina, "Patterns of Role Dominance and Conflict in Parents of Schizophrenic Patients," Journal Abnormal Social Psychology, 61 (1960), pp. 31-38.

Thus, the index appears to be an excellent source for describing the bonding concept.

Two of the indices selected, number of syllables per mesowave and wave length, have reference to the length of the vocal utterance. Cass treats the concept wave length in terms of sound duration. On the concept, Cass writes:

> Any sound lasts for a discernible length of time. It might be very short and staccato, like a gunshot, or long and drawn out, like the tone of a siren.
>
> . . . Although the meaning of sound duration is simple and easy to understand in terms of any single sound, the timing of a series of sounds of varying lengths of duration that are separated by intervals of silence (or breaks in sound continuity) which are also varied in terms of time duration can be very complicated.[20]

Goldman-Eisler recognizes the length of vocal utterances both in terms of the number of syllables per utterance and the length of the wave in time.

> The total amount of speech can be measured either as the total duration of the vocal activity in the utterance, or be expressed by the number of words, syllables, or letters produced in it. The latter quantity has the advantage of allowing the elimination of irrelevant vocal production, i.e., noise, such as repetitions of the same words, or other obvious forms of marking time vocally.[21]

The concept of wave length has reference to the duration of the vocal utterance in time. The concept of points has reference to the total number of syllables vocalized in any given utterance. Both are closely related to the density index. However, these indices have the added

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[20] Cass, p. 61.

[21] Goldman-Eisler, Psycholinguistics, p. 54.

advantage of revealing the length of the vocal utterance either in terms of time or the number of syllables emitted. As Goldman-Eisler suggests, these indices can be extremely useful in describing the information transfer loop.

The last two indices formulated for this research design are area and slope. Both indices are created by a dual function of intensity and time. However, both produce unique descriptions of the conversational contact. The area measure is an integral function of time and intensity. The slope measure is an exponential function of time and intensity. The area index is a summation of the space within the boundaries of the wave-like formation for any given vocal utterance. Thus, it is a technique for describing an actor's energy investment for any given vocal utterance. Total area can also be obtained for the entire contact by summing the areas of each unique mesowave.

Slope, on the other hand, represents the acceleration or deceleration of the energy investment. A very steep slope, for example, indicates a very rapid investment of considerable energy. A flat slope suggests little or no fluctuation in energy investment. A positive slope indicates that a speaker begins at one level of loudness and gets louder as he continues. A negative slope suggests that a speaker begins with greater intensity than he finishes. It is hoped that the relationship of these indices to the previously discussed indices can be established.

These indices will provide the form and structure for the research under consideration.

CHAPTER V

THE EMPIRICAL MODEL

In order to present the empirical model most effectively, the following chapter disgresses somewhat from a traditional approach. The chapter begins with a discussion of the sample and experimental setting. The second part of the chapter delineates a list of terms and their usage in this research. The definitions are given first in order to aid in understanding succeeding sections in the chapter. The third part of the chapter is devoted to a discussion of the eleven computer phases through which the data has been taken. An awareness of the various data phases facilitates understanding of the hypotheses. Thus, the chapter concludes with a list of the hypotheses developed for this research effort.

Research Setting and Sample

The data source for the research under consideration was seventy unique dyads. Upper level college students were paired for five minutes of conversation, from a group of 47 students, 27 females and 20 males. A list of the students and the dyads in which they participated can be found in Appendix A. The students were instructed to talk about anything they wished. Subjects were only slightly acquainted and were fully aware that their conversations were being recorded. For the most part, female subjects participated in both a female-female dyad and a male-female dyad. Likewise, male subjects participated in both a male-male dyad and a male-female dyad.

Operational Definitions

The following operational definitions of vocal intensity characteristics have been formulated for this research:

Amplitude - range in loudness variation for vocalized syllables.

Area - summation measure of energy investments. It is an integral function of intensity and time. It is that part of the curve bounded by the horizontal axis and the curvilinear function.

Banding - tendency for certain intensity levels to occur more frequently than others.

Density - the number of vocalized syllables per second.

Equilibrium - ratio of the lower to the higher syllable output by two actors.

Hesitancy -	ratio of gap time to speech time.
Intensity shift -	difference in millivolts between any two adjacent intensity levels.
Intensity level -	specific intensity value in millivolts representative of one vocalized syllable.
Interactor gap -	the length of a silent pause (in time) between actor emissions.
Interrupt -	overlap in vocal emissions of two actors. Simultaneous vocal emissions from both actors.
Intra-actor gap -	the length of a silent pause (in time) between adjacent mesowaves (see below) emitted by the same actor.
Interactor mesowaves -	series of mesowaves which involve the actor transmissions of both actors.
Intra-actor mesowaves -	series of uninterrupted mesowaves emitted by the same actor.
Mesowave -	two or more microwaves - an uninterrupted or continuous

string of vocalized syllables terminated by a period of silence or by vocalized emissions from the other actor.

Microwave - the peak digital value in millivolts of one vocalized syllable.

Slope - ratio ($^{y}/x$) of intensity variation (y) and time (x) for a series of syllables.

Spectrum - range of loudness levels, the range being from 0 to 999 digital units where a digital unit is approximately .005 volts.

Syllable interval - the length of time between adjacent vocalized syllables regardless of actor.

Wave length - time duration of a mesowave in seconds. The wave is measured from trough to trough.

Phases of Methodology

The methodology employed in the administration of the present research involves numerous computer manipulations. The design is an initial effort to develop a computer-based mathematical analysis of the conversational bond. To achieve this analysis, eleven computer phases have been launched.

Before the initial computer phase could be undertaken, special manipulation of the audio tape equipment was necessary. An amplifying unit was connected to the tape recorder into which was built a rectifier and filter system. The purpose of the rectifier system was to convert the alternating current passing through the recorder to direct current in order to eliminate all negative values. The elimination of the negative values was primarily a simplifying technique as the positive and negative values in this alternating current are simply mirror images of one another. The filter was a system of resistors and capacitors which neutralized fluctuations in tone. The filters functioned as a means of removing differences due to tone or pitch so that only loudness variation remained. The reason for this manipulation was to eliminate error which might be attributed to the interdependence of these two factors upon one another. Once these manipulations were made and the conversations had been recorded, the first computer phase was executed.

Phase I of the computer analysis was a conversion of the magnetic fluctuation representing vocalization to a digital record. The tape recorder was connected to an analog digital converter whose sample rate can be controlled by the operator. The purpose of this connection was to give a digital reading as an analog of loudness. The analog units passed to the computer correspond to the voltage units of the filtered recording. The input to the analog-digital converter was restricted to a maximum of five volts. This truncated a small portion of the upper range, but afforded maximum legibility over the remainder of the intensity range. The digital units ranged from 0 to 999 units, although in actuality, no unit goes above 965, the equivalent of the five-volt maximum. Thus, one digital unit is approximately equivalent to .005 volts. The sampling rate used with these dyads provided fifty digitized samples per second. The rationale for sampling vocal output fifty times per second was to obtain a sample for each second of output sufficiently large enough to insure that the maximum value of each vocalized syllable was obtained. A sample rate of fifty analog digits per second insures the high level of accuracy desired. Thus, for each second of the five minute contact, the vocalization pattern was sampled fifty times per second, producing a record of approximately 15,000 digits for each dyadic contact. This phase of the analysis delineates the data in its most voluminous form.

Phase II of the computer analysis was a pictorial or graphic representation of the digital record produced in Phase I. In the graphic depiction of these conversations, intensity is pictured on the vertical axis and time on the horizontal axis. The primary purpose of this particular computer phase was to create a visual image of the auditory patterns to aid in theory building. The plots proved extremely valuable as a first step toward recognizing that differences between dyads do exist. The plots offer a precise pictorial representation of the digital record.

The third computer phase constitutes the first attempt to condense the data. The purpose of this computer phase was to abstract from each record those maximum intensity values indicative of each vocalized syllable by establishing well-defined intensity controls. At the same time, by establishing time controls, syllables were chained together in their natural sequence, thus forming syllable strings or mesowaves. The controls discussed in the following paragraphs were the outgrowth of the theoretical model discussed earlier and the findings delineated in the literature.

Lennard and Bernstein, in their book, Patterns in Human Interaction, suggest that there has been considerable controversy concerning how the flow of interaction should be segmented. The problem appears to have become polarized around the issue of "natural" versus "artificial" units.[1] Barker, in his book, The Stream of Behavior, argues that "natural" behavioral units represent self-generated parts of the stream of behavior.[2] Bales' research also places

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[1] Henry L. Lennard and Arnold Bernstein. Patterns in Human Interaction (San Francisco, 1969), p. 53.

[2] R. Barker, The Stream of Behavior (New York, 1963).

emphasis on the "natural" unit.[3] The following design proposes use of the natural unit referred to as a syllable string. By definition, a natural syllable string, called a mesowave, can be terminated by two conditions: (1) a lapse of time filled with silence or (2) vocalization created by the other partner. For the latter, the program terminated one mesowave and began another when one actor ceased talking and the other actor commenced. This procedure was quite simple as the unabridged data was coded by actor sequences. The first control was not quite so easily manipulated. At this point, it was necessary to establish a span of time which might be considered a time lapse. Goldman-Eisler, in her book, Psycholinguistics: Experiments in Spontaneous Speech, uses one-tenth of a second as a time lapse sufficient to denote a pause.[4] Her research indicates that pauses were never longer than three seconds and that 99 per cent were less than two seconds. For the current research effort, the time segment selected was four-tenths of a second. The selection of this time segment was based upon findings in the literature reviewed earlier. The literature on the concept of syllable rate tended to indicate that the mean rate of normal speech is between six and eight syllables per second. With having sampled at the rate of 50

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[3] R. F. Bales, Interaction Process Analysis (Cambridge, Mass., 1950).

[4] F. Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech (New York, 1968).

samples per second, each record has available approximately eight digital samples representative of each syllable. Thus, selection of .4 seconds would correspond approximately to the amount of time needed to vocalize between two and three syllables, which was deemed a sufficient amount of silence to mark the termination of a continuous syllable string.

In addition to the mesowave controls, it was necessary to establish controls for locating the intensity value representative of each vocalized syllable (microwave). The first control needed was a control establishing the minimum time interval to exist between syllables. Having sampled in Phase I at 50 samples per second, if a maximum speech rate could be maintained, there would be approximately six digital samples for each vocalized syllable. Consequently, the control was set to six digital samples which corresponds to .12 seconds. This insures a minimum of .12 seconds between any two adjacent vocalized syllables.

In addition to the time controls, it was necessary to establish one intensity control; that is, the minimum intensity level which could be tolerated. As has been previously indicated, intensity translated to an analog of digits ranging from 0 to 999. Usage of the analog digital converter indicates that intensity values whose digital representation is less than 20 (100 millivolts) can be interpreted as machine noise. Thus, only digital values of 20 (100 millivolts) or above were retained as microwave values. With these controls identified, Phase III was executed for all 70 dyads, resulting in the first condensation of the data. All succeeding data phases were executed by using this abridged data set.

Before Phase IV of the computer analysis was executed, Phase II underwent a second execution. It will be recalled that in the first execution of Phase II, the plots acquired were graphic representations of the unabridged digital record. The second execution of Phase II resulted in a graphic representation of the abridged data produced in Phase III. Sample plots of the various dyad structures can be found in Appendix C. The plots represent each mesowave and its family of microwaves. Again, the purpose of the plots was to aid in theory building. They also afforded valuable insight into the descriptive mathematical phase which is to follow.

Phase IV of the computer analysis can be characterized as an attempt to describe in mathematical terms the mesowaves extracted in Phase III. Thus, for each mesowave having three or more syllables, six measures were abstracted: (1) slope, (2) amplitude, (3) wave length, (4) area, (5) density, and (6) number of syllables per mesowave. These measures were not acquired for mesowaves consisting of only one or two syllables due to the instability associated with such short vocalized emissions. In addition to these six measures obtained uniquely for each mesowave, several summary measures were retained independently for each actor in the dyad. The reason for this was to facilitate the analysis of differences which might be attributable to actor make-up. In addition to summary measures obtained for each actor, summary measures were also retained for each two and one-half minute segment of the five minute contact. The purpose of this was to facilitate the analysis of the contact as it progressed in real time. The primary interest was to determine the effect of time on the contact. Figure 2 illustrates the design of the output for one actor. The summary table is comprised of seven rows and twelve columns. The first six columns are summary measures for actor one. The second six are summary measures for actor two. The first three measures in row one were the number of mesowaves comprised of either one, two, or three or more points. The second three measures in row one represent a summary of the time in seconds for which there was silence, short emissions (mesowaves of only one or two points), and longer emissions (mesowaves of three or more points). The next three rows are summary measures of the six aforementioned variables associated with each unique mesowave. Row two delineates the over-all mean slope, amplitude, wave length, area, density, and number of points (syllables) per mesowave for each actor. Rows three and four delineate the means of each of these variables for each actor for the first and second halves, respectively. Row five digresses from the mesowave analysis. The summary measures obtained here are more macroscopic in nature. Again, though, the analysis is by

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              1PTS     2PTS     3PTS      gap    short     long
              35.0     21.0     48.0     50.2      4.3     54.4

              SLOP     AMPL     WLEN     AREA     DENS      PTS
              -2.6      3.5      0.9      3.1      5.9      4.9

1st H         -2.3      3.5      0.9      3.3      5.8      4.9
2nd H         -3.2      3.4      0.8      2.7      6.1      4.8

             AREAT    AREA1    AREA2     TPTS     MES1     MES2
             150.1    110.0     40.1    104.0     33.0     15.0

              +SL1     -SL1     +SL2     -SL2     +SLT     -SLT
               4.2     -6.0      2.9     -7.2      3.8     -6.4
COUNTS        12.0     21.0      6.0      9.0     18.0     30.0

                                       Dyad 1
                                       Seconds    283.7
                                       Talk       127.9
                                       Silence    132.1
                                       Interrupt   23.8
                                       Actors   18 & 30
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Figure 2. Layout of Computer Phase IV

actor. The summary measures represented include each actor's total area, area by halves, total number of vocalized syllables, and total number of mesowaves for each half, respectively. Rows six and seven are devoted to an analysis of the slope function. Slope is differentiated on the basis of its sign. Thus, positive and negative slopes are analyzed independently of each other. Likewise, slope is analyzed by actors and by halves. Row six, then denotes the mean positive and negative slope by actor for the first and second half and for the total contact. Row seven gives a frequency count of the number of positive and negative slopes for the first and second half and for the total contact.

As is readily apparent, Phase IV of the analysis produced numerous variables descriptive of the mesowave phenomena. However, it is also readily apparent that many of these overlap with one another. Thus, Phase V of the computer analysis was an attempt to allow the dependent variables to group naturally in order to determine the relation of the variables on one another. Phase V is another effort to reduce the data to a more manageable form. More precisely, Phase V was a computer program which factor analyzed all of the descriptive indicators previously mentioned. The factor analysis made it possible to observe the loading pattern of the 84 variables extracted from each dyad record. This data phase also produced a correlation matrix, thus allowing one to observe the degree of association between dependent variables. The factor analyses were run by dyadic structure producing three main analyses: (1) male-male set, (2) male-female set, and (3) female-female set.

The execution of the fifth computer phase stimulated the development of the last six phases. With the completion of Phase V, the relationships between the variables began to emerge. Thus, computer Phase VI produced a series of _t_ tests comparing the variables discussed in Phase IV first by actor and second by halves, incorporating the _t_ values obtained, and the associated probabilities. The _t_ test applied to the data was the _t_ test for paired samples. The rationale for this can be found in the theoretical model. The conversational bond can be pictured as a veridical social system in real time. The bond is created between the two actors as information cycles within the system. Thus, it cannot be assumed that each actor's responses are totally independent of one another. Likewise, it cannot be assumed, then, an actor's response pattern in the first two and one-half minutes are totally independent of his response pattern in the second two and one-half minutes. For this reason, the _t_ test assuming dependence between samples was chosen.

The seventh computer phase can be described as a special analysis of the slope function in all mesowaves. As will be recalled, the analysis of slope to this point has been to calculate the mean positive and negative slope by actor and by halves. However, with each computer phase, it became readily apparent that this procedure was not producing the greatest accuracy desired. An examination of the pictorial plots produced in the second execution of Phase II revealed that slope divided naturally into four categories: (1) monotonic positive, (2) monotonic negative, (3) polytonic positive, and (4) polytonic negative. A monotonic slope is one which does not change direction. A polytonic slope is one which does change direction. With this concept in mind, Phase VII of the computer analysis was an attempt to apply selected indices to monotonic and polytonic mesowaves. First, a frequency count of the number of monotonic positive and negative and polytonic positive and negative mesowaves was obtained by actor and by halves. In addition, the mean number of syllables per mesowave in each of the above was retained. As has been indicated, the slope function for monotonic and polytonic positive and negative was calculated both by actor and halves. Other indices of the conversational bond considered in this analysis phase include density, amplitude, and time. Again, a <u>t</u> test for paired data was applied comparing the indices by actors and by halves. Exact probabilities of the <u>t</u> values were also calculated.

The eighth data phase was an effort to gain more extensive analysis regarding the function of silence and specific intensity shifts. In the previously mentioned phases, there was no attempt to analyze the size of the shift between the syllables in a mesowave. However, it was established in Phase III that a minimum of .12 seconds must exist between any two microwaves (syllables). Likewise, in the preceding analysis no attempt was made to analyze the interactor or intra-actor gaps. Quite similarly, none of the preceding data phases attempted to analyze the intensity intervals between adjacent points. Phase VIII of the computer analysis attempts all of these comparisons. First, the computer program obtains a frequency count and proportional distribution of the occurrence of all possible time intervals (between syllables). In addition, the program calculates the mean and standard deviation of the syllable intervals by actor and by halves. The program also calculates the maximum and minimum syllable interval within each mesowave of three or more syllables, the mean time interval within the two-syllable mesowave, and the mean time interval within the three-syllable or more mesowave. The program is also designed to analyze the relationship between intensity and syllable interval size.

The data retained on intensity shift is a frequency count and proportional distribution of all shifts originally ranging from one to 970 by actors and by halves. This record was converted to a scale of one to 97 by dividing all values by 10. In addition, means and standard deviations of the intensity shifts were calculated. The analysis also included a record of the maximum and minimum intensity shifts by actor and by halves.

Phase VIII of the computer analysis produced two distinct versions of the gap concept. The first was a frequency count and proportional distribution of the occurrence of all possible size gaps between any one actor's adjacent mesowaves. If the silence was terminated by vocalization on the part of the other actor, the act was recorded under interactor gap. Thus, computer Phase VIII produced an intensive analysis of intensity shifts, intra-actor and interactor gap intervals and intervals between syllables.

Phases IX, X, and XI of the computer analysis were an outgrowth of data findings in Phase VIII displaying the frequency count and proportional distribution of the intensity shifts. The data displayed an impressive degree of regularity. The proportional distribution displayed in the eighth computer phase suggested a curvilinear function which could be described mathematically. Thus, computer Phase IX was an attempt to discover a mathematical formula which would predict with a small margin of error the frequency of the occurrence of the various intensity shifts.

In conjunction with the development of the mathematical function, a tenth computer phase was executed which plotted the curvilinear function observed in Phase IX. The function was plotted for each actor and for each half within each dyad structure, resulting in twelve plots. The plots depict the observed frequency distribution and that predicted by the mathematical function delineated in Phase IX.

Phase XI of the computer analysis was an effort to analyze the banding effect of intensity shifts evident in Phases IX and X. The banding effect refers to the tendency for certain intensity levels to occur more frequently than others. The program recognized the levels at which the banding effect occurred. Likewise, it calculated the mean number of steps or levels between bands for each actor, half, and dyad set structure. The program was also constructed to picture the levels at which the banding effect occurred in an effort to determine if any given band was characteristic of a given sex or dyad sex structure.

Hypotheses

Presentation and discussion of the hypotheses have been postponed until this time in order that the reader might first become familiarized with the data phases. Familiarity with the data phases facilitates understanding of the logical sequencing of the hypotheses. For this reason, the hypotheses have been held until the computer phases could be discussed. The following hypotheses have been formulated for this research:

H_1: There is a significant relationship between the dyadic structure and the level of energy investment.

Corollary: Differences in energy investments will be greater in the mixed dyads.

H_2: The initial phase of the dyadic contact manifests greater energy investments than the terminal phase.

H_3: There is a significant relationship between equilibrium and the type of dyadic structure.

H_4: There is a spectrum of loudness indicated by a scale of loudness levels identifiable from the natural groupings of intensity variation.

H_5: The mathematically ascertained variables descriptive of conversational bonding can be reduced in number to a more comprehensive group.

H_6: There is a positive correlation between intensity intervals and time intervals.

Corollary: An increase in the vertical interval shifts will be accompanied by an increase in the intersyllable interval.

H_7: There is a significant relationship between gap and dyadic structure.

CHAPTER VI

TESTING OF THE HYPOTHESES

As will be recalled, the research effort under consideration is an attempt to analyze and describe conversational patterns by a precise mathematical analysis. Because the mathematical analysis was produced through a series of eleven computer phases, it does not seem too surprising that a voluminous number of transformations of the data has resulted. As might be expected, not all of the emergent effects arising in the data have been predicted in advance. Consequently, this chapter will deal solely with the formal hypotheses which have been stated earlier. Chapter VII will attempt to discuss, in detail, serendipitous findings.

Hypothesis 1 states that there is a significant relationship between the dyadic sex structure and the level of energy investment. A corollary to that hypothesis is that differences in energy investments will be greater in the mixed sex dyad. The energy investment being referenced is that evidenced through the previously established variables. More precisely reference is made to indices of slope, amplitude, wave length, area, density, and number of syllables per mesowave. To test this hypothesis, a series of $\underline{t}$ tests were run comparing the various indices by actor for each dyad sex structure. The results are given in Table I. In the homogeneous dyad structures, there are no significant differences by actor in energy investments as ascertained by the selected indices. In other words, in the homogeneous dyads, the energy investments of the two actors on these indices are quite similar. An examination of the *t*'s obtained in the heterogeneous set reveals significantly different results. There is a significant difference by actor for energy investments as measured by amplitude, wave length, area, and number of syllables per mesowave. The *t* values obtained are positive suggesting greater energy investments on the part of the male participant. There are two possible implications to be gained from this significance. The significance may be a function of the sex factor or it may be a function of the dyadic sex structure. In other words, male intensity patterns and female intensity patterns may be distinct enough to suggest this difference. A second possible explanation is that there may be a significant shift in the male and female patterns as one moves from the homogeneous sex structure to the heterogeneous sex structure. Thus, the first hypothesis is supported. There does appear to be a significant relationship between the level of energy investment and the dyadic structure. More specifically, differences in energy investments are greater in the mixed dyad structure as hypothesized.

Hypothesis 2 states that the initial phase of the dyadic contact manifests greater energy investments than the

TABLE I

ACTOR ENERGY INVESTMENTS FOR THE MIXED SEX DYAD STRUCTURE

Index	t	p
Slope	1.47	.146
Amplitude	3.99	.001***
Wave Length	2.38	.021*
Area	4.62	.001***
Density	- .41	.684
Points	2.19	.032*

*$p < .05$

**$p < .01$

***$p < .001$

M-F: $n_1 + n_2 = 4049$

terminal phase. To test this hypothesis, two series of t tests were run. The first series of tests compared each actor's performance in the first half of the five-minute contact to his performance in the second half of the five-minute contact. The comparisons made used the six variables previously mentioned. The purpose of these comparisons was to ascertain whether or not any given actor's energy investments accelerated or decelerated as the interaction progressed in time. The results of the t tests are given in Table II. As can be seen, in the male-male structure, three significant statistics can be noted. There is a significant difference between the density index for both actors as one moves from the first to the second half. It is noteworthy that the t values are positive indicating a decline in speech rate as the contact progresses in time. The final significant index to emerge is the t value obtained by comparing the summed area in the first half to that in the second half for actor one. The t value is negative suggesting a substantial increase in energy investments in the second half of the five-minute contact as measured by this particular index.

In the female-female structure, the only significant statistic is the amplitude index of the first actor. The t is positive suggesting a significant decline in intensity shift as one moves through the five-minute contact. At this point, it is difficult to determine why the amplitude index would be significant for one actor and not the other. To

TABLE II

COMPARISON OF ACTOR ENERGY INVESTMENTS BY TEMPORAL HALVES

Index	Male-Male				Female-Female				Male-Female			
	Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
	t	p	t	p	t	p	t	p	t	p	t	p
Slope	- .08	.932	-1.08	.298	-1.70	.105	- .80	.562	- .37	.716	.24	.809
Amplitude	1.49	.152	.64	.536	2.25	.037*	1.52	.144	1.28	.208	3.94	.002**
Wave Length	-1.44	.165	- .70	.502	.95	.645	1.51	.146	2.07	.043*	2.95	.006**
Area	- .93	.633	-1.79	.089	.45	.657	.45	.661	.95	.647	2.77	.009**
Density	2.16	.044*	2.86	.011*	1.76	.094	1.63	.119	1.28	.208	1.84	.070
Points	-1.36	.187	- .52	.616	1.23	.236	1.48	.154	2.12	.039*	2.96	.005**
Summed Area	-2.84	.011*	-1.90	.072	- .55	.592	-1.21	.242	-2.69	.010**	.37	.714
Mesowaves	-1.65	.114	-1.31	.207	-1.19	.247	-2.08	.052	-3.73	.001***	-1.60	.115

*p < .05

**p < .01

***p < .001

M-M: $n_1 + n_2 = 1995$

F-F: $n_1 + n_2 = 1868$

M-F: $n_1 + n_2 = 4049$

determine this, other distinguishing variables would have to be extracted and controlled.

Examination of the male-female structure reveals the greatest differences. For the male actors in this dyad structure, significant differences between the first and second half can be seen for wave length, number of syllables per mesowave, summed area, and number of mesowaves. The _t_ values of the latter two indices are negative indicating an increase in the summed area and the number of mesowaves from the first to the second half. However, the _t_ values obtained by comparing halves for the wave length and the number of syllables per mesowave are positive suggesting a decline in the mean number of points and the mean wave length as time progresses. Because the number of points per mesowave and the wave length decrease from one half to the other, the fact that an increase is observed in the area and number of mesowaves by halves might appear to be a contradiction. The implication suggested by this pattern is that although total energy investments are greater, the male's speech patterns become more fragmented. As time progresses, the speech utterances of the male become shorter and somewhat choppier. There will be more breaks and pauses in his vocal emissions. In other words, speech utterances are significantly more fragmented in the second half of the dyadic contact for the male actor in the heterogeneous dyad structure. For the female participant in the heterogeneous dyad structure, four significant _t_ values emerge. There is a significant difference in energy investments between the first and second half as measured by amplitude, wave length, area, and number of syllables per mesowave. As will be noted, the t values obtained are positive suggesting a significant decline in energy investments from the first to the second half.

The second series of t tests dealing with Hypothesis 2 compared actor one's to actor two's performance in the first half and actor one's to actor two's performance in the second half. The purpose of these tests was to determine if differences in energy investments between actors by halves could be ascertained. Table III gives the results of these tests. No significant differences were found in the homogeneous dyad structures. However, in the heterogeneous dyad structure, several differences are apparent. On the amplitude and area indices, differences were found in both the first and second half. It should be noted that the t values obtained in the second half of the contact are substantially larger suggesting greater differences between actors in the second half. The t values obtained for the wave length index and the number of syllables per mesowave are also significant for the second half of the five-minute contact. This suggests that on these particular indices, in the first two and one-half minutes of the contact, there was very little difference between the energy investments of the two partners. However, movement into the second two and one-half minutes established significant differences. The

TABLE III

COMPARISON OF ENERGY INVESTMENTS BETWEEN ACTORS BY TEMPORAL HALVES IN THE MIXED SEX DYAD STRUCTURE

Index	Male-Female			
	Half 1		Half 2	
	t	p	t	p
Slope	.61	.552	1.53	.130
Amplitude	2.07	.043*	4.23	.001***
Wave Length	1.27	.209	2.78	.009**
Area	3.05	.004**	5.49	.001***
Density	- .83	.585	.09	.923
Points	1.25	.217	2.68	.011*

$*p < .05$

$**p < .01$

$***p < .001$

M-F: $n_1 + n_2 = 4049$

positive _t_ values obtained suggest increased energy investments on the part of the male and decreased energy investments for the female participant. The implication is that as the interaction progresses in time, the two actors move away from an equilibrium model rather than approaching one within the five-minute time period.

The data suggests some support for the hypothesis if reference is made specifically to the heterogeneous dyad structure. If reference is made to the homogeneous dyad structure, the hypothesis must be rejected as the data suggests very few differences, most of which may be ascribed to chance variation.

The third hypothesis states that there is a significant relationship between equilibrium and dyadic structure. It will be recalled that equilibrium has reference to the ratio of less to greater vocal outputs on the part of both actors. A ratio of 1.00 would suggest equal participation. Therefore, the closer the measure is to 1.00 the better the equilibrium. The ratios can be observed in Table IV. As can be seen, equilibrium is highest in the homogeneous dyad structures indicative of more equal participation on the part of both actors in the homogeneous dyads. Equilibrium is lowest in the heterogeneous dyads suggesting one partner is more active than the other. The data indicates that the greatest participation is attributable to the male actor in the mixed dyads. From a theoretical point of view, the implication is that bonding is tighter in the homogeneous

TABLE IV

EQUILIBRIUM RATIOS IN THE DYAD SEX STRUCTURES

Female-Female	Male-Male	Male-Female
.88	.96	.68

TABLE V

COMPARISON OF VOCALIZATION PATTERNS BETWEEN ACTORS

Index	Female-Female		Male-Male		Male-Female	
	t	p	t	p	t	p
2 Points	1.05	.310	.39	.704	2.19	.033*
3+ Points	.96	.645	.23	.812	3.44	.002**
Short	.78	.545	.46	.653	2.40	.021*
Long	.81	.564	.26	.795	3.65	.001***
Total Pts	1.33	.201	.04	.969	2.60	.013*
Meso 1	1.38	.186	.08	.935	2.43	.019*
Meso 2	.43	.673	.32	.752	3.70	.001***

*$p \leq .05$

**$p \leq .01$

***$p \leq .001$

dyad structure.

In addition to observing this ratio, a series of t tests were run comparing each actor's short emissions with his partner's short emissions and each actor's longer emissions with his partner's longer emissions within each dyad sex structure. In this case, short emissions refer to mesowaves consisting of only one or two syllables. Longer emissions refer to mesowaves having three or more points or syllables. These two summary measures were based on a time duration. In other words, short and long emissions simply refer to a summation of the time spent in vocalizing each type. In addition, t tests were run comparing the two actors with one another within each dyad on the following variables: (1) number of two-syllable mesowaves, (2) number of three or more syllable mesowaves, (3) total number of syllables, (4) number of mesowaves in the first half, and (5) number of mesowaves in the second half. The results are shown in Table V. Within the homogeneous dyad structures, no significant differences were found suggesting that the two actors' vocal performances were similar. However, in the heterogeneous dyad structure, significant differences were found to exist for all of these factors with no exception suggesting the two actors' vocal performances were not so very similar. As will be noted, the t values obtained are positive suggesting greater participation on the part of the male actor. Thus, Hypotheses 3 is supported. There does appear to be a significant relationship between equilibrium and the dyad structure, with equilibrium seemingly better in the homogeneous dyad structure.

Hypothesis 4 states that there is a spectrum of loudness indicated by a scale of loudness levels identifiable from the natural groupings of various intensity levels. It was thought that the frequency of the occurrence of these intensity levels formed a regular pattern which could be mathematically described. To test this hypothesis, a table was built containing a frequency count and proportional distribution of the occurrence of all intensity shifts between adjacent syllables within mesowaves. The proportional distribution of the total set can be seen in Table VI. The regularity of the pattern can be observed and does suggest support for the fourth hypothesis. Once the regularity was determined, a second effort was put forth in an attempt to determine if this regularity could be mathematically described. Such a mathematical function was ascertained by means of the formula given below. The development of the formula was achieved by a trial and error basis until the closest fitting curve was determined. Table VII gives the observed and predicted distributions obtained by use of the mathematical function. The proportional distribution of the various intensity intervals can be described mathematically as follows. It should be noted that the formula works with either proportions or frequencies.

$$e^{-(\alpha+(\iota-1)\beta)}$$

TABLE VI

DISTRIBUTION OF SIZE OF INTENSITY SHIFTS FOR TOTAL SET

Size of Shift	Proportion	Size of Shift	Proportion	Size of Shift	Proportion
1 (5)	.0826	34 (170)	.0071	67 (335)	.0009
2 (10)	.0687	35 (175)	.0067	68 (340)	.0007
3 (15)	.0555	36 (180)	.0065	69 (345)	.0008
4 (20)	.0477	37 (185)	.0062	70 (350)	.0007
5 (25)	.0452	38 (190)	.0065	71 (355)	.0006
6 (30)	.0428	39 (195)	.0058	72 (360)	.0005
7 (35)	.0407	40 (200)	.0053	73 (365)	.0002
8 (40)	.0371	41 (205)	.0051	74 (370)	.0005
9 (45)	.0351	42 (210)	.0051	75 (375)	.0004
10 (50)	.0319	43 (215)	.0045	76 (380)	.0004
11 (55)	.0311	44 (220)	.0037	77 (385)	.0003
12 (60)	.0293	45 (225)	.0037	78 (390)	.0002
13 (65)	.0271	46 (230)	.0037	79 (395)	.0004
14 (70)	.0259	47 (235)	.0036	80 (400)	.0004
15 (75)	.0246	48 (240)	.0032	81 (405)	.0003
16 (80)	.0234	49 (245)	.0028	82 (410)	.0002
17 (85)	.0207	50 (250)	.0029	83 (415)	.0003
18 (90)	.0190	51 (255)	.0025	84 (420)	.0002
19 (95)	.0188	52 (260)	.0026	85 (425)	.0002
20 (100)	.0176	53 (265)	.0021	86 (430)	.0001
21 (105)	.0169	54 (270)	.0019	87 (435)	.0001
22 (110)	.0146	55 (275)	.0019	88 (440)	.0002
23 (115)	.0144	56 (280)	.0020	89 (445)	.0001
24 (120)	.0138	57 (285)	.0014	90 (450)	.0001
25 (125)	.0130	58 (290)	.0018	91 (455)	.0001
26 (130)	.0123	59 (295)	.0016	92 (460)	.0000
27 (135)	.0127	60 (300)	.0014	93 (465)	.0000
28 (140)	.0119	61 (305)	.0012	94 (470)	.0000
29 (145)	.0108	62 (310)	.0010	95 (475)	.0000
30 (150)	.0109	63 (315)	.0014	96 (480)	.0000
31 (155)	.0093	64 (320)	.0012	97 (485)	.0000
32 (160)	.0090	65 (325)	.0011		
33 (165)	.0078	66 (330)	.0010		

NOTE: Size of shift given in digital units with millivolts, divided by a factor of 10, are shown in parentheses.

TABLE VII

OBSERVED AND PREDICTED DISTRIBUTION OF INTENSITY SHIFTS 1 THROUGH 25 FOR TOTAL SET FIRST HALF

Level	Observed	Predicted	Error	Mean Error
1 (5)	.0826	.0826	.0	.0
2 (10)	.0687	.0607	-.008	-.008
3 (15)	.0555	.0566	.0011	-.0035
4 (20)	.0477	.0528	.0051	-.0006
5 (25)	.0452	.0493	.0041	.0006
6 (30)	.0428	.0460	.0032	.0011
7 (35)	.0407	.0429	.0023	.0013
8 (40)	.0371	.0401	.0030	.0015
9 (45)	.0351	.0374	.0023	.0016
10 (50)	.0319	.0349	.0030	.0018
11 (55)	.0311	.0326	.0015	.0017
12 (60)	.0293	.0304	.0011	.0017
13 (65)	.0271	.0284	.0012	.0016
14 (70)	.0259	.0265	.0006	.0016
15 (75)	.0246	.0247	.0001	.0016
16 (80)	.0234	.0230	-.0003	.0013
17 (85)	.0207	.0215	.0008	.0013
18 (90)	.0190	.0201	.0011	.0013
19 (95)	.0188	.0187	-.0001	.0012
20 (100)	.0176	.0175	-.0002	.0011
21 (105)	.0169	.0163	-.0006	.0011
22 (110)	.0146	.0152	.0006	.0010
23 (115)	.0144	.0142	-.0002	.0010
24 (120)	.0138	.0133	-.0006	.0009
25 (125)	.0130	.0124	-.0006	.0009

NOTE: Millivolts, divided by a factor of 10, are shown in parentheses.

where:

e = base of the natural logarithm (2.72)

L = intensity intervals ranging from 2 to 97

α = mean log calculated for level 3 as it is the mean of levels 1 through 6, over 12 columns for 2 actors by 2 halves by 3 dyad types.

$$\alpha = \ln\left[\sum_{i=1}^{m} \sum_{j=1}^{n} f_{ij} / (m \cdot n)\right]$$

γ = mean log of levels 21 through 26 over 12 columns for actors by 2 halves by 3 dyad types.

β = mean difference per level between γ and α

$$\beta = (\gamma - \alpha)/20.$$

Using this formula, two tests were run: One on the smoothed and one on the unsmoothed data. An examination of the data in Table VIII reveals that for the most part, the highest proportions are at the lower levels with a steady decline in the proportional distribution of larger intensity shifts as one moves from a shift of 5 millivolts to 485 millivolts. There are a few exceptions to this however. Thus, one test of the data resulted in what is referred to as smoothing the data. This refers to a shifting of the proportional distributions so that they are in hierarchial order from highest to lowest. Table VIII illustrates the data in its smoothed form. Thus, the data was analyzed in both its unsmoothed original form and in its smoothed form. In both cases, the mean error and the absolute mean error were calculated. The

TABLE VIII

SMOOTHED AND PREDICTED DISTRIBUTION OF INTENSITY SHIFTS 1 THROUGH 25 FOR TOTAL SET FIRST HALF

Level	Smoothed	Predict	Error	Mean Error
1 (5)	.0826	.0826	.0	.0
2 (10)	.0687	.0609	-.0078	-.0078
3 (15)	.0555	.0569	.0014	.0032
4 (20)	.0477	.0531	.0054	-.0003
5 (25)	.0542	.0496	.0043	.0008
6 (30)	.0428	.0463	.0035	.0014
7 (35)	.0407	.0432	.0025	.0016
8 (40)	.0371	.0404	.0033	.0018
9 (45)	.0351	.0377	.0026	.0019
10 (50)	.0319	.0352	.0033	.0018
11 (55)	.0311	.0328	.0017	.0020
12 (60)	.0293	.0307	.0014	.0020
13 (65)	.0271	.0286	.0015	.0019
14 (70)	.0259	.0267	.0008	.0018
15 (75)	.0246	.0250	.0004	.0017
16 (80)	.0234	.0233	-.0001	.0016
17 (85)	.0207	.0218	.0011	.0016
18 (90)	.0190	.0203	.0013	.0016
19 (95)	.0188	.0190	.0001	.0015
20 (100)	.0176	.0177	.0001	.0014
21 (105)	.0169	.0165	-.0003	.0013
22 (110)	.0146	.0154	.0008	.0013
23 (115)	.0144	.0144	.0000	.0012
24 (120)	.0138	.0135	-.0003	.0012
25 (125)	.0130	.0126	-.0004	.0011

NOTE: Millivolts, divided by a factor of 10, are shown in parentheses.

mean error refers to the cumulative error divided by the number of levels. This measure of error allows one to determine if the error is relatively well-distributed above and below the mean. The absolute mean error refers to the cumulative absolute error over 96 shift sizes divided by this number of shift sizes. As has been indicated, the occurrence of a few high frequencies out of order was anticipated in advance. The tendency for this to occur is referred to as a banding effect. Banding can be defined as the tendency for certain shift sizes to occur more frequently than others. This would suggest that certain intensity shifts are functionally equivalent. The fact that certain shifts continually occur suggests that they serve some function in conversation. For example, perhaps there are certain intensity shifts characteristic of beginning or ending a mesowave. There may be certain intensity shifts associated with syllabic stress. The functional significance of the band can only be implied. A comparison of the absolute mean errors of the smoothed and unsmoothed data sets reveal that portion of the error attributable to this banding effect. If the banding effect were present, it was thought that the absolute mean error should be higher in the unsmoothed data set than in the smoothed data set. Table IX reveals this comparison. As predicted, the absolute mean error is higher in the unsmoothed data set. The banding effect, the tendency for certain shift sizes to be used more frequently than others, accounts for a portion of error

TABLE IX

COMPARISON OF ABSOLUTE MEAN ERROR IN SMOOTHED AND UNSMOOTHED DISTRIBUTION OF INTENSITY SHIFTS

Actor and Half Characteristic	Female-Female		Male-Male		Male-Female	
	Smoothed Error	Un-Smoothed Error	Smoothed Error	Un-Smoothed Error	Smoothed Error	Un-Smoothed Error
Actor 1 Half 1	.0004	.0015	.0014	.0019	.0007	.0010
Actor 1 Half 2	.0008	.0014	.0014	.0018	.0012	.0013
Actor 2 Half 1	.0007	.0011	.0019	.0022	.0007	.0011
Actor 2 Half 2	.0006	.0013	.0020	.0023	.0007	.0010
Unit of Measure:	.0004		.0004		.0002	

NOTE: Unit of measure represents the single occurrence of one shift.

which can be explained but not readily eliminated. It is interesting to note that the absolute mean error is highest for the male actor suggesting that his intensity pattern is somewhat more variable than that of the female participant. This is also partially attributable to the male's bigger resonating chamber.

Since the absolute mean error is largest for the male actor, logically one would predict the absolute mean error to be largest in the male-male dyad. The data indicates this to be the case. As can be observed in Table IX, the absolute mean error is lowest in the female-female dyad structure. It is interesting to note the reduction in the absolute mean error of the male actor as one moves from the male-male dyad structure to the male-female dyad structure. However, the male still has the highest absolute mean error. This suggests that the proportional distribution of intensity intervals is affected by both sex and dyad sex structure. The fact that the male actor has the most variable pattern in both the male-male and male-female dyad structures suggests that sex is certainly creating some of the differences. However, if sex were the only factor creating this difference, the absolute mean error should be the same in both the male-male and male-female structures. The tendency for this error to become smaller suggests that perhaps the male actor is attempting to adjust to the intensity pattern of his female partner. Consequently, it appears that both sex and mixed sex dyad structure are significant factors.

The clear emergence of the banding effect based on the comparison of the smoothed and unsmoothed data sets inspired an eleventh computer program which attempted to analyze the banding. The banding effect refers to the tendency for certain intensity shifts to occur more frequently than others. Operationally, a band was defined and identified as the occurrence of any intensity shift preceded and followed by less frequently occurring shifts. The program extracted these intensity shifts and calculated the mean number of steps or shifts between them. The results are given in Table X. As can be seen, the mean number of steps between bands is extremely stable regardless of sex or dyad structure. The means range between 3.03 and 3.95 with a standard deviation of 2 or less. In addition to this data, a picture of the bands was drawn in an effort to determine if certain bands are characteristic of a given sex or dyad sex structure. However, examination of the data suggests that banding is not a function of sex or dyad sex structure.

A table of _z_ scores was developed which compared the banding pattern for actors, halves, and dyad sex structure. The pattern predicted was one in which small _z_ scores and large probabilities were produced. The rationale was that if the banding effect were similar for all actors, halves, and dyad sex structures, small _z_ scores and large probabilities would be indicative of this. The results are given in Table XI. As the table indicates, the _z_ scores are

TABLE X

BANDING EFFECT IN THREE DYAD STRUCTURES

Actor and Half Characteristics	Female-Female			Male-Male			Male-Female		
	Number of Bands	Mean Band Width	$\hat{\sigma}$	Number of Bands	Mean Band Width	$\hat{\sigma}$	Number of Bands	Mean Band Width	$\hat{\sigma}$
Actor 1 Half 1	25.00	3.56	1.63	26.00	3.23	1.25	24.00	3.63	1.75
Actor 1 Half 2	24.00	3.50	1.61	26.00	3.35	1.27	25.00	3.56	1.70
Actor 2 Half 1	23.00	3.78	1.84	26.00	3.31	1.43	24.00	3.63	1.28
Actor 2 Half 2	22.00	3.95	2.08	29.00	3.03	1.22	26.00	3.42	1.21

TABLE XI

Z SCORES FOR BAND DIFFERENCE

				Female-Female				Male-Female				Male-Male			
				Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
				Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
F-F	Act 1	H1	1	1.00											
		H2	2	-0.13	1.00										
	Act 2	H1	3	0.44	0.56	1.00									
		H2	4	0.72	0.82	0.29	1.00								
M-F	Act 1	H1	5	0.13	0.26	-0.30	-0.58	1.00							
		H2	6	0.00	0.13	-0.43	-0.71	-0.13	1.00						
	Act 2	H1	7	0.16	0.30	-0.34	-0.64	0.00	0.15	1.00					
		H2	8	-0.34	-0.19	-0.80	-1.06	-0.47	-0.33	-0.57	1.00				
M-M	Act 1	H1	9	-0.81	-0.66	-1.21	-1.43	-0.91	-0.79	-1.10	-0.56	1.00			
		H2	10	-0.52	-0.37	-0.95	-1.20	-0.64	-0.51	-0.77	-0.22	0.33	1.00		
	Act 2	H1	11	-0.59	-0.44	-1.00	-1.23	-0.70	-0.57	-0.82	-0.31	0.21	-0.10	1.00	
		H2	12	-1.33	-1.17	-1.68	-1.85	-1.40	-1.29	-1.71	-1.18	-0.59	-0.93	-0.76	1.00

Z SCORE PROBABILITIES

				Female-Female				Male-Female				Male-Male			
				Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
				Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
F-F	Act 1	H1	1	1.000											
		H2	2	0.865	1.000										
	Act 2	H1	3	0.662	0.583	1.000									
		H2	4	0.520	0.585	0.762	1.000								
M-F	Act 1	H1	5	0.863	0.786	0.758	0.570	1.000							
		H2	6	1.000	0.867	0.668	0.513	0.864	1.000						
	Act 2	H1	7	0.850	0.760	0.732	0.529	1.000	0.852	1.000					
		H2	8	0.732	0.829	0.568	0.291	0.644	0.738	0.576	1.000				
M-M	Act 1	H1	9	0.575	0.518	0.224	0.149	0.633	0.562	0.272	0.581	1.000			
		H2	10	0.608	0.709	0.658	0.229	0.530	0.618	0.553	0.808	0.738	1.000		
	Act 2	H1	11	0.565	0.661	0.680	0.215	0.507	0.575	0.585	0.749	0.818	0.882	1.000	
		H2	12	0.182	0.241	0.089	0.061	0.159	0.195	0.084	0.235	0.563	0.643	0.544	1.000

extremely small and the calculated probabilities are large, thus suggesting no significant differences in banding by actor, half, and dyad sex structure.

In addition to developing the mathematical function, a plot routine was executed which offers a pictorial representation of the proportional distributions. Figures 3, 4, and 5 illustrate this function for each dyad structure. The graphs of the proportional distribution of intensity shifts exhibit a decreasing exponential trend. The banding effect is also clearly represented in the graphs. Thus, it was desirable to determine if additional structure evident in the banding could be described as a periodic component.

The frequency of the occurrence of any given intensity shift level may be assumed to be selected from a Poisson distribution. The mean of the Poisson distribution is different for each shift level and is unknown. The standard deviation (square root of the variance) of the Poisson distribution is equal to the square root of the mean. Since the mean is unknown, the statistical error in the population of each shift level is taken equal to the square root of the population, as is common practice. If the population is zero, the error is taken to be 1.0. Thus s_i, the error in y_i, the population, is taken to be: $s_i \equiv \max(y_i, 1.0)$.

A weighted least squares fit to the data was made using an exponential function. Using standard methods, the values of A and B were calculated that minimize the weighted sum of squares:

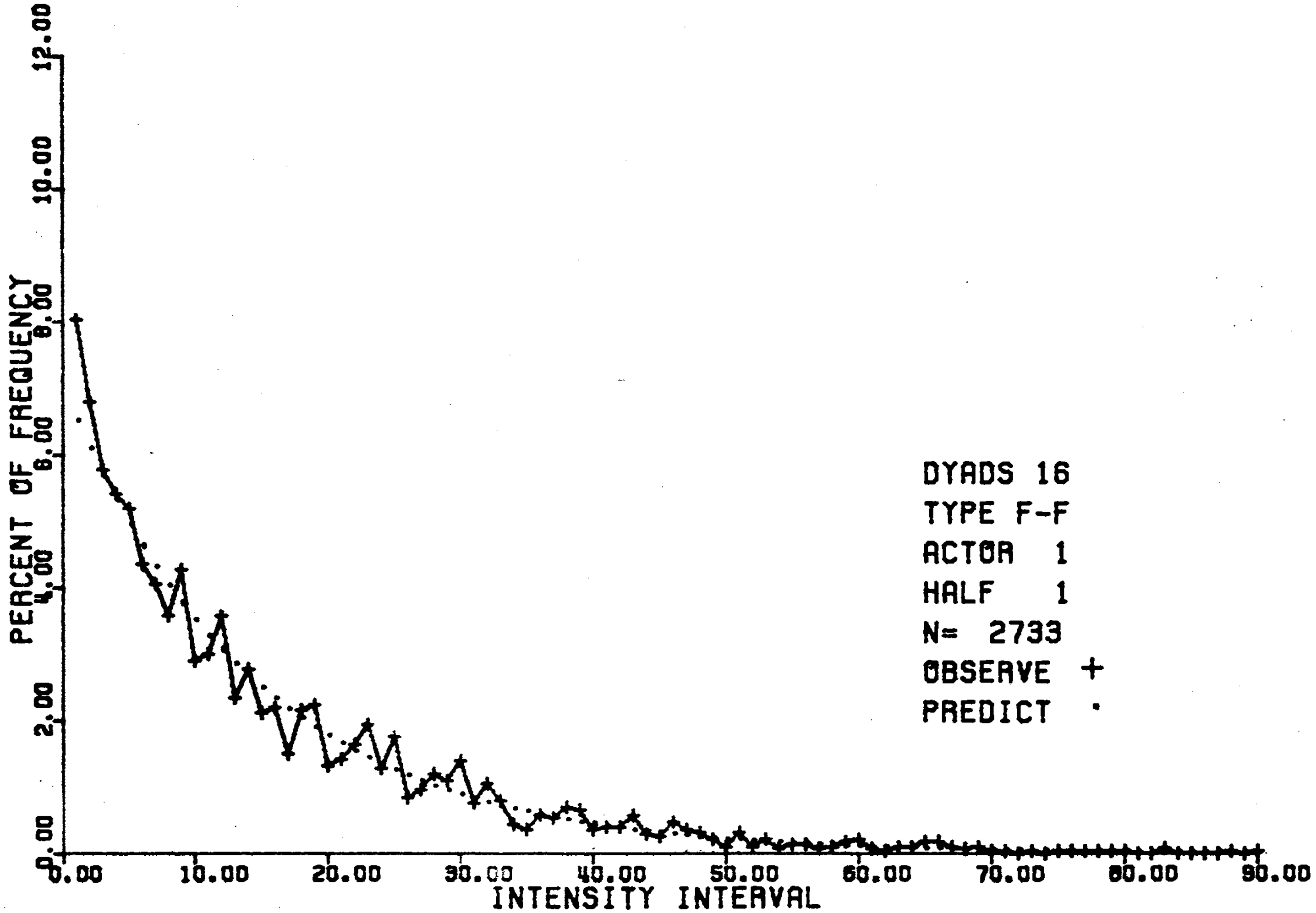

Figure 3. Distribution of Intensity Intervals - Female-Female

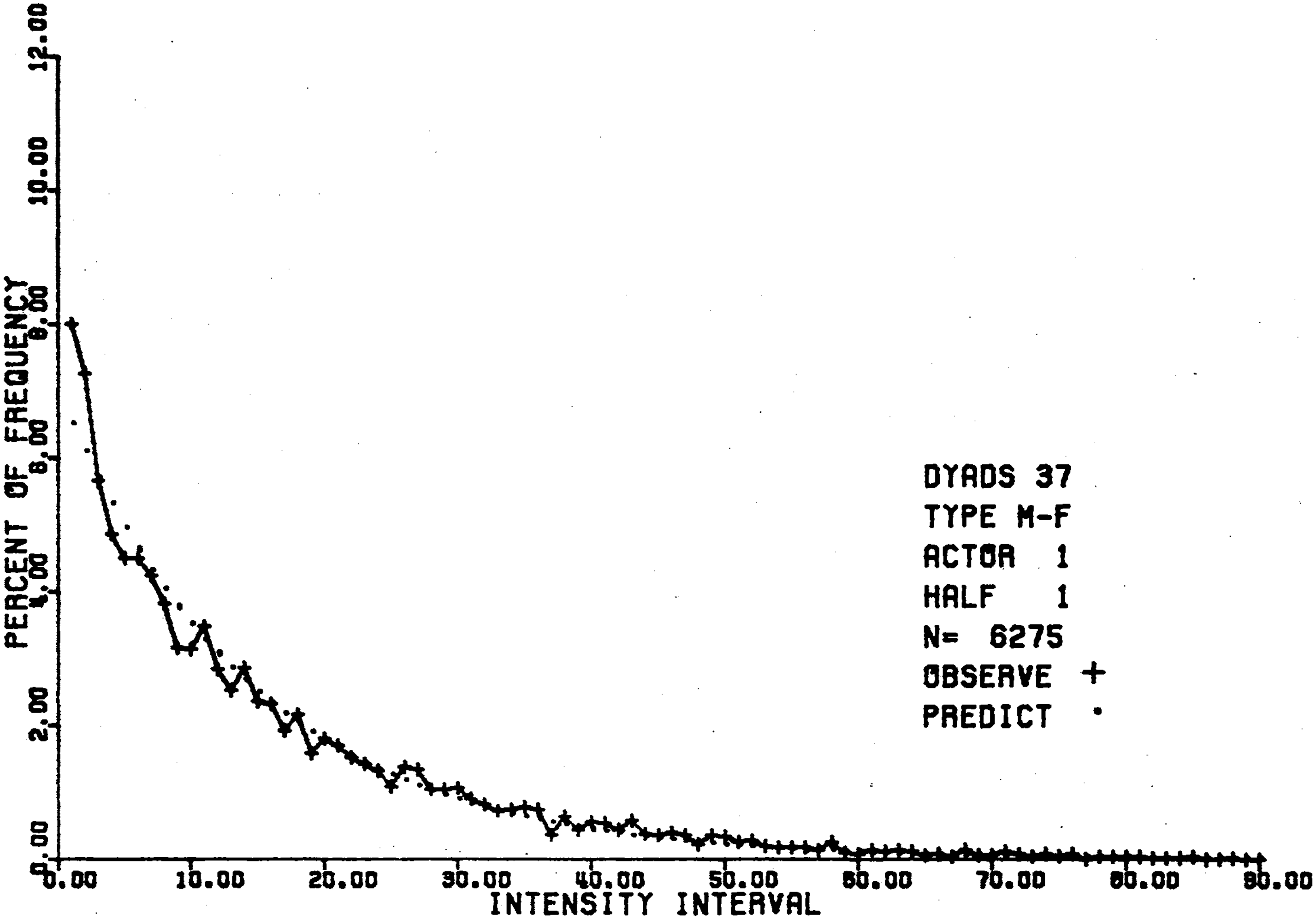

Figure 4. Distribution of Intensity Intervals - Male-Female

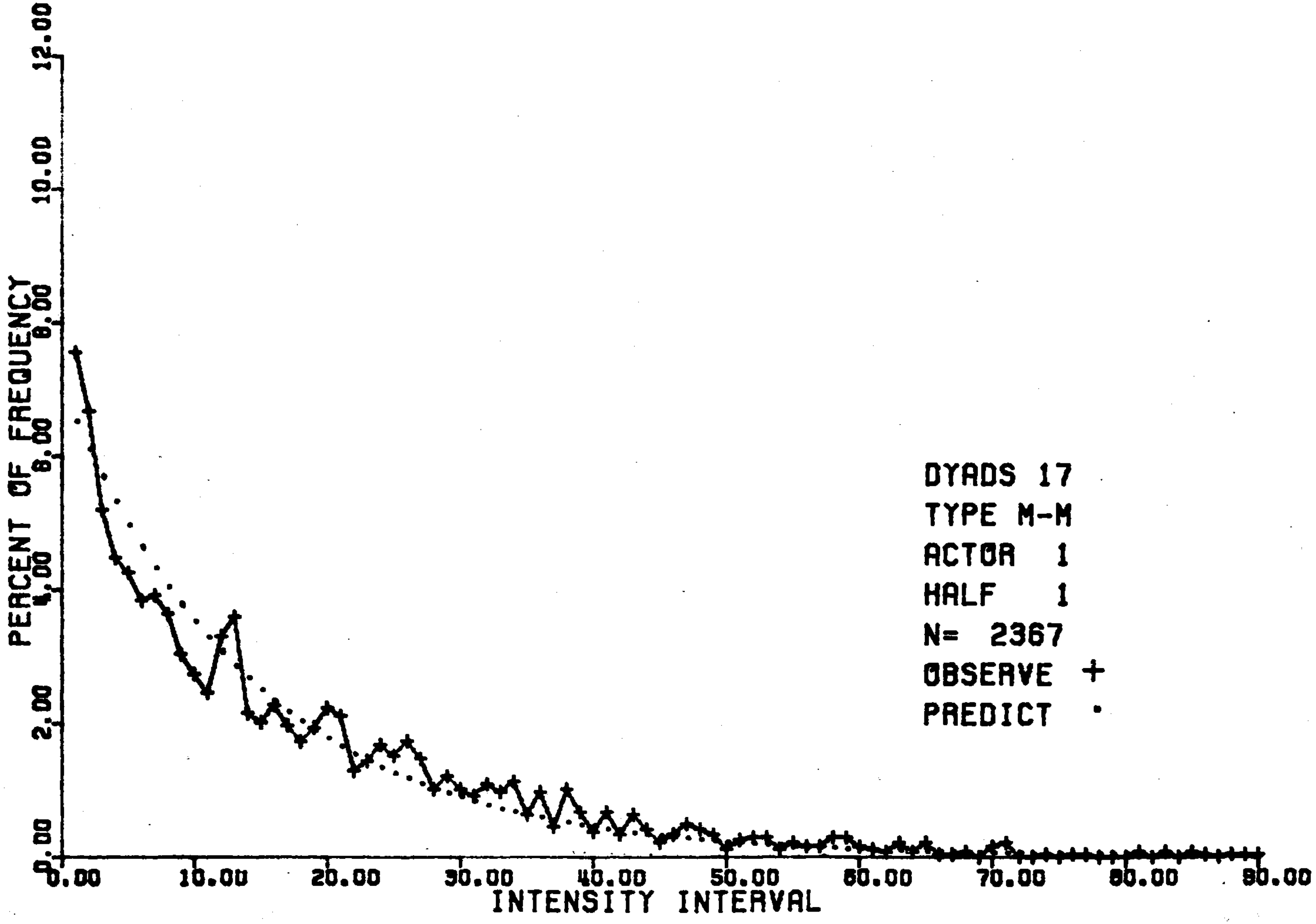

Figure 5. Distribution of Intensity Intervals - Male-Male

$$S_i = \sum_{i=1}^{n} (Ae^{bx_i} - y_i)^2$$

where:

n = the number of shift levels considered

A = the vertical axis intercept

b = the declining distance between any two coordinates by a factor of e = 2.71828

x = shift level being considered

y = population within any shift level.

The fitted value, obtained by this mathematical technique, was subtracted from each data point leaving a set of residuals. The residuals are positive and negative numbers of generally decreasing magnitude that contain the remaining structure, if any. In order to magnify the later residuals to a magnitude comparable to the preceding residuals and, thus, make more obvious any periodic component, the residuals were multiplied by the exponent $-bx_i$, where b and x_i have been previously defined.

At this point, two methods of analysis were pursued. First, the autocovariance function, $c(\tau)$, of these "detrended" and magnified residuals was computed. The autocovariance function can be defined as: $r(\tau) \equiv c(\tau)/c(0)$ where:

$$c(\tau) = {}^1\!/\!_n \sum_{i=1}^{n-\tau} (Y_i - \overline{Y})(Y_{i+\tau} - \overline{Y})$$

$$\overline{Y} = {}^1\!/\!_n \sum_{i=1}^{n} Y_i .$$

If the Y_i consist of a sine function plus random noise, the autocovariance function will be a damped sine function plus noises, as shown in Figure 6. If there is no periodic component, the autocovariance function will consist mainly of noise for $\tau \neq 0$. $r(0)$ is unity by definition (Figure 7). The autocovariance function is limited in that exact statistical tests regarding the significance of the oscillations are difficult to make. Consequently, a least squares fit of a general sine function was applied to the modified residuals Y_i. The error in Y_i is equal to t_i:

$$t_i \equiv s_i e^{-cbx_i}$$

where:

c is a constant slightly less than unity.

The sum of squares which is minimized in this second fit is

$$S_2 = \sum_{i=1}^{n} \left(\frac{d \sin(\omega x_i + \varphi) - Y_i}{t_i} \right)^2$$

where:

d = amplitude

ω = angular frequency

φ = phase.

In a nonlinear least squares fit, there may be more than one set of parameters, d, ω, φ, that give a "local minimum" in S_2. Consequently, fits were performed using two starting points for ω.

Data analysis reveals that in most cases, the first one

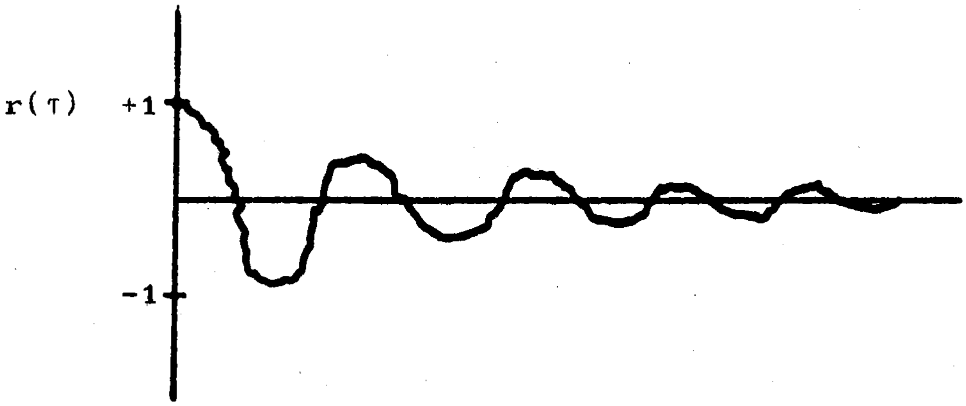

Figure 6. Graphic Representation of Autocovariance Function if a Sine Function Exists

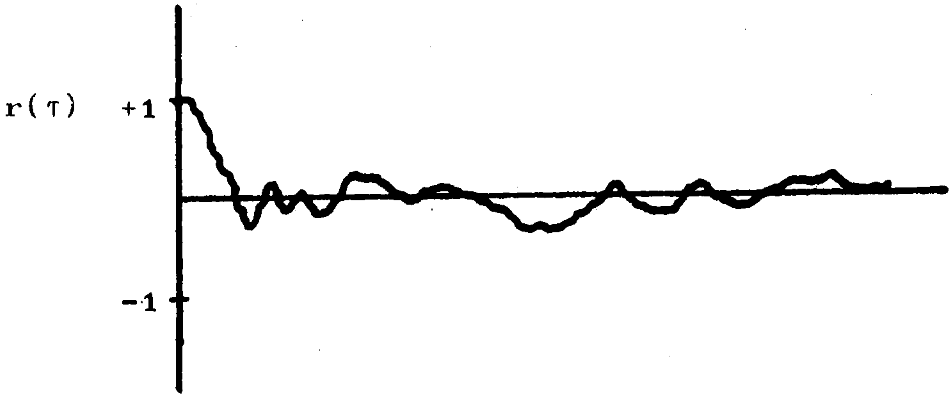

Figure 7. Graphic Representation of Autocovariance if No Periodic Component Exists

or two intensity shift levels lay above the fitted exponential values by two or three times the corresponding s_i. The value of s_i is approximately distributed as a chi-square variable with n-2 degrees of freedom. The approximation arises because the fitted function is nonlinear in the parameter b. Testing the value of s_i on this basis, an acceptable fit was obtained to the exponential in five of the twelve cases ($p > .05$). These results are given in Table XII. In the other seven cases, the distribution is exponential, but the chi square probabilities suggest that perhaps there is additional structure. The autocovariance functions were examined for evidence of structure, however none was evident as illustrated in Table XIII.

A second test using the chi square variables was performed in an effort to describe additional structure. Since chi square variables are additive, the sum of two chi square variables with m_1 and m_2 degrees of freedom, respectively, is a chi square variable with $m_1 + m_2$ degrees of freedom. For this reason, the quantity $S_1 - S_2$ can be tested as a chi square variable with three degrees of freedom. If the chi square probability is small, then the value of S_2 is significantly less than the value of S_1 indicating that there is a significant amount of sine function structure in the modified residuals. This was not found to be the case in any of the proportional distributions. From the data analysis, it can be concluded that the proportional distributions of the intensity shift levels are fairly well represented by an

TABLE XII

FIT OF THE EXPONENTIAL TO INTENSITY DISTRIBUTIONS

Actor	Female-Female		Male-Female		Male-Male	
Number	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
1	.009	.028	.012	.123*	.038	.443*
2	.626*	.160*	.013	.619*	.047	.003

Chi square probabilities:

$^*p > .05$

TABLE XIII

AUTOCOVARIANCE FOR LEVELS 2 THROUGH 12 IN ALL DYAD STRUCTURES

Level	Female-Female				Male-Female				Male-Male			
	Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
2	-.068	-.040	-.005	.112	-.029	.238	.305	.203	-.008	-.031	.273	.038
3	-.038	-.051	.024	-.099	-.005	-.044	.001	.223	-.049	-.065	.138	.185
4	-.020	-.016	-.051	-.053	.053	.087	-.203	.222	-.034	.067	.086	.033
5	-.061	.042	-.179	.112	.067	-.175	-.111	.031	-.034	.085	.061	-.041
6	.023	-.115	.124	.122	.101	.063	-.075	-.019	.273	-.101	.042	-.061
7	-.071	-.135	.008	-.287	-.020	.046	.124	-.225	-.037	-.189	-.131	-.175
8	.284	.046	-.123	-.023	-.127	-.142	.053	-.146	.073	-.199	-.031	.061
9	-.169	-.038	.186	.015	.032	.046	.206	-.151	-.001	-.090	-.069	-.091
10	.087	-.161	-.086	.082	.099	-.064	.113	-.042	-.054	-.100	-.206	-.054
11	.033	-.015	-.115	-.012	-.082	-.124	-.050	-.014	-.089	-.096	-.208	-.003
12	.014	.064	-.005	-.270	-.123	-.043	-.304	.102	-.009	-.051	-.190	.050

exponential function, particularly if the first level is not fitted, and that although there may be further structure, it is not of a simple periodic nature.

Hypothesis 5 states that the mathematically ascertained variables can be reduced in number to a more comprehensive group. Formulation of this hypothesis was the direct result of the number and diversity of indices. For example, when indices were ascertained for unique actors and halves, 84 factors emerged. The underlying thought was that many of these 84 variables were measuring the same element. The question to be answered was which of these variables were measuring the same attribute. To test this hypothesis, a correlation matrix, correlating each variable with each other variable was built. From this matrix, a factor analysis was run for each dyadic sex structure. The factor loadings reveal some interesting relationships in the data. In the male-female dyads there were 13 factors. In the male-male and female-female dyads, there were 11 unique factors, suggesting two factors might be associated with sex. Although 11 factors in the homogeneous dyads and 13 factors in the heterogeneous dyads were found, several of the factors were ambiguous. The ambiguity becomes evident in the weak loadings. However, in all three dyadic structures, there were five factors which emerged with a degree of clarity. The variables loading under these various factors can be seen in Table XIV. The similarity between the factor loadings in the homogeneous dyad structures can be

TABLE XIV

FACTOR ANALYSIS LOADINGS OF THE FIVE LEADING FACTORS

Factor 1: Energy

Male-Female wt. = 12.5				Male-Male wt. = 18.2				Female-Female wt. = 14.4			
Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
		3 pts	.809	area	.729	W L	.949	1 pt	-.617		
		long	.858	area 1	.807	area	.922	area	.590		
		W L	.594	area 2	.763	pts	.893	amp 1	.615		
		Pts	.548			W L 1	.889	W L 1	.879		
		area T	.787			area 1	.937	area 1	.876		
		area 1	.877			pts 1	.884	pts 1	.906		
		Mes 1	.860			W L 2	.775	amp 2	.619		
		Mes 2	.608			area 2	.719	W L 2	.969		
		# +sl 1	.675			pts 2	.828	area 2	.873		
		# -sl 1	.773			area T	.798	pts 2	.972		
		# -sl 2	.584			area T1	.814	area T	.759		
		# +sl T	.631			area T2	.719	area T2	.783		
		3 -sl T	.762								

KEY TO ABBREVIATIONS:

pts = Points
W L = Wave Length
Mes 1 = Mesowaves for Half 1
Mes 2 = Mesowaves for Half 2
sl = Slope
amp = Amplitude
TPTS = Total Points

shrt = Short
dens = Density
area T = Total Area
area 1 = Area for Half 1
area 2 = Area for Half 2
wt = Variance Associated With Specified Factor

TABLE XIV (CONTINUED)

Factor 2: Action

Male-Female wt. = 18.2

Actor 1		Actor 2	
3 pts	-.925	1 pt	+.733
gap	.613	2 pts	.817
area T	-.611	gap	.882
area T2	-.623		
T pts	-.749	area	-.549
Mes 1	-.795	T pts	.821
Mes 2	-.892	# +s12	.521
# +sl 1	-.719		
# +sl T	-.791		
# -sl T	-.748		

Male-Male wt. = 27.9

Actor 1		Actor 2	
1 pt	.686	1 pt	-.627
2 pts	.657	2 pts	-.878
3 pts	.973	3 pts	-.921
gap	.877	gap	-.860
shrt	.666	shrt	-.898
long	.877	long	-.816
T pts	.889	T pts	-.888
Mes 1	.795	Mes 1	.767
Mes 2	.917	Mes 2	-.868
# -sl 1	.766	# +sl 1	-.711
# +sl 2	.814	# -sl 2	-.893
# -sl 2	.831	# +sl T	-.733
# +sl T	.785	# -sl T	-.870
# -sl T	.876		

Female-Female wt. = 21.9

Actor 1		Actor 2	
2 pts	-.760	1 pt	.634
3 pts	-.849	2 pts	.524
gap	-.846	3 pts	.912
shrt	-.700	gap	.716
long	-.642	shrt	.513
T pts	-.876	long	.838
Mes 1	-.912	area 2	.724
# +sl 2	-.838	T pts	-.876
# -sl 2	-.795	Mes 2	.956
# +sl T	-.766	# +sl 2	.808
# -sl T	-.688	# +sl 1	.796
		# +sl T	.832
		# -sl T	.769

TABLE XIV (CONTINUED)

Factor 3: Intensity Rythm

Male-Female wt. = 16.2				Male-Male wt. = 10.8				Female-Female wt. = 19.1			
Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
amp	-.658	amp	-.666			amp	.829	amp	-.506	amp	-.785
amp 1	-.827	amp 1	-.805			amp 1	.875	+sl 2	-.593	area	-.815
amp 2	-.861	amp 2	-.799			amp 2	.822			sl 1	.680
area 2	-.665	-sl 1	.590			+sl 1	.719			amp 1	-.833
-sl 1	.843	+sl 1	-.667			-sl 1	-.755			W L 1	-.802
+sl 2	-.735	+sl 2	-.662			-sl 2	-.869			area 1	-.893
-sl 2	.783	-sl 2	.683			+sl T	.770			pts 1	-.782
		+sl T	-.763			-sl T	-.890			sl 2	.672
		-sl T	.715							amp 2	-.752
										W L 2	-.673
										area 2	-.877
										pts 2	-.773
										area T	-.774
										area T1	-.668
										-sl 1	-.876
										-sl 2	.532
										-sl T	.849

Factor 4: Density

Male-Female wt. = 4.09				Male-Male wt. = 2.99				Female-Female wt. = 4.95			
dens 1	-.821					dens 1	.927	W L	.602		
dens 2	-.828					dens 2	.901	dens 1	-.864		
								dens 2	-.842		

Factor 5: Density

Male-Female wt. = 3.70				Male-Male wt. = 7.73				Female-Female wt. = 3.31			
		dens 1	.796	dens 1	-.813					dens 1	.718
		dens 2	.884	dens 2	-.915					dens 2	.775
				-sl 1	.824						
				-sl 2	.792						
				-sl T	.837						

observed from the table. However, examination of the loadings in the heterogeneous dyad structure reveals precise dissimilarities when compared with the loadings in the homogeneous dyad structure. Factors which load clearly in the homogeneous dyad structure are somewhat less clear in the mixed sex dyad structure. It seems evident from this that the mixed sex factor is creating some ambiguity. The ambiguity is evident from the intermixing of the various variables in the mixed sex structure which load more consistently in the homogeneous dyad structures. Factor one has been labeled energy. Factor two has been labeled frequency of act emissions. Factor three has been labeled intensity rhythm. Factors four and five have been labeled density. The fourth and fifth factors, it will be noted, are both descriptive of horizontal rhythm. From this listing, it becomes readily evident that the density patterns of the two actors are independent and do necessarily load as unique and separate factors. However, the factor five is labeled as is factor four. The names selected are meant to be explicatory of the variables loading under each of these factors. Factor one, as can be seen, is composed primarily of variables calculated as a function of time and intensity. Factor two is composed primarily of measures calculated as frequencies of acts. They are summation measures of time or speech units. The third factor is primarily amplitude and slope. The label intensity rhythm has been applied to this factor as the variables have reference to the rising and falling pattern of the speech utterances. The fourth and fifth factors have been labeled density. The variables loading are primarily density measures, thus suggesting the label selected. The additional factors have not been declared because of the ambiguity. However, the factor analysis, as set forth, does suggest support for the fifth hypothesis. Perhaps the most significant aspect of the factor analysis was that it demonstrated the need to run the additional data phases. Consequently, it is the fifth phase, the factor analysis, which is primarily responsible for the development and execution of the last data phases.

Hypothesis 6 states that there is a positive relationship between intensity shifts and time intervals. A corollary suggested is that an increase in the intensity shifts will be accompanied by an increase in the time intervals between syllables. To test this hypothesis, reference is made to the eighth data phase. Within this data phase, a table was built which calculated the mean intensity interval for shifts of less than 500 millivolts, between 500 and 1000 millivolts, between 1000 and 1500 millivolts, between 1500 and 2000 millivolts, and greater than 2000 millivolts. The results can be seen in Table XV. Regardless of the dyadic structure, there appears to be a consistent tendency for the size of the point interval to increase as the intensity interval increases. It should be understood that reference is being made to intensity shifts or intervals, not a unique intensity level. The implication in this finding is that

TABLE XV

MEAN INTENSITY SHIFTS

Type	Intensity Interval	Actor 1				Actor 2			
		Half 1		Half 2		Half 1		Half 2	
		Time	N	Time	N	Time	N	Time	N
Female-Female	< 50	.218	1193	.216	1110	.215	958	.219	1034
	50-95	.226	638	.223	675	.225	544	.230	631
	100-145	.232	351	.237	307	.237	275	.241	284
	150-195	.242	186	.240	158	.253	137	.236	176
	200-485	.262	174	.261	179	.268	154	.250	148
Male-Male	< 50	.222	917	.222	946	.227	925	.224	871
	50-95	.227	531	.231	600	.227	506	.231	480
	100-145	.233	344	.235	339	.225	362	.231	338
	150-195	.246	195	.253	202	.242	188	.242	202
	200-485	.268	188	.256	196	.265	226	.254	199
Male-Female	< 50	.221	2639	.223	2451	.222	1989	.222	1759
	50-95	.227	1476	.229	1399	.231	1007	.230	990
	100-145	.236	804	.236	874	.238	496	.236	453
	150-195	.245	426	.242	452	.251	290	.234	240
	200-485	.263	461	.256	487	.260	284	.269	237

NOTE: Intensity Intervals are expressed in millivolts divided by a factor of 10.

the greater the intensity shifts, the more time needed to produce the shift. Thus, Hypothesis 6 is accepted. The evidence suggests that an increase in the intensity shifts will be accompanied by an increase in the time intervals between syllables. It can also be observed from the table that there is an inverse relationship between the size of the intensity shift and the frequency of its occurrence. The smaller the shift, the more frequently it occurs. This concurs with the findings supportive of Hypothesis 4.

Hypothesis 7 states that there is a significant relationship between gap and dyadic structure. To examine this hypothesis, a t test was run comparing the mean gap of each actor within a given dyadic sex structure. As can be seen from Table XVI, there was no significant difference between the actor's gap indices in the homogeneous dyad structures. The calculated probabilities are far from significant. However, in the heterogeneous dyad structure, the table indicates a significant difference between the gap indices of the two actors, thus supporting the hypothesis. In addition to these t tests, an examination was made of both the intra-actor gaps and the interactor gaps. Interactor gaps were grouped into three categories: (1) gaps less than or equal to .4 second, (2) gaps between .4 and 1.00 second, and (3) gaps greater than 1.00 second. The table illustrating the distribution of intra-actor gaps utilizes only the latter two gap categories. The reason for this is obvious as .4 seconds was taken to be sufficient silence to create a

TABLE XVI

t TESTS COMPARING GAP INDICES BETWEEN ACTORS IN THE THREE DYAD STRUCTURES

Female-Female		Male-Male		Male-Female	
t	p	t	p	t	p
1.25	.227	.02	.983	2.75	.009

natural break in conversation. Any gap of less than .4 seconds constitutes an interrupt. Interrupt refers to simultaneous vocal emissions on the part of both actors. Consequently, this table also contains the percentages of interrupt by halves and actors. From Table XVII, it is apparent that there is little differences between dyadic structure and distribution of interactor gaps. The significant $\underline{t}$ (Table XVI) obtained by comparing actors in the heterogeneous structure appears to result from intra-actor gaps. The differences become apparent in intra-actor gaps greater than one. There is a distinct tendency for the proportion of gaps in this category to increase as one moves from the homogeneous dyad structure to the heterogeneous dyad structure (Table XVIII). In addition to these gap statistics, the mean gap for each of the three dyadic structures was obtained. It is interesting to note that the mean total gap time per dyad in the female in the homogeneous dyad structure is 58 seconds. For the male actor in the homogeneous dyad structure, the mean total gap is 65 seconds. However, examination of the mean total gap for the male in the heterogeneous dyad structure indicates an average gap of 75 seconds. The female remains relatively stable with a mean total gap of 57 seconds in the mixed dyad structure. Thus, Hypothesis 7 is supported. There does appear to be a significant relationship between gap and dyadic sex structure.

TABLE XVII

INTERACTOR GAPS BY ACTOR AND HALF
(Per Cent)

Time Interval	Female-Female				Male-Female				Male-Male			
	Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
< .4	81	87	84	84	85	85	82	84	81	82	87	81
.4 - 1.00	17	11	14	16	12	13	16	13	17	15	10	17
> 1.00	2	2	2	0	3	2	2	3	2	3	3	2

TABLE XVIII

INTRA-ACTOR GAPS BY ACTOR AND HALF
(Per Cent)

Time Interval	Female-Female				Male-Female				Male-Male			
	Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
≥ .4 - 1.00	81	91	90	88	84	86	88	87	87	89	88	90
> 1.00	7	5	5	6	11	9	8	9	8	8	10	7
Interrupts	7	4	5	6	5	5	4	4	5	3	2	3

CHAPTER VII

ADDITIONAL FINDINGS

The execution of eleven computer phases produced many trends and findings which had not been hypothesized in advance. The computer phases carried out in the research study under examination have been identified as Phases I through XI. However, the computer phases can be further divided into two segments: (1) those data phases which converted the data to a testable stage and (2) those phases which applied statistical tests to the transformed data. This chapter will deal with the statistical stages as set forth in the last seven data phases. Phase V, it will be recalled, was an attempt to correlate and factor analyze the 84 working variables. This particular computer phase was run by dyadic sex structure, thus constituting three main runs. This particular phase describes the relationship between the previously established indices both by actor and half within the context of the designated dyadic sex structure.

Although the gap concept (silence or pause) has been discussed in relation to the formal hypotheses, there are some related ideas which should not be overlooked. First, there is a relationship of the total speech time to the total gap time. In all dyadic sex structures, the gap time is extremely high. Using the index which Goldman-Eisler has labeled hesitancy, it is relatively simple to obtain the ratio of gap time to speech time. The closer this ratio to 1.00, the more nearly equal are the two time segments. The implications for the bonding process is that bonding increases as this ratio decreases. Examining the data, the hesitancy ratio in the female-female dyad structure is .68. In the male-male dyad structure, this ratio was calculated to be .80. The hesitancy ratio was highest in the mixed dyad; a ratio of .86. This means that the female-female structure produces the least gap time and the greatest speech time. The mixed dyad, on the other hand, produces the least speech time and the greatest gap time. The male-male structure falls between these two. This would suggest that the loosest bonding is in the heterogeneous dyad. The tightest bonding appears to be in the homogeneous dyads and most specifically in the female-female structure.

It will be recalled that in attempting to describe each unique mesowave, six distinct indices were developed: slope, amplitude, wave length, area, density, and number of points per mesowave. In utilizing these indices to test the the formal hypotheses, one index failed to establish consistent and clear significance: that of slope. However, an examination of the mean slope per emission within each dyad sex structure does reveal that in all cases, the mean slope is negative. A mean negative slope indicates that there is a tendency for actors to begin their vocal emissions with greater intensity than which they end. The effect of time on the mean slope appears to be that with the passage of time there is a tendency for the mean slope to become less negative. This is true in all cases except for the female in the male-female dyad structure. In this particular dyadic sex structure, the mean slope per emission of the female becomes more negative with the passage of time. In the male-female dyad structure, it will be recalled the male dominates the conversational contact. The increased negative slope of the female may be her attempt to gain a larger segment of the interaction situation.

Four of the indices, amplitude, wave length, area, and number of points per mesowave, were found to be significantly related to the heterogeneous dyad structure. It might be of value to examine specific statistics on these various indices. Amplitude, defined as the range in loudness variation for each vocalized syllable, was measured by two methods. In the fifth data phase, amplitude was calculated as the distance between the highest and lowest point in any single mesowave. Defined in this manner, the mean amplitude in the male-male dyad structure was found to be 380 digital units or 1900 millivolts. The mean amplitude was somewhat lower in the female-female dyad being 351 digital units or 1755 millivolts. An examination of the mean amplitude in the mixed dyad structure reveals a decline of 80 millivolts for both the male and the female. The mean amplitude is

1675 millivolts for the female and 1820 millivolts for the male. In the seventh data phase, amplitude was defined in a somewhat different manner: the maximum intensity shift determined by the distance between any two adjacent syllables. In this particular data phase, amplitude was calculated for monotonic and polytonic positive and negative mesowaves. A monotonic mesowave is one whose slope does not change direction. A polytonic mesowave is one whose slope does change direction: positive and negative refers to the direction of the slope. The mean number of syllables in the monotonic mesowaves was three. The mean number of syllables in the polytonic mesowaves was seven. Table XIX illustrates the mean amplitude for these various mesowave types by actor, half, and dyad sex structure. Surprisingly enough, there is very little difference between the two methods for measuring amplitude. It is interesting to note that, in general, the polytonic positive mesowave has a slightly higher though not statistically significant amplitude than the polytonic negative mesowave. The over-all implication is the intensity rhythm appears to play an important part in the interpersonal contact.

The mesowave length viewed in terms of the dyadic sex structure reveals an interesting observation. The mean wave length for a male in the homogeneous dyad structure was found to be .99 seconds. For the female, in the homogeneous dyad, the mean wave length was 1.07 seconds. However, an examination of the heterogeneous structure revealed the

TABLE XIX

MEAN AMPLITUDE OF MONOTONIC AND POLYTONIC POSITIVE AND NEGATIVE MESOWAVES BY HALVES

Mesowave Type	Female-Female						Male-Male						Male-Female					
	Actor 1			Actor 2			Actor 1			Actor 2			Actor 1			Actor 2		
	H1	H2	t	H1	H2	t	H1	H2	t	H1	H2	t	H1	H2	t	H1	H2	t
Mono +	168	180	- .42	181	181	-.03	225	231	1.84	164	207	.67	183	226	.09	181	166	2.97**
Mono -	173	172	.18	169	168	.20	205	201	-1.47	238	174	1.18	200	217	2.38**	163	162	3.547***
Poly +	404	408	1.83	353	390	.65	422	421	.48	409	392	1.08	390	384	-.37	397	358	1.28
Poly -	315	336	-1.53	348	346	-.47	363	360	.38	355	384	-1.07	351	363	2.73**	308	333	1.87*

*p < .05

**p < .01

***p < .001

reverse pattern. The female's mean wave length decreased to .99 seconds and the male's mean wave length increased to 1.04 seconds. Although the difference may appear small, it is great relative to variance and is statistically significant.

Examination of the mean area for males and females by dyadic sex structure reveals another interesting trend. The mean area per emission for the male in the homogeneous structure is calculated to be 5.2 square units. In the female-female structure, the mean area is 4.39 square units. In the heterogeneous dyad structure, the mean area is 4.11 square units for the female and 5.09 square units for the male. The trend seen in previously discussed variables appears to emerge. There appears to be a steady decline in energy investments as one moves from the homogeneous to the heterogeneous dyad suggesting a looser bond in the latter.

The mean number of syllables per mesowave reveals a pattern similar to that seen in the other indices. More specifically, the mean number of syllables per mesowave can be seen to be 5.44 for the male in the male-male dyad and 5.83 for the female in the female-female structure. It should be understood that this mean is figured from all mesowaves, both monotonic and polytonic. In the heterogeneous structure, the pattern just viewed becomes reversed with the mean number of syllables per mesowave being 5.70 for the male and 5.47 for the female. These findings, in regard to length of utterance, are in agreement with

Goldman-Eisler's research on length of speech utterance. Goldman-Eisler, in discussing the length of a speech utterance, indicates that in a situation where speech is most unprepared and speakers least under social pressure, 50 per cent of the speech is broken up into phrases of less than three words, 75 per cent into phrases of less than five words, 80 per cent into phrases of less than six words, 90 per cent in less than ten words.[1]

Of the six indices descriptive of mesowaves, five have been examined leaving only the density index. Before discussing this index, an examination of the relationship of these indices to one another will be made. Correlations were run in an attempt to determine the degree of association between these six variables. The results are given in Table XX. As can be seen slope does not appear to correlate with the other variables. It can also be observed that the correlations between amplitude, wave length, area, and number of points per mesowave are positive. Returning to density, it appears that density is the only factor which consistently correlates negatively with the other variables. This suggests that there is an inverse relationship between density and the other variables. In other words, as wave length, area, amplitude and number of points per mesowave decrease, the density increases. These correlations are in agreement with the statistics produced in the seventh data

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[1] F. Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech (New York, 1968).

TABLE XX

CORRELATIONS OF THE SIX MESOWAVE INDICES BY DYAD STRUCTURE

	Actor 1						Actor 2					
	Slope	Amp	W L	Area	Den	Pts	Slope	Amp	W L	Area	Den	Pts
Female-Female												
Slo	1.00	-.18	.15	-.07	-.32	.09	1.00	-.15	-.43	-.30	.08	-.35
Amp		1.00	.58	.83	-.35	.58		1.00	.69	.93	.05	.76
W L			1.00	.81	-.71	.99			1.00	.77	-.19	.98
Area				1.00	-.46	.82				1.00	.01	.84
Den					1.00	-.66					1.00	-.13
Pts						1.00						1.00
$r_{.05} = .482$												
Male-Male												
Slo	1.00	.10	.13	-.19	-.11	.13	1.00	-.09	-.14	-.20	-.37	-.17
Amp		1.00	.33	.63	-.08	.36		1.00	.24	.54	-.07	.23
W L			1.00	.63	-.26	.96			1.00	.83	-.50	.98
Area				1.00	.00	.70				1.00	-.38	.79
Den					1.00	-.02					1.00	-.37
Pts						1.00						1.00
$r_{.05} = .468$												
Male-Female												
Slo	1.00	.01	.17	-.05	-.26	-.07	1.00	.03	-.25	-.27	.24	-.25
Amp		1.00	.49	.79	-.24	.47		1.00	.47	.73	-.29	.52
W L			1.00	.78	-.67	.97			1.00	.83	-.70	.97
Area				1.00	-.46	.77				1.00	-.48	.88
Den					1.00	-.57					1.00	-.55
Pts						1.00						1.00
$r_{.05} = .325$												

phase. In this data phase density was calculated for both monotonic and polytonic mesowaves. In the monotonic mesowaves, the mean density was 6.5 syllables per second with a standard deviation of 1.5. In the polytonic mesowaves, the mean density was 5.3 syllables per second with a standard deviation of .9. The implication is that density or speech rate per unit of time is an extremely stable and constant function which increses in stability as the speech unit increases. Goldman-Eisler's research supports this finding. She indicates that syllable rate or density stabilizes with an increase in the speech unit. Goldman-Eisler's findings are supported in this data phase as can be seen by examining the means and standard deviations in Table XXI.

Examination of these statistics reveals just how the dyadic sex structure affects the interpersonal contact. The theoretical implications regarding the bonding process have suggested that a decrease in energy investments, an increase in gap time, and an equilibrium ratio diverging from 1.00 are obstructions to the bonding process. The reasoning is that these types of factors decelerate the transfer of information which creates the bonding. The fact that these various findings have occurred consistently in the heterogeneous dyad structure and rarely in the homogeneous dyad structure suggests that there is an element of commonality among the factors with regard to their relation to bonding.

In addition to the research efforts to compare actor's responses within a given dyad sex structure, the research

TABLE XXI

DENSITY PATTERNS IN MONOTONIC AND POLYTONIC POSITIVE AND NEGATIVE MESOWAVES

	Female-Female				Male-Male				Male-Female			
	Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2	Half 1	Half 2
Monotonic +	6.55	6.82	6.74	6.49	6.37	6.45	6.39	6.34	6.54	6.39	6.46	6.64
Standard Dev.	1.54	1.67	1.74	1.34	1.75	1.24	1.53	1.43	1.50	1.36	1.51	1.54
N	68	80	70	66	72	65	78	70	203	190	161	170
t, p	-.66	.52	1.34	.18	-.06	.95	.45	.66	.52	.61	-1.70	.09
Monotonic -	6.26	6.62	6.50	6.35	6.43	6.37	6.35	6.47	6.43	6.41	6.22	6.41
Standard Dev.	1.50	1.74	1.48	1.61	1.58	1.64	1.58	1.66	1.53	1.66	1.36	1.35
N	122	115	95	91	137	112	117	99	277	274	207	225
t, p	-1.15	.25	1.15	.25	.42	.68	-.45	.66	1.58	.11	.05	.96
Polytonic +	5.33	5.34	5.26	5.34	5.38	5.38	5.21	5.21	5.25	5.32	5.22	5.41
Standard Dev.	.92	.82	.83	.81	.99	.96	.86	.78	.84	.88	.85	1.02
N	150	146	104	121	105	114	120	134	317	329	215	178
t, p	.58	.57	-.03	.97	1.43	.15	1.51	.12	.43	.67	-.91	.64
Polytonic -	5.45	5.42	5.27	5.30	5.34	5.12	5.45	5.38	5.36	5.33	5.36	5.30
Standard Dev.	.85	.88	.83	.89	.93	.72	.99	.99	.90	.91	.84	.87
N	168	151	155	166	169	182	160	142	409	404	297	278
t, p	1.94	.05	1.13	.25	-.99	.68	-2.63	.01	.01	.99	.45	.66

effort was also interested in determining the effect of the passage of time upon the interpersonal contact. As has been indicated by the formal hypotheses, statistics delineating this aspect were calculated (Tables II and III). In all three dyadic sex structures, an examination of the mean amplitude and density reveals a decline from the first to the second half. For the other indices, wave length, area, and number of points per mesowave, this same trend is evident in the male-female dyad and the female-female dyad. In the male-male structure, the pattern on these three indices is reversed. There is a slight increase in the wave length, area, and number of points per mesowave for each actor. These findings must be viewed in conjunction with the statistics on the summation area by halves and the mesowave count by halves. In all three dyad structures, there is an increase in these two measures by halves. Earlier, when explaining hypothesis two, it will be recalled that a tenable explanation for this phenomenon in the heterogeneous dyad structure was thought to be the result of an increase in fragmented speech. It should also be recalled, though that this finding was significant only for the male actor in the heterogeneous dyad structure. Although this pattern holds for the female actors in both the heterogeneous and homogeneous dyad structures, the differences are slight and not statistically significant. Therefore, no implications are drawn. For the male homogeneous dyad structure, the same pattern holds, but again the difference is not statistically significant. However, the trend is consistent with the other trends found in the data and is, therefore, noteworthy.

In addition to observing the differences in the vocalization patterns by halves, a series of correlations were obtained measuring the degree of association between any given actor's responses in the first and second half. These correlations are given in Table XXII. As was expected, there is a positive correlation between an actor's responses in the first and second half. In all cases, these correlations are extremely high. This would suggest that there is a high degree of stability in an actor's speech patterns.

The eighth computer phase, it will be recalled, was an effort to provide an intensive analysis of the interactor and intra-actor gaps, time intervals between syllables, and intensity shifts. A portion of these data findings have been cited in the testing of the formal hypotheses. Many of the findings, though, which emerged were unforeseen but quite interesting. More specifically, this data phase supports many of the operational definitions developed in the early stages of the project. To begin with, this particular data phase developed a table delineating the frequencies and proportions of the occurrence of all possible point or syllable intervals. The concept syllable interval has reference to the lapse of time between two adjacent vocal emissions in a single mesowave. It will be recalled that in establishing the guidelines for extracting the peak digital

TABLE XXII

CORRELATION OF AN ACTOR'S RESPONSES BETWEEN HALVES

Index	Female-Female		Male-Male		Male-Female	
	Actor 1	Actor 2	Actor 1	Actor 2	Actor 1	Actor 2
Slope	.909	.745	.878	.391	.829	.813
Amplitude	.954	.898	.885	.973	.943	.933
Wave Length	.876	.767	.961	.939	.815	.770
Area	.953	.919	.960	.993	.955	.895
Density	.861	.940	.900	.792	.918	.913
Points	.897	.782	.964	.976	.851	.805
	$r_{.05} = .482$		$r_{.05} = .468$		$r_{.05} = .325$	

values in Phase III, an intersyllable shift of .12 seconds was established. The rationale for this was based upon published research on speech rates. The execution of this particular aspect of Phase VIII permits serious evaluation of the accuracy of the choice. In the male-female dyads and the male-male dyads, the predominant time interval between syllables appears to be .18 second, suggesting that .12 second was a conservative choice. However, in the female-female dyad, a bimodal pattern is observed. Two predominant intersyllable shifts occur: .14 second and .20 second. In both cases, though, the selection of .12 seconds as a minimum interval is a conservative one. The fact that a unimodal pattern emerges in the male-female and male-male dyads and a bimodal pattern emerges in the female-female dyads is an interesting phenomenon and one that deserves remark. The fact that the bimodal pattern disappears in the female's speech pattern in the mixed dyad is certainly noteworthy. The implication drawn is that within the female-female dyads, the participants have two rates for transferring messages. When this is decreased to one rate, information transfer measured by syllable emission may be slowed down. This particular explanation is in agreement with the bulk of data already discussed.

A second phenomenon dealt with in this particular data phase was that of gap or lapses of silence. The data was evaluated such that interactor and intra-actor gaps were handled uniquely. Referring to the third data phase, it will be recalled that termination of a mesowave was defined to be either a gap of .4 second or a change in speakers. The selection of .4 second was based upon research publications in the area of speech rates. Support for this criteria can be found by examining the frequency distribution of various gap sizes. Table XXIII illustrates this picture quite clearly. As can be seen, two natural breaks appear to occur. One is a very short gap where termination of one actor's speech results in almost instantaneous emissions from the other actor. The other is a natural break of .4 second. It should be made clear that the interactor gaps being observed are by definition gaps that result when a change of speakers is introduced. Therefore, the frequency distribution of various size gaps is the direct result of one actor terminating vocalization and the other beginning. The evidence is clearly supportive of the operational control established in Phase III.

TABLE XXIII

FREQUENCY DISTRIBUTION OF INTERACTOR GAPS

Seconds	Female-Female				Male-Female				Male-Male			
	Actor 1		Actor 2		Actor 1		Actor 2		Actor 1		Actor 2	
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
.02	26	26	42	33	49	50	67	53	22	17	26	15
.04	17	24	19	18	48	32	43	50	20	11	15	12
.06	14	10	17	9	40	29	28	30	13	12	21	14
.08	11	8	9	10	24	34	32	35	13	8	12	16
.10	8	9	11	8	33	16	19	29	12	9	14	7
.12	9	7	6	8	31	23	21	24	7	5	7	9
.14	13	11	12	6	12	27	19	19	10	8	10	6
.16	2	3	3	2	18	17	13	9	7	4	11	5
.18	7	7	2	2	6	7	7	5	4	5	6	3
.20	1	0	4	2	12	10	8	4	3	2	7	2
.22	5	0	4	1	7	10	4	5	3	2	4	1
.24	2	1	1	3	4	3	1	5	3	0	1	4
.26	0	0	0	0	3	3	2	0	1	2	1	0
.28	2	1	0	0	2	1	0	2	2	0	3	1
.30	0	0	2	0	2	1	1	0	1	0	2	0
.32	1	0	0	0	2	1	0	0	1	1	0	0
.34	0	0	0	0	1	0	2	0	1	1	0	0
.36	0	0	0	0	1	0	0	0	0	1	0	0
.38	0	0	0	1	0	0	0	0	1	1	0	0
.40	14	9	8	9	16	23	30	14	8	11	7	5
.46	10	3	8	6	16	13	14	12	8	3	5	4
.52	3	3	3	5	7	5	15	10	4	6	4	0
.58	4	0	1	3	2	3	8	5	3	2	3	5
.64	1	1	5	4	3	4	6	4	2	2	1	3
.70	3	3	1	2	3	2	6	4	3	2	0	0
.76	3	0	3	0	1	4	2	1	3	0	1	1
.82	2	4	0	0	3	3	3	0	1	1	0	1
.88	1	0	0	0	2	2	2	2	2	0	2	2
.94	1	0	1	0	1	3	1	1	2	1	0	1
1.00	0	0	1	1	4	6	1	4	0	1	1	4
1.10	2	1	1	0	3	2	3	1	2	1	1	0
1.20	0	0	0	0	2	1	2	2	0	0	0	1
1.30	0	0	1	0	2	0	0	2	1	0	0	1
1.40	0	1	0	0	0	1	0	1	0	0	1	0
1.50	1	0	0	0	0	0	1	1	0	1	0	0
1.60	0	0	0	0	1	0	0	0	0	0	1	0
1.70	0	0	0	0	0	1	0	1	0	0	0	0
1.80	0	0	0	0	1	0	1	1	0	0	0	0
1.90	0	0	0	0	0	0	2	0	0	0	0	0
2.00	0	0	2	0	1	0	0	1	0	1	2	0

CHAPTER VIII

INTERPRETATIONS AND CONCLUSIONS

The beginning of this sociological inquiry stated an interest in studying the patterning of vocal emissions. More specifically, the project was concerned with developing a mathematical description of the sequencing of vocal outputs. Interest was focused on the most elementary form of communication: dyadic vocal interaction. The research effort proceeded by developing an eleven phase computer-based methodology for analyzing seventy recorded dyads.

From a theoretical point of view, interest was in that which has been called the conversational bond. By conversational bond, reference is made to the veridical transfer of information between two individuals. Quite simply, the research effort centered on how varying energy investments (defined in terms of intensity variations) and their temporal distribution relate to the core properties of the conversational bond. An examination of each of these core properties in terms of the empirical findings is desirable.

The first core property was defined as the interlock between conversational partners. It will be recalled from the discussion of the theoretical model that the interlocking referenced here is the nearly simultaneous emission and intake of syllable strings where the thought of one partner becomes the nearly identical thought of the other. The relation of the interlocking lies in the ability to transfer information between partners one syllable at a time. In order for this to take place, there must be an element of intensity. Intensity or loudness variation was interpreted as energy investment on the part of an actor. The data suggested that loudness variation was of considerable importance in studying the conversational bond. This first became apparent in examining Hypothesis 1. This hypothesis suggested that there were differences in energy investments by dyad sex structure and that these differences were greater in the male-female structure. In comparing the two actors on the six prime indices, slope, amplitude, wave length, area, density, and the number of syllables per mesowave, significant differences were found in the male-female structure. The findings suggest that the vocalization patterns of males and females within this structure differ in terms of amplitude, wave length, area, and number of syllables per mesowave. This suggests different patterns of transfer of information for the two actors. The observed pattern is only apparent in the heterogeneous dyad structure. There is a significant difference between energy investments for the male and the female in the heterogeneous dyad. The differences were significant in both the first and second half. However, the significance is far greater in the second half suggesting quite different patterns for the two actors. These findings suggest that variations in energy investments are partly a function of variations in the wave length, area, number of syllables per mesowave, and intensity shifts. These functions become apparent in the analysis of monotonic and polytonic mesowaves as the data shows a higher mean intensity shift in the polytonic (Table XIX). These variations are indicative of longer or shorter vocal utterances of more dense or less dense vocal utterances, two concepts which are related to the information transfer.

A second core property introduced in the theoretical model was that of reciprocity in emergent action sequences. Simply stated, the element of reciprocity refers to the give and take relationship in terms of vocalization upon the part of both partners. If, for example, one encounters a dyadic contact in which one person does the majority of talking, then certainly reciprocity does not exist. However, equal participation on the part of both subjects does not necessarily indicate reciprocity. By way of illustration, a dyadic contact dominated in the first half by actor one and dominated in the second half by actor two, does not suggest reciprocity. By reciprocity is meant a fairly regular looping of vocalizations between the two partners in a rhythmic manner. The fourth data phase offers the most precise description of the reciprocity elements. It is interesting to note the very close relationship between this particular property and the property of equilibrium. If equal participation can be observed, reciprocity appears to be present.

The data suggest that regardless of the equilibrium index, reciprocity appears to emerge. In other words, there does not appear to be a tendency for one actor to talk primarily in the first half and for the other actor to talk primarily in the second half. On the contrary, there seems to be some kind of need for both partners to actively participate at some minimal level in order to maintain the contact. The least participating actor must respond periodically in order to display interest and to assure the speaker that he has been listening. Consequently, the vocalization time is shared in a more or less rhythmic sequencing between the two actors. This has been referred to as reciprocity and is quite apparent in all dyadic sex structures. This element of reciprocity facilitates the bonding process.

The third property, equilibrium refers to the ratio of less to greater vocal outputs on the part of both actors. It was thought that this particular property is extremely important to the bonding process as it allows one to compare the total syllable output of the two participants. Transfer of information is a two-way process. Information must pass from one individual to the other and vice versa. For this reason, the concept of equilibrium offers a powerful index for determining whether or not this type of transfer occurs. Hypothesis 3 dealt with the relationship between equilibrium and dyadic sex structure. It will be recalled that the greatest differences in equilibrium were found in the heterogeneous dyad structure (Tables IV and V). In other words, the equilibrium ratio was lowest in this particular dyad structure. This suggests that when comparing all three dyad sex structures, in the heterogeneous dyad structure, more time was spent in silence and pauses. It is also apparent when examining Table III that equilibrium in the mixed dyad structure deteriorates with the passage of time. More specifically, the male actor dominates in both halves. However, his controlling interest in the second half is considerably more significant than his controlling interest in the first half. The implications drawn from this are that the information transfer is unidirectional in this particular dyad structure, thus weakening the conversational bond.

The fourth property recognized within the conversational bond was that of cycling and periodicity. It is important to keep in mind, at this point, that the oscillatory character being referred to is the intensity rhythm in vocalization. More specifically, this refers to the tendency for certain intensity shifts to occur and recur. The research findings have already suggested that there is a limited range within which the syllable stress points can vary. Table XIX suggests that mean amplitude ranges from 815 millivolts to 2110 millivolts, depending upon the type of mesowave under consideration. Hypothesis 4 states that there is a spectrum of loudness indicated by a scale of loudness levels identifiable from the natural groupings of intensity levels. The data supportive of this hypothesis suggests that there is considerable regularity in the proportional distribution of intensity shift levels. The distribution was so regular it could be described mathematically with only a small margin of error. In addition, comparison of the data in its smoothed and unsmoothed form identified a banding effect. Banding was identified as those levels which occur more frequently than others. From a theoretical point of view, it would seem that regularity in this intensity rhythm is supportive of bonding. The regularity suggests a rhythm in one's energy investments. If subjects display similar intensity rhythms, they likewise will display similar energy investments. From a theoretical point of view, then, it would seem that regularity in this intensity rhythm is supportive of bonding. The greater the regularity in the intensity rhythm, the lower the margin of error in predicting the proportional distribution of intensity shifts (Tables VII and VIII). It will be recalled that the absolute mean error was smallest among the female actors and largest among the males. This is not to suggest the absence of intensity rhythm among males. However, it would seem that the vertical rhythm is slightly less regular with the male sex.

A fifth core property recognized in the conversational bond is the information replication. An important property to be considered at this point is density, the number of syllables emitted per unit of time. Vocalizations are received on the part of the listening actor as they are emitted. Interestingly enough, density patterns within each of the three dyadic sex structures were extremely stable (Table XXII). Little variation was observed. From a theoretical perspective, this would suggest that there is a comfortable conversation speech rate which facilitates interaction. In other words, there is a comfortable speed for talking which allows the speaker to vocalize with ease and which also allows the listener to hear and understand what is being said. Speech which is extremely slow becomes laborious to the listener. Likewise, speech emitted too rapidly cannot be totally comprehended by the listener. Conversation which incorporates a diversity of speech rates most probably force the participants to concentrate too much on how a thing is said rather than what is said. Rather, the data suggests that the subjects attempt to adjust to each other's density patterns which facilitates information transfer, thus strengthening the conversational bond.

A sixth and final element recognized within the conversational bond was a minute affect increment. The affective increment being referenced is one resulting from understanding of what is said and not necessarily agreement with what is said. Maintenance of the dyadic contact suggest some affect involvement though it may be only minimal. It was thought that this affect increment would be generalized from a macroscopic view of the dyadic contact. Bonding evidenced in the aforementioned properties would imply a greater affective increment than a lack of bonding evidenced in these properties. In other words, if significant differences can be seen when comparing actors on the various indices, there would be little reason to suspect much affective involvement.

As has been indicated, the theoretical model was woven around six core properties which were thought to relate directly to the bonding process. The obvious question would seem to concern the criteria which establish the relationship between these properties. The recurring finding throughout this research effort has been the ability to distinguish significant differences within the heterogeneous dyadic structure. In each of the seven major hypotheses discussed, the significant differences were found in the heterogeneous dyads. An examination of the homogeneous dyads revealed few significant differences. In fact, in the case of the homogeneous dyads, the similarities were much more apparent. Likewise, in the chapter dealing with serendipitous findings, the differences were, for the most part, in the heterogeneous dyad. Additionally, a comparison of the homogeneous dyad structure with the heterogeneous structure has revealed a definite changing pattern.

The important factor to keep in mind is the stability of the pattern which is emerging. The fact that the differences consistently occur in one type of dyad structure suggests an element of a relationship. If, on the other hand, the established six core properties and their significance distributed randomly among the three dyadic structures, there would be considerable doubt concerning their relation to that labeled the conversational bond. The significant findings which do occur are within the male-female structure. It is this stability and consistency which suggests support for the proposed theoretical and empirical models. It would be worthwhile to replicate this research effort considering other identifiable differences: race, social class, education level, and age. If individuals could be paired with clear differences on one or more of these variables and similar research findings emerged, the evidence would support the findings reported here in that the bonding concept would be substantiated.

The current research effort, then, appears to be a first step in an effort to study the conversational bond from the perspective of vocal intensity. This is not to suggest that the present study is an all-encompassing approach to the study of interaction. Human interaction is a complex phenomenon which includes both verbal and nonverbal behavior, both structure and content. Although the research under consideration deals only with the structure of verbal behavior, it recognizes the significance of the other perspectives. The current research effort is certainly not without limitations. If the sample is defined in terms of the subjects who performed, the study can be criticized for a limited sample. Perhaps a replication of this study could expand the number of subjects involved and the number of dyads recorded while at the same time controlling for the social variables mentioned earlier. However, it should be kept in mind that what is being studied is vocalization patterns. Therefore, the sample can also be viewed in terms of each unique vocal utterance in which case the sample is not as limited as it might appear at first glance.

In the same vein, a second limitation might be the lack of consideration given to the previously mentioned variables. Although this is a recognized limitation, it might be pointed out that this information regarding age, race, religion, occupation, and educational level of parents was recorded. However, homogeneity of the college sample did not result in distinct enough differences to allow accurate consideration. This additional information can be found in Appendix A which lists the subjects and dyads in which they participated.

A third limitation might be cited as the length of the vocal interaction. The literature indicates a variety of opinions regarding the ideal length of an interactional contact. Some authors argue that weeks or even months must pass before characteristic patterns of behavior are revealed. Others contend only a fractional portion of time is necessary. The present research effort concurs with the work of Birdwhistell[1] and Pittenger[2] who maintain that characteristic patterns of interaction are revealed with a few minutes or less.

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[1] R. L. Birdwhistell, Introduction to Kinesics. (Louisville, Ky., 1952).

[2] Robert E. Pittenger, Charles F. Hockett, and John J. Danehy, The First Five Minutes (Ithaca, New York, 1960).

A fourth possible limitation of the study is the nature of the interactional contact. As indicated earlier, the current research effort has been primarily concerned with vocal patterning in spontaneous or natural interaction. The current research effort is aware that there may be differentiated "thresholds" for interacting within given communicated environments specifically for the processing of given communications. Therefore, it is not assumed that communication which is predominantly hostile, deceptive, demeaning, etc., is similar in all respects to communication which is spontaneous. The research under consideration does not attempt to generalize to all interactional situations. Rather, findings are discussed only in the context of the defined boundaries.

A fifth limitation might be the laboratory setting in which the research was conducted. Specifically, one must consider the influence or lack of influence of the subject's awareness of being observed. The literature considers both perspectives. The current research effort concurs with Lennard and Bernstein who argue that the experimental approach to the study of "natural" interaction should be encouraged more.

It is readily recognizable that the current research effort deviates from the traditional research approach in sociology. Although this might be considered a limitation, more probably it is an advantage. Perhaps it can best be captured as an effort to discover by innovative techniques.

The current research project can be best characterized by describing learning as a creative process.

Because the research effort is a pioneering effort, caution has been taken in making claims for the data. The findings are clear and distinct. The data suggests that intensity variation is an important variable in the dyadic contact and that this importance can be evidenced as time progresses. The evidence suggests a real relationship between intensity and the transfer of information labeled bonding.

Goldman-Eisler, in discussing the quantitative analysis of conversation writes:

> What seemed the most promising aspect of measuring the duration of events in sequence was that by this method objective measurement and quantification of behavior in progress could be achieved without breaking up its continuity and temporal pattern.
>
> In using it I found that it was possible to distill from the spontaneous and free flow of conversation temporal patterns of considerable invariance.[3]

Goldman-Eisler concludes that there is more information to be got out of the acts of speakers than the verbal content of the linguistic product. Concurring with Goldman-Eisler, the research under consideration utilizes such an approach. It is hoped that the value of this technique can be recognized and implemented in further research dealing with the communication process, and the conversational bond.

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[3] F. Goldman-Eisler, Psycholinguistics: Experiments in Spontaneous Speech (New York, 1968), Preface.

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APPENDIX A

ACTORS AND ACTOR CHARACTERISTICS

Actor Number	Age	Sex	Race	Classi-fication	Full Time Student	Social Class	Fraternity	Marital	Family Religion	Own Religion	Dyads
28	21	F	W		1			S			1
30	21	F	W		1			S			1
15	47	M	W	9	1	UM	0	M	P	P	2,6,29,30, 31,32
38		F	W		1			S			2
52	21	F	W	4	1	UM	1	S	P	P	3
54	20	F	W	3	1	UM	0	S	C	NP	3,5
17	21	M	W	4	1	UM	1	S	P	P	4,5
21	21	M	W	4	1	UM	0	S	C	NP	4
22	22	F	W	4	1	UM	0	S	NP	NP	6
25	22	M	W	4	1	LM		S	J	J	10,7,11
24	52	F	W	3	0	LM	0	M	P	P	9,8,7
48	24	F	W	2	0	LM	0	S	C	C	8,11,12
23	30	M	N	5	0	UM	0	M	P	P	10,9,12
19	19	M	N	3	1	UM	1	S	P	P	13,14,18,19 36,39,41,42
50	20	F	W	3		UM		S	P		13,16,15,20
27	22	M	W	4		LM	1	S	C		14,17,15,21
40	20	F	W	3	1	UM	0	M	NP	NP	15,17,16,18 22
29	31	M	W	2	1	UM	0	M	NP	NP	19,20,21,22
1	22	M	W	4	1	UM	0	S	C	C	23,25,29
2	21	F	W	4	1	UM	1	S	P	NP	23,24,26,27 30
4	22	F	W	3	1	UM	0	S			25,27,28,32
3	24	M	W	4	1	UM	1	S	P	NP	24,26,28,31
6	24	F	W	3	1	LM	1	M	P	P	33,34,35,36
7	22	M	W	4	1	UM	1	S	P	P	33,37,38,39
8	22	F	W	4	1	LM	0	D	NP	NP	34,37,40,41
37	20	M	W	3	1	UM	0	S	J	J	43,48,52,56

Actor Number	Age	Sex	Race	Classification	Full Time Student	Social Class	Fraternity	Marital	Family Religion	Own Religion	Dyads
10	36	F	W	4	0	UM	0	M	P	NP	35,38,40,42
9	20	M	N	4	1	UM	0	S	P	P	43,59,36
42	21	F	W	4	1	LM	1	S	C	C	44,57,60
20	23	F	W	4	1	UM	1	S	P	NP	44,46
5	20	M	W	3	1	UM	1	S	P	P	45,48,54,60 62
39	20	M	N	3	1	UM	0	S	P	P	45,49,51,55 61
12	20	F	W	3	1	LM	0	S	C	NP	47,49,52
46	20	F	W	4	1	UM	1	S	P	P	46,54,61
26	20	F	W	3	1	UM	0	S	C	C	47,58
14	20	F	W	3	1	LM	1	S	P	NP	50
18	21	F	W	4	1	LM	0	S	P	NP	50,53
16	22	F	W	4	0	LM	1	S	C	NP	51,56,58
44	20	F	W	3	1	LM	1	S	C	C	53
11	21	M	N	3	1	UM	0	S	P	NP	55,57,59
13		M	W				1				62
31	22	M	W	4	1	UM	1	S	P	P	63,65,70,72
34	21	F	W	4	1	UM	1	S	C	C	63,66,71,69
32	19	F	W	2	1	UM	1	S	P	C	64,66,68,74
35	22	M	W	4	1	UM	0	S	C	C	69,67,72,74
36	21	F	W	4	1	UM	0	S	C	C	65,68,71,73
33	22	M	W	4	1	LM	0	S	C	NP	67,70,73,64

APPENDIX B

COMPUTER PROGRAMS

```
//RFG1   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C  PHASE II, FIRST EXECUTION:
C
C  THIS PROGRAM PRODUCES A GRAPHIC REPRESENTATION OF THE ABRIDGED DATA
C  SET.  THE WAVE FORMATIONS RESULTING FROM THE NATURAL SEQUENCING OF
C  VOCAL OUTPUTS ARE PLOTTED.  TIME IS REPRESENTED ON THE HOROZONTAL
C  AXIS AND INTENSITY IS REPRESENTED ON THE VERTICAL AXIS.  THE MESO-
C  WAVES ARE SEPARATED BY A MINIMAL HOROZONTAL DISTANCE TO INDICATE THE
C  END OF ONE MESOWAVE AND THE BEGINNING OF ANOTHER.  THE MESOWAVES ARE
C  ALSO DIFFERENTIATED BY ACTORS.
C
C
      DIMENSION D(15000),X(602),Y(602),LB(8)
      CALL PLOTS
      DO 35 KZ=1,2
      WRITE(6,500)
  500 FORMAT('1')
      READ(5,1) LB
    1 FORMAT(8A4)
      J1=0
      I1=1
      DO 5 I1=1,15000,18
      I2=I1+17
      READ(5,2) (D(I),I=I1,I2)
    2 FORMAT(18(1X,F3.0))
      IF(D(I2).EQ.995.) GO TO 7
    5 CONTINUE
    7 DO 8 I=1,600
      A=I
    8 X(I)=A
      CALL SCALE(X,6.0,600,1)
      DO 30 MM=1,481,48
      M2=MM+36
      CALL PLOTC(9.0,-11.0,-3)
      CALL PLOTC(0.0, 9.50,-3)
      CALL SYMBOL(1.0,0.2,0.14,LB,0.0,32)
      CALL SYMBOL(-1.,0.0,0.14,' TOTAL',0.0,6)
      CALL SYMBOL(-1.,-0.3,0.14,'SECONDS',0.0,7)
      CALL PLOTC(0.0,0.0,3)
      CALL PLOTC(0.0,-8.,2)
      CALL AXIS(0.0,-8.,'SECONDS',-7,6.0,0.0,X(601),2.0)
      DO 20 L=MM,M2,12
      A=L-1
      CALL PLOTC(0.0,-2.,-3)
      IF(L.LT.M2) CALL PLOTC(6.0,0.0,2)
      CALL NUMBER(-0.5,0.0,0.14,A,0.0,-1)
      DO 14 N=1,600
      J=J1+N
      IF(D(J).GT.990.) GO TO 11
      Y(N)=D(J)
      GO TO 14
   11 IF(D(J).EQ.995.) GO TO 15
      ACT=D(J)-990.
      NB=MAX0(N-6,1)
      DO 12 NN=NB,N
   12 Y(NN)=0.0
      AX=NB+1
      AX=AX*.01
      CALL NUMBER(AX,1.8,0.07,ACT,0.0,-1)
      WRITE(6,13) J,N,AX,   ACT
   13 FORMAT(' J=',I8,' N=',I5,' AX=',F5.2,'  ACTOR',F3.0)
   14 CONTINUE
      GO TO 18
   15 DO 16 I=N,600
   16 Y(I)=0.
   18 CALL SCALE(Y,2.0,600,1)
      CALL LINE(X,Y,600,1,0,1)
      IF(D(J).EQ.995.) GO TO 35
   20 J1=J1+600
   30 CONTINUE
   35 CONTINUE
   40 STOP
      END
//GO.PLOTOUT DD UNIT=PLOT,SPACE=(TRK,(10,10)),DISP=(,KEEP),
//     DSN=PLOT.ACT11646.ALLEN
//GO.SYSIN DD *
//
```

```
//REG2   JOB (11646,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C  PHASE II EXECUTION II:
C
C  THIS PROGRAM PLOTS THE MESOWAVES COMPRISING THE ABRIDGED DATA SET.
C  INTENSITY IS PLOTTED ON THE VERTICAL AXIS AND TIME ON THE HORIZONTAL
C  AXIS.  REAL TIME IS PRESERVED THROUGHOUT THE PLOT.  ACTOR CODES ARE
C  INSERTED AT THE BASE OF THE TIME AXIS, IDENTIFYING VOCAL EMISSIONS BY
C  ACTOR.
C
C
      DIMENSION X1(1200), Y1(1200), X(152), Y(152), LB(8)
      CALL PLOTS
      READ(5,1) LB
    1 FORMAT(8A4)
      DO 2 I1=1,1201,12
      I2=I1+11
      READ(5,4) (X1(J),Y1(J), J=I1,I2)
    4 FORMAT(24F3.0)
      IF (X1(I2)+Y1(I2) .EQ. 0.0) GO TO 5
    2 CONTINUE
    5 DO 8 L=1,150
      X(L)=X1(L)/300.
    8 Y(L)=Y1(L)
      L=150
      ACT=0.
      DO 30 MM=1,149,148
      M2=MM+111
      CALL PLOTC(9.0,-11.0,-3)
      CALL PLOTC(0.0,10.25,-3)
      CALL SYMBOL(1.0,0.2,0.14,LB,0.0,32)
      CALL SYMBOL(-1.,0.0,0.14,' TOTAL',0.0,6)
      CALL SYMBOL(-1.,-0.3,0.14,'SECONDS',0.0,7)
      CALL PLOTC(0.0,0.0,3)
      CALL PLOTC(0.0,-9.,2)
      CALL AXIS(0.0,-9.,'SECONDS',-7,6.24,0.0,0.0,6.0)
      DO 20 LL=MM,M2,37
      A=LL-1
      CALL PLOTC(0.0,-2.25,-3)
      IF(LL.LT.M2) CALL PLOTC(6.24,0.0,2)
      CALL NUMBER(-0.5,0.0,0.14,A,0.0,-1)
      CALL PLOTC(0.0,0.0,3)
      SET=0.
      Z=0.
      DO 18 I=1,150
      Z=Z+X(I)
      IF(X(I)+Y(I).LE.4.) GO TO 10
      Y(I)=Y(I)/500.+.2
      IF(X(I-1).GT.0.0) GO TO 12
      CALL PLOTC(Z,Y(I),3)
      GO TO 13
   12 CALL PLOTC(Z,Y(I),2)
   13 CALL SYMBOL(Z,Y(I),.07,3,0.0,-1)
      GO TO 18
   10 IF(Y(I).EQ.ACT) GO TO 16
      IF(X(I)+Y(I).EQ.0.0) GO TO 50
      ACT=Y(I)
      SET=Z+.05
      CALL NUMBER(SET,.05,0.07,ACT,0.0,-1)
   16 IF(SET.GT.6.24) GO TO 15
   18 CONTINUE
   15 DO 19 I=1,150
      L=L+1
      X(I)=X1(L)/300.
      Y(I)=Y1(L)
      IF(X(I)+Y(I).EQ.0.0) GO TO 20
   19 CONTINUE
   20 CONTINUE
   30 CONTINUE
   50 CALL PLOTC(Z,Y(I),3)
      STOP
      END
//GO.PLOTOUT DD UNIT=PLOT,SPACE=(TRK,(10,10)),DISP=(,KEEP),
//     DSN=PLOT.ACT11646.GUY
//GO.SYSIN DD *
//
```

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//RFG2   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C  PHASE III:
C
C  THIS PROGRAM IS DESIGNED TO SELECT OUT THE MAXIMUM INTENSITY VALUE OF
C  EACH VOCALIZED SYLLABLE.  THIS PROGRAM OPERATES ON A DIGITAL RECORD OF
C  APPROXIMATELY 15,000 VALUES WHICH ARE CODED BY ACTORS.  ONE INTENSITY CONTROL
C  AND TWO TIME CONTROLS WERE ESTABLISHED.  THE INTENSITY CONTROL ESTABLISHES
C  THE MINIMUM INTENSITY VALUE WHICH CAN BE IDENTIFIED AS A SYLLABLE.  ONE TIME
C  CONTROL ESTABLISHES THE MINIMUM TIME SPAN BETWEEN VOCALIZED SYLLABLES.  THE
C  OTHER TIME CONTROL ESTABLISHES THE MINIMUM TIME SPAN ESTABLISHING SILENCE.
C  THE MAXIMUM INTENSITY VALUE OF EACH VOCALIZED SYLLABLE IS RECORDED ALONG WITH
C  THE TIME INTERVAL BETWEEN ADJACENT VOCALIZED SYLLABLES.  WHEN AN ACTOR CHANGE
C  OCCURS, THIS IS ALSO RECORDED.
C
C
      DIMENSION Y(1818), XM(350,30), IM(28), IX(10000)
      READ (5,1) NO
    1 FORMAT (I4)
      I=19
      DO 130 MMM=1,2
      ISET=I-1/MMM
      U=0.
      TXD=0.
      AR=0.
      KV=0
      LL=1
      DO 3 K=1,350
      DO 3 J=1,30
    3 XM(K,J)=0.
      IF (MMM.EQ.1) GO TO 9
      I=I+1
      NO=Y(I)
      GO TO 13
    5 DO 6 J=1,18
    6 Y(J)=Y(J+1800)
      KV=KV+1800
      I=I-1800
      MARK=MARK-1800
    9 READ(5,10,END=11) (Y(J),J=19,1818)
   10 FORMAT (18 (1X, F3.0))
   11 IF(KV.EQ.0) GO TO 13
      IF(Y(I).LT.985.) GO TO 18
   13 I1=I
      DO 15 I=I1,1810
      IF(Y(I).LE.990.) GO TO 15
      IF(994.GE.Y(I)) GO TO 16
      IF(Y(I).EQ.995.) GO TO 75
   15 CONTINUE
      GO TO 5
   16 AN=Y(I)-990.
      MARK=I
      I=I+1
      PL=0.
      P1=0.
      GO TO 28
   18 I2=I
   19 I1=I2
      DO 22 I=I1,1810
      IF(Y(I+1).GT.Y(I)) GO TO 23
   22 CONTINUE
      GO TO 5
   23 PL=Y(I)
      I1=I+1
      DO 24 I=I1,1810
      IF(Y(I+1).LT.Y(I)) GO TO 25
   24 CONTINUE
      GO TO 5
   25 IF(Y(I).GE.985.) GO TO 60
   26 IF((I+5).LT.1810) GO TO 28
      I=I-3
      GO TO 5
   28 IF(Y(I).GE.985.) GO TO 32
      P=Y(I)
      XD=I-MARK
      I1=I+1
      I2=I+5
      DO 31 I=I1,I2
      IF(P.LT.Y(I)) GO TO 26
   31 CONTINUE
      IF((P-PL).LT.16.)  GO TO 19
      IF(PL.EQ.0.0) GO TO 40
   32 IF(XD.LT.20.) GO TO 50
      IF(TXD.GT.0.)XM(LL,29)=U/(TXD*.02)
      XM(LL,26)=MARK+KV-ISET
      XM(LL,30)=AR
      XM(LL,28)=TXD
      U=0.
      TXD=0.
      AR=0.
   40 IF (P.LE.20.) GO TO 13
      LL=LL+1
      KL=(-1)
      XM(LL,27)=AN
   50 KL=KL+2
      IF(KL.EQ.1) XM(LL,25)=MARK+KV-ISET
      IF(KL.LE.23) GO TO 52
      LL=LL+1
      KL=1
   52 XM(LL,KL+1)=P
      U=U+1.
      MARK=I1-1
      XM(LL,KL)=XD
      A=KL
      IF(A+XM(LL-1,23).EQ.1.) GO TO 55
      IF((A.EQ.1.).AND.XM(LL,1).GE.20.) GO TO 55
      TXD=TXD+XD
      AR=AR+( XD*P1+XD/2. * (P-P1)) / 50.
   55 P1=P
      IF(Y(I).LT.985.) GO TO 19
   60 IF(TXD.GT.0.)XM(LL,29)=U/(TXD*.02)
      XM(LL,26)=MARK+KV-ISET
      XM(LL,30)=AR
      XM(LL,28)=TXD
      U=0.
```

```
      TXD=0.
      AR=0.
      GO TO 13
   75 SEC=I+KV-ISET
      SEC=SEC/50.
      WRITE(6,77) ND, SEC
   77 FORMAT    ('1REBECCA GUY- STUDY OF VOCAL INTENSITY VARIATION.  DYA
     1C ',I3,'   SECONDS=',F6.1/)
      WRITE (6,76) (K,K=1,12)
   76 FORMAT(4X,12(2X,' P(',I2,')'),'  FROM   TO  A XDF  DENS   AREA'/)
      DO 79 K=1,LL
      DO 78 J=1,28
   78 IM(J) = XM(K,J)
   79 WRITE (6,80) K, (IM(J), J=1,28),XM(K,29),XM(K,30)
   80 FORMAT         (25I4,2I6,I2,I4,F6.2,F7.1)
      J1=(-1)
      DO 117 K=2,LL
      J1=J1+2
      IF(XM(K,27).EQ.0.) GO TO 112
      IX(J1)=0
      IX(J1+1) = XM(K,27)
      J1=J1+2
  112 KL=(-1)
      DO 114 J=J1,10000,2
      KL=KL+2
      IX(J) = XM(K,KL)
      IX(J+1) = XM(K,KL+1)
      IF (XM(K,KL+2).EQ.0.0) GO TO 117
      IF(KL.EQ.23) GO TO 117
  114 CONTINUE
  117 J1=J
      J1=J1+2
      J2=J1+30
      DO 119 J=J1,J2
  119 IX(J)=0
      J1=1
      I2 = (J+1)/24+1
      DO 120 K=1,I2
      J2=J1+23
      PUNCH 118, (IX(J), J=J1,J2),ND,K
  118 FORMAT (24I3,2I4)
  120 J1=J1+24
  130 CONTINUE
  140 STOP
      END
//GO.SYSPUNCH DD SYSOUT=B
//GO.SYSIN DD *
//
```

```
//RFG3   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C   PHASE IV:
C
C   THIS PROGRAM DESCRIBES EACH UNIQUE MESOWAVE IN TERMS OF SIX PROPERTIES:
C   SLOPE, AMPLITUDE, WAVE LENGTH, AREA, DENSITY, AND NUMBER OF POINTS(SYLLABLES)
C   PER MESOWAVE.  IN ADDITION THE PROGRAM DIVIDES THE FIVE MINUTE CONTACT
C   INTO TWO TWO AND ONE-HALF MINUTE SEGMENTS.  CONSEQUENTLY THE PROGRAM
C   SUMMARIZES THE SIX PROPERTIES FOR EACH ACTOR AND FOR EACH HALF BY ESTAB-
C   LISHING THE MEAN SLOPE, AMPLITUDE, WAVE LENGTH, AREA, DENSITY, AND NUMBER OF
C   SYLLABLES PER MESOWAVE.  IN ADDITION THE PROGRAM ESTABLISHES THE TOTAL AREA
C   FOR THE FIVE MINUTE CONTACT, THE TOTAL AREA FOR EACH HALF, AND THE TOTAL
C   NUMBER OF MESOWAVES FOR EACH HALF.  SLOPE IS ALSO ANALYZED WITH REGARD TO
C   WHETHER IT IS POSITIVE OR NEGATIVE.
C
C
      DIMENSION V(200,12),Y(1300),X(1300),LB(32),MP(84)
      DATA LB/'1PTS','2PTS','3PTS',' GAP','SHRT','LONG','SLOP','AMPL',
     1 'WLEN','AREA','DENS',' PTS','ARTO',' AR1',' AR2','TPTS','MES1',
     2 'MES2','+SL1','-SL1','+SL2','-SL2','+SLT','-SLT','    ','    ',
     3 '1ST ','HALF','2ND ','HALF','COUN','TS  '/
    4 DO 7 I=1,200
      DO 7 J=1,12
    7 V(I,J)=0
C   READ DYAD,, CODE 2=FF 1= NOT-FF, ACT1 ACT2, TOTAL SECONDS.
      READ(5, 6,END=80)ID,CODE,N1,N2,TIME
    6 FORMAT(I3,F3.0,2I3,F4.1)
      L=7
      DO 8 I1=1,1313,12
      I2=I1+11
      READ(5,10) (X(I),Y(I), I=I1,I2)
      IF(Y(I2).EQ.0.) GO TO 9
   10 FORMAT(24F3.2)
    8 CONTINUE
    9 HALF=0.0
      DO 12 I=1,I2
      HALF=HALF+X(I)
   12 X(I)=X(I)*2.
      N=0
C   IDENTIFICATION OF ACTOR
   11 N=N+1
      SEMI=0.
      DO 16 J=4,6
   16 SEMI=SEMI+V(1,J)+V(1,J+6)
      IF(SEMI.GE.HALF) GO TO 17
      MID=L+2
      IF(SEMI.GT.HALF-10.) WRITE(6,18) MID,SEMI,L
   18 FORMAT('  MID=',I4,'  SEMI=',F6.0,'  L LINE=',I4)
   17 IF(Y(N).GT..04) GO TO 20
      IF(SEMI.GE.HALF.AND.SEMI.LE.HALF+10.) WRITE (6,18) MID,SEMI,L
      IF(Y(N).EQ.0.)GO TO 30
      KR=6
      IF(Y(N)/CODE.LT.0.02) KR=0
      N=N+1
C   MESOWAVE ANALYSIS
   20 V(1,KR+4)=V(1,KR+4)+X(N)
      IF(X(N+1).NE.0.0) GO TO 22
      V(1,1 +KR)=V(1,1 +KR)+1.0
      GO TO 11
   22 N=N+1
      IF(X(N+1).EQ.0.0) V(1,KR+5)=V(1,KR+5)+X(N)
      IF(X(N+1).NE.0.0) GO TO 24
      V(1,2 +KR)=V(1,2 +KR)+1.
      GO TO 11
   24 HYPT=0.0
      L=L+1
      V(1,KR+6)=V(1,KR+6)+X(N)
      V(1,3 +KR)=V(1,3 +KR)+1.
      YMAX=Y(N-1)
      YMIN=Y(N-1)
      V(L,6+KR)=1.
      GO TO 27
   26 N=N+1
   27 YD=(Y(N)-Y(N-1))
      HYP=(YD*YD+X(N)*X(N))**.5
      HYPT=HYPT+HYP
      V(L,1+KR)=V(L,1+KR)+(YD/X(N))*HYP
      IF(Y(N).GT.YMAX)YMAX=Y(N)
      IF(Y(N).LT.YMIN)YMIN=Y(N)
      V(L,3+KR)=V(L,3+KR)+X(N)
      AREA=X(N)*Y(N)-X(N)*YD/2.
      V(L,4+KR)=V(L,4+KR)+AREA
      V(L,6+KR)=V(L,6+KR)+1.
      V(1,6+KR)=V(1,6+KR)+X(N)
      IF(X(N+1).NE.0.0) GO TO 26
      V(L,2+KR)=YMAX-YMIN
      V(L,1+KR)=V(L,1+KR)/HYPT
      V(L,5+KR)=V(L,6+KR)/ V(L,3+KR)
      GO TO 11
   30 DO 40 I=8,L
      LR=(I/MID)*2+2
      KR=6
      IF(V(I,2).GT.0.0)KR=0
      DO 32 J=1,6
   32 V(LR,J+KR)=V(LR,J+KR)+V(I,J+KR)
      V(5,5+LR/4+KR)=V(5,5+LR/4+KR)+1.
      IF(V(I,1+KR).GE.0.) LR=LR-1
      V(6,LR+KR)=V(6,LR+KR)+V(I,1+KR)
   40 V(7,LR+KR)=V(7,LR+KR)+1.
      DO 41 J=6,7
      DO 41 I=1,7,6
      V(J,4+I)=V(J,I)+V(J,I+2)
   41 V(J,5+I)=V(J,I+1)+V(J,I+3)
      DO 42 I=1,7,6
      V(5,I+3)=V(1,I)+V(1,I+1)+V(1,I+2)
      V(5,I+1)=V(2,I+3)
      V(5,I+2)=V(4,I+3)
   42 V(5,I)=V(5,I+1)+V(5,I+2)
      DO 50 J=1,12
      KR=(J/7)*6
      V(3,J)=(V(2,J)+V(4,J))/(V(5,5+KR)+V(5,6+KR))
      IF(V(5,5+KR).GT.0.) V(2,J)=V(2,J)/V(5,5+KR)
      IF(V(5,6+KR).GT.0.) V(4,J)=V(4,J)/V(5,6+KR)
   50 IF(V(7,J).GT.0.) V(6,J)=V(6,J)/V(7,J)
```

```
      SIMUL=TIME-SEMI
      SIL=V(1,4)+V(1,10)
      SEMI=SEMI-SIL
      WRITE(6,70)ID,TIME,SEMI,SIL,N1,SIMUL,N2
   7C FCRMAT('1DYAD',I3,'  SECONDS',F6.1,'  TALK',F6.1,'  SILENCE',F6.1,
     1 7X,'ACTOR1',I3,5X,'  INTERRUPT',F6.1,29X,'ACTOR2',I3)
      WRITE(6,71) ((LB(I),I=1,6),J=1,2)
   71 FCRMAT(/6X,6(6X,A4),6(6X,A4))
      WRITE(6,73) LB(25),LB(26),(V(1,J),J=1,12)
   73 FCRMAT(1X,2A4,F7.1,11F10.1)
      WRITE(6,71) ((LB(I),I=7,12),J=1,2)
      WRITE(6,73) LB(25),LB(26),(V(3,J),J=1,12)
      WRITE(6,73) LB(27),LB(28),(V(2,J),J=1,12)
      WRITE(6,73) LB(29),LB(3C),(V(4,J),J=1,12)
      WRITE(6,71) ((LB(I),I=13,18),J=1,2)
      WRITE(6,73) LB(25),LB(26),(V(5,J),J=1,12)
      WRITE(6,71) ((LB(I),I=19,24),J=1,2)
      WRITE(6,73) LB(25),LB(26),(V(6,J),J=1,12)
      WRITE(6,73) LB(31),LB(32),(V(7,J),J=1,12)
      WRITE (6,72)
   72 FCRMAT(/3X,2(6X,'** FIRST ACTOR **',14X,'** SECONO ACTOR **',10X))
      WRITE(6,74) ((LB(I),I=7,12),J=I,4)
   74 FCRMAT(4X,2(5A5,A4,2X),7X,5A5,A4,2X,5A5,A4)
      LS=L/2+4
      LR=LS-7
      CC 100 I=8,LS
      I4=I+LR
      A=V(I,2)
      B=V(I+LR,2)
      IF(A+B.EQ.0.) WRITE(6,88) I,(V(I,J),J=7,12),I4,(V(I+LR,J),J=7,12)
      IF(A*B.NE.0.) WRITE(6,85) I,(V(I,J),J=1, 6),I4,(V(I+LR,J),J=1, 6)
      IF(A*B.NE.C.) GO TO 100
      IF(A.GT.0.)   WRITE(6,86) I,(V(I,J),J=1, 6),I4,(V(I+LR,J),J=7,12)
      IF(B.GT.0.)   WRITE(6,87) I,(V(I,J),J=7,12),I4,(V(I+LR,J),J=1, 6)
   85 FORMAT(I3,1X,    5F5.1,F4.0,31X,I8,1X,    5F5.1,F4.0)
   86 FORMAT(I3,1X,    5F5.1,F4.0,31X,I8,1X,31X,5F5.1,F4.0)
   87 FCRMAT(I3,1X,31X,5F5.1,F4.0,    I8,1X,    5F5.1,F4.0)
   88 FORMAT(I3,1X,31X,5F5.1,F4.0,    I8,1X,31X,5F5.1,F4.0)
  100 CONTINUE
      DO 1C2 I=1,73,12
      II=I/12+1
      CC 102 J=1,12
      J2=I+J-1
  102 MP(J2)=V(II,J)*1C.
      CC 103 I=1,73,18
      ICD =I/18+1
      K=I+17
      IF(I.EQ.73) GC TC 106
  103 PUNCH 105, (MP(J),J=I,K),ID,N1,N2,ICD
  105 FCRMAT(18I4,4I2)
  106 K=64
      PUNCH 107, (MP(J),J=I,K),ID,N1,N2,ICD
  107 FCRMAT(12I4,24X,4I2)
      GO TC 4
   8C STOP
      ENC
//GC.SYSIN DD *
//
```

```
//RFG4   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C   PHASE V:
C
C   THIS COMPUTER PROGRAM IS DESIGNED TO BUILD A CORRELATION MATRIX CORRELATING
C   EACH VARIABLE WITH EACH OTHER VARIABLE.  THE CORRELATION MATRIX IS USED TO
C   FACTOR ANALYZE ALL VARIABLES IN ORDER TO DETERMINE THE NATURAL GROUPINGS
C   OF THE VARIABLES.
C
C
      DIMENSION KF(20), R(84,84), V(84,84), X(84), Y(84), W(84,84),
     1Z(84), KS(84), A(84), S(84)
      ND=84
    5 CALL CODS (KF,NV,NS,KA,KB,KC)
      K11=KA/10000
      K12=MOD (KA/1000,10)
      K13=MOD (KA/100,10)
      K14=MOD (KA/10,10)
      K15=MOD (KA,10)
      KEV=KB/1000
      K18=MOD (KB/100,10)
      K19=MOD (KB/10,10)
      K20=MOD (KB,10)
      K21=KC/10000
      K22=MOD (KC/1000,10)
      K23=MOD (KC/100,10)
      VN=NV
C    COMPUTE R MATRIX FROM RAW DATA
      CALL CORS(NS,NV,R,A,S,KF,ND)
C    OUTPUT MEANS, SIGMAS, AND INTERCORRELATIONS.
      CALL PRTS(A,NV,1,'MEAN','S   ',ND)
      CALL PRTS(S,NV,1,'SIGM','AS  ',ND)
      IF(K13.EQ.1.OR.K13.EQ.3) CALL PRTS(R, NV, NV, 'R MA','TRIX',ND)
C     PRINCIPAL-AXIS ANALYSIS.
      NF=NV
      C=KEV
      IF (KEV.LE.1) GO TO 90
      NF=KEV
      C=0.0
   90 CALL SEVS (NV,NF,C,R,V,X,Y,ND)
      CALL PRTS (X,NF,1,'EIGN','ROOT',ND)
      CALL PRTS (Y,NF,1,'PC T','RACE',ND)
      IF (K18.EQ.1) CALL PRTS(V,NV,NF,'PRAX','LOAD',ND)
C     COMPUTE PRINCIPAL-AXIS FACTOR-SCORE WEIGHTS.
      DO 95 J=1,NF
      DO 95 I=1,NV
   95 R(I,J)=V(I,J)/X(J)
      IF (K19.EQ.1) CALL PRTS (R,NV,NF,'PRAX',' WTS',ND)
C     ADJUST PA WEIGHTS FOR MODIFYING VARIMAX LOADINGS.
  130 DO 135 J=1,NF
      DO 135 I=1,NV
  135 R(I,J)=R(I,J)/X(J)
      CALL AXBS(R,V,W,NV,-NV,NF,ND)
C     VARIMAX ROTATION OF PRINCIPAL AXES.
      CALL VORS (NV,NF,V,X,Y,Z,ND)
      CALL PRTS (X,NF,1,'PCT.',' VAR',V,ND)
      CALL PRTS (Y,NV,1,'PCT.',' COM',C,ND)
                      CALL PRTS(V,NV,NF,'VMAX','LOAD',ND)
C     COMPUTE VARIMAX FACTOR-SCORE WEIGHTS AND FACTOR SCORES.
      CALL AXBS(W,V,R,NV,NF,NV,ND)
                      CALL PRTS (R,NV,NF,'VMAX',' WTS',ND)
      GO TO 5
      END
      SUBROUTINE CORS(NS,NV,R,A,S,KF,ND)
      DIMENSION R(ND,NV), A(NV), S(NV), KF(20)
      T=NS
      DO 5 I=1,NV
      A(I)=0.0
      DO 5 J=1,NV
    5 R(I,J)=0.0
      DO 10 K=1,NS
      READ(5,KF)S
      DO 10 I=1,NV
      A(I)=A(I)+S(I)
      DO 10 J=I,NV
   10 R(I,J)=R(I,J)+S(I)*S(J)
      DO 15 I=1,NV
      A(I)=A(I)/T
   15 S(I)=SQRT(R(I,I)/T-A(I)**2)
      DO 25 I=1,NV
      DO 20 J=I,NV
      IF(S(I)*S(J).EQ.0.0) GO TO 20
      R(J,I)=(R(I,J)/T-A(I)*A(J))/(S(I)*S(J))
   20 R(I,J)=R(J,I)
   25 R(I,I)=1.0
      WRITE(6,30)
   30 FORMAT(// 27H INTERCORRELATION ANALYSIS.)
      RETURN
      END
      FUNCTION SUMF (X, KK, NN, ND)
      DIMENSION X(ND,1)
      SUMF=0.0
      N=IABS(NN)
      K=IABS(KK)
      IF (NN)5,55,10
    5 IF(KK)15,55,25
   10 IF(KK)35,55,45
   15 DO 20 I=1,N
   20 SUMF= SUMF+X(K,I)**2
      RETURN
   25 DO 30 I=1,N
   30 SUMF= SUMF+X(I,K)**2
      RETURN
   35 DO 40 I=1,N
   40 SUMF= SUMF+X(K,I)
      RETURN
   45 DO 50 I=1,N
   50 SUMF=SUMF+X(I,K)
   55 RETURN
      END
      FUNCTION SCPF (X,Y,KX,KY,N,ND)
      DIMENSION X(ND,1), Y(ND,1)
      SCPF=0.0
      J=IABS(KX)
```

```
      K=IABS(KY)
      IF(KX)5,55,10
    5 IF(KY)15,55,25
   10 IF(KY)35,55,45
   15 DO 20 I=1,N
   20 SCPF= SCPF+X(J,I)*Y(K,I)
      RETURN
   25 DO 30 I=1,N
   30 SCPF= SCPF+X(J,I)*Y(I,K)
      RETURN
   35 DO 40 I=1,N
   40 SCPF= SCPF+X(I,J)*Y(K,I)
      RETURN
   45 DO 50 I=1,N
   50 SCPF= SCPF+X(I,J)*Y(I,K)
   55 RETURN
      END
      SUBROUTINE CCDS (KF,KI,KJ,KK,KL,KM)
      DIMENSION KF(20), KH(20)
      READ 5,KH
    5 FORMAT (20A4)
      IF(KH(1) .EQ. KH(2))STOP
      READ 10,KI,KJ,KK,KL,KM,KF
   10 FORMAT (5I5/20A4)
      PRINT 15,KH,KI,KJ,KK,KL,KM,KF
   15 FORMAT ('1',20A4//' PARAMETERS'/' COL 1-5=',I5/
     1' COL 6-10=',I5/' COL 11-15=', I5/' COL 16-20=',
     2I5/' COL 21-25=',I5//' DATA FORMAT=',20A4)
      RETURN
      END
      SUBROUTINE PRTS (X,N,M,KH,KJ,ND)
      DIMENSION X(ND,M)
      IF(M .GT. 1) GO TO 20
      PRINT 15
      DO 10 I=1,N,12
      J=MIN0(I+11,N)
      PRINT 5, KH,KJ,(K,K=I,J)
    5 FORMAT(2X,2A4,12I10)
   10 PRINT 15,(X(K,1),K=I,J)
   15 FORMAT (10X,12F10.2)
      RETURN
   20 DO 25 K=1,M,12
      PRINT 15
      L=MIN0(K+11,M)
      PRINT 5,KH,KJ,(J,J=K,L)
      DO 25 I=1,N
   25 PRINT 30,I,(X(I,J),J=K,L)
   30 FORMAT ( I6,4X,12F10.3)
      RETURN
      END
      SUBROUTINE AXBS (A,B,C,KA,KB,N,ND)
      DIMENSION A(ND,1),B(ND,1),C(ND,1)
      K=IABS(KA)
      L=IABS(KB)
      IF (KA)5,55,10
    5 IF (KB)15,55,25
   10 IF (KB)35,55,45
   15 DO 20 I=1,K
      DO 20 J=1,L
   20 C(I,J)=SCPF(A,B,I,-J,N,ND)
      RETURN
   25 DO 30 I=1,K
      DO 30 J=1,L
   30 C(I,J)=SCPF(A,B,I,J,N,ND)
      RETURN
   35 DO 40 I=1,K
      DO 40 J=1,L
   40 C(I,J)=SCPF(A,B,-I,-J,N,ND)
      RETURN
   45 DO 50 I=1,K
      DO 50 J=1,L
   50 C(I,J)=SCPF(A,B,-I,J,N,ND)
   55 RETURN
      END
      SUBROUTINE SEVS (NV,NF,C,R,V,E,P,ND)
      DIMENSION R(ND,NV), V(ND,NF), E(NF), P(NV)
C     COMPUTE TRACE.
      T=0.0
      DO 5 I=1,NV
    5 T=T+R(I,I)
      DO 30 K=1,NF
C     COMPUTE ROOT IN E(K) AND VECTOR IN V(.K).
      DO 10 I=1,NV
   10 P(I)= 1.0
      E(K)=1.0
      DO 25 M=1,25
      DO 15 I=1,NV
   15 V(I,K)=P(I)/E(K)
      DO 20 I=1,NV
   20 P(I)=SCPF(R,V,-I,K,NV,ND)
      EE=SCPF(P,V,1,K,NV,ND)
   25 E(K) = SQRT(ABS(EE))
      IF (EE .LT. C*C) GO TO 35
C     DEFLATE R MATRIX.
      DO 30 I=1,NV
      DO 30 J=1,NV
   30 R(I,J)=R(I,J)-V(I,K)*V(J,K)
      GO TO 40
   35 NF=K-1
C     COMPUTE PERCENTS OF TRACE.
   40 DO 45 I=1,NF
   45 P(I)=E(I)/T*100.0
      EV=SUMF(P,1,NF,ND)
      PRINT 50, T, EV, NF
   50 FORMAT (//'  PRINCIPAL AXIS ANALYSIS.'//' TRACE=',F10.4//
     1F7.2,' PCT. OF TRACE WAS EXTRACTED BY', I3,'ROOTS.')
      RETURN
      END
      SUBROUTINE VORS (NV,NF,V,A,B,C,ND)
      DIMENSION V(ND,NF), A(NV), B(NV), C(NV)
      T=NV
C     NORMALIZE ROWS OF V.
      DO 5 I=1,NV
      B(I)=SQRT(SUMF(V,-I,-NF,ND))
      DO 5 J=1,NF
    5 V(I,J)=V(I,J)/B(I)
   10 KR=0
      DO 40 M=1,NF
```

```
      DO 40 N=M,NF
      IF (M.EQ.N) GO TO 40
C     COMPUTE ANGLE OF ROTATION.
      DO 15 I=1,NV
      A(I)=V(I,M)**2-V(I,N)**2
   15 C(I)=2.0*V(I,M)*V(I,N)
      AA=SUMF(A,1,NV,ND)
      BB=SUMF(C,1,NV,ND)
      CC=SUMF(A,1,-NV,ND)-SUMF(C,1,-NV,ND)
      DD=SCPF(A,C,1,1,NV,ND)*2.0
      XN=CC-2.0*AA*BB/T
      XD=DD-(AA**2-BB**2)/T
      Y=ATAN(XN/XD)
      IF (XD.GE.0.0) GO TO 20
      IF (XN.GE.0.0) Y=Y+6.2832
      Y=Y-3.1416
   20 Y=Y/4.0
      IF (ABS(Y).LT. 0.0175) GO TO 40
C     ROTATE PAIR OF AXES.
      CY=COS(Y)
      SY=SIN(Y)
      KR=1
      DO 35 I=1,NV
      C=V(I,M)*CY+V(I,N)*SY
      V(I,N)=V(I,N)*CY-V(I,M)*SY
   35 V(I,M)=C
   40 CONTINUE
      IF (KR .GT. 0) GO TO 10
C     DENORMALIZE ROWS OF V. COMPUTE PCT. T AND C.
      DO 50 J=1,NF
      DO 45 I=1,NV
   45 V(I,J)=V(I,J)*B(I)
   50 A(J)=SUMF(V,J,-NV,ND)/T*100.0
      DO 55 I=1,NV
   55 B(I)=B(I)**2*100.0
      PRINT 60
   60 FORMAT (//' VARIMAX ROTATION ANALYSIS.')
      RETURN
      END
//GO.SYSIN DD *
//
```

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//RFG6   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C  PHASE VI:
C
C  THIS PROGRAM IS DESIGNED TO COMPARE THE PROPERTIES ESTABLISHED IN
C  PHASE IV FIRST BY ACTORS AND SECOND BY HALVES.  A SERIES OF T TESTS ARE
C  RUN WHICH COMPARE AN ACTOR'S PERFORMANCE IN THE FIRST HALF TO HIS
C  PERFORMANCE IN THE SECOND HALF.  A SERIES OF T TESTS ARE ALSO RUN COM-
C  PARING THE OVERALL MEAN PERFORMANCE BETWEEN THE TWO ACTORS.  IN ADDITION
C  EXACT PROBABILITIES FOR EACH T VALUE ARE OBTAINED.
C
C
      DIMENSION V(56,12),E(7,12),C(4),LB(47)
      DATA LB/'1PTS','2PTS','3PTS',' GAP','SHRT','LONG','SLOP','AMPL',
     1 'WLEN','AREA','CENS',' PTS','ARTO',' AR1',' AR2','TPTS','MES1',
     2 'MES2','+SL1','-SL1','+SL2','-SL2','+SLT','-SLT','    ','    ',
     3 '1ST ','HALF','2ND ','HALF','COUN','TS  ','  T ','  P ','ACTR',
     4 'TOTA','L SE','T   ','MALE','-FEM','ALE ','MALE','-MAL','E   ',
     5 'FEMA','LE-F','EMAL'/
      DO 2 I=1,56
      DO 2 J=1,12
    2 V(I,J)=0.
      READ(5,3) C
    3 FORMAT(4F3.0)
      DO 15 I=1,70
      KR=(1+I/39+I/55)*14
      READ(5,10) ((E(J,K),K=1,12),J=1,7)
   10 FORMAT(4(18F4.1/),12F4.1)
      DO 11 J=1,7
      DO 11 K=1,6
      DIF=E(J,K)-E(J,K+6)
      DO 11 N=1,2
      L= J+KR*(N/2)
      V(L,K)=V(L,K)+DIF
   11 V(L,K+6)=V(L,K+6)+DIF**2
      DO 12 K=1,12
      DIF=E(3,K)-E(4,K)
      DO 12 N=1,2
      L= 9+KR*(N/2)
      V(L,K)=V(L,K)+DIF
   12 V(L+1,K)=V(L+1,K)+DIF**2
      DO 13 K=2,11,3
      DIF=E(5,K)-E(5,K+1)
      DO 13 N=1,2
      L=11+KR*(N/2)
      V(L,K)=V(L,K)+DIF
   13 V(L+1,K)=V(L+1,K)+DIF**2
C K2 VALUES: 1,2,5,6,7,8,11,12
C K3 VALUES: 1,2,5,5,7,8,11,6
      DO 14 K=1,8
      K2=K+2*((K+1)/4)
      K3=K2-5*(K2/12)-K2/6+K2/7
      K4=K2+2-K2/11-K2/12
      IF((K.EQ.3).OR.(K.EQ.4)) K4=6+5*(K/4)
      DIF=E(6,K3)-E(6,K4)
      DO 14 N=1,2
      L=13+KR*(N/2)
      V( L,K2)=V( L,K2)+DIF
   14 V(L+1,K2)=V(L+1,K2)+DIF**2
   15 CONTINUE
      DO 22 I=1,43,14
      M=1+I/14
      I2=I+6
      DO 20 J=I,I2
      DO 20 K=1,6
      K6=K+6
      V(J,K)=V(J,K)/C(M)
      SM=(V(J,K6)/C(M)-V(J,K)**2)**.5
      V(J,K)=V(J,K)/(SM/(C(M)-1.)**.5)
   20 V(J,K6)=PRBF(1.,C(M)-1.,V(J,K)**2)
      I2=I+8
      I3=I2+4
      DO 22 J=I2,I3,2
      J1=J+1
      DO 22 K=1,12
      IF(V(J,K).EQ.0.) GO TO 22
      V(J,K)=V(J,K)/C(M)
      SM=(V(J1,K)/C(M)-V(J,K)**2)**.5
      V(J,K)=V(J,K)/(SM/(C(M)-1.)**.5)
      V(J1,K)=PRBF(1.,C(M)-1.,V(J,K)**2)
   22 CONTINUE
      DO 90 M=1,4
      M1=M*3+33
      M2=M1+2
      WRITE(6,32) C(M),(LB(I),I=M1,M2)
   32 FORMAT('1PAIRED DIFFERENCE T TESTS. N=',F3.0,3X,3A4//
      I1=1+(M-1)*14
      DO 66 K1=1,19,6
      K2=K1+5
      WRITE(6,71)((LB(J),LB(K),K=K1,K2),J=33,34)
   71 FORMAT(/8X,6(2X,2A4),4X,6(2X,2A4))
   73 FORMAT(1X,2A4,F9.4,5F10.4,4X,6F10.4)
      LD=K1/6
      L1=I1+LD+(LD/2)*2
      L2=L1+LD*2-(LD/2)*(LD+2)
      N1=(-2)
      DO 64 LL=L1,L2
      N1=N1+2
      IF(LL.EQ.7) N1=N1+4
      L=LL
      IF((LD.EQ.1).AND.(LL.EQ.  L1)) L=L+1
      IF((LD.EQ.1).AND.(LL.EQ.L1+1)) L=L-1
   64 WRITE(6,73) LB(N1+25),LB(N1+26),(V(L,J),J=1,12)
   66 CONTINUE
      WRITE(6,74)
   74 FORMAT(////)
      DO 80 K1=7,19,6
      K2=K1+5
      WRITE(6,71)((LB(J),LB(I),I=K1,K2),J=25,26)
      DO 80 K=33,34
      I9=I1+6+(K1/6)*2+K/34
   80 WRITE(6,73)  LB(28),LB(K),(V(I9,J),J=1,12)
   90 CONTINUE
      STOP
```

```
      END
      FUNCTION PRBF(DA,DB,FR)
      PRBF=1.
      IF(DA*DB*FR.EQ.0.) RETURN
      IF(FR.LT.1.) GO TO 5
      A=DA
      B=DB
      F=FR
      GO TO 10
    5 A=DB
      B=DA
      F=1./FR
   10 AA=2./(9.*A)
      BB=2./(9.*B)
      Z=ABS(((1.-BB)*F**(1./3.)-1.+AA)/(BB*F**(2./3.)+AA)**.5)
      IF(B.LT.4.) Z=Z*(1.+.08*Z**4/B**3)
      PRBF=.5/(1.+Z*(.196854+Z*(.115194+Z*(.000344+Z*.019527))))**4
      IF(FR.LT.1.) PRBF=1.-PRBF
      RETURN
      END
//GO.SYSIN DD *
//
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//RFC5   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C  PHASE VII:
C
C  THIS PROGRAM IS CONSTRUCTED TO DIFFERENTIATE MESOWAVES ON THE BASIS OF
C  SIGN AND DIRECTION.  MESOWAVES WHICH DO NOT CHANGE DIRECTION ARE
C  IDENTIFIED AS MONOTONIC.  MESOWAVES WHICH DO CHANGE DIRECTION ARE
C  REFERRED TO AS POLYTONIC.  ONCE THE DIRECTION IS ESTABLISHED, THE PROGRAM
C  IS CONSTRUCTED TO DETERMINE IF THE WAVE IS POSITIVE OR NEGATIVE.  ONCE
C  THESE FOUR CATEGORIES ARE ESTABLISHED, SEVERAL PROPERTIES ARE SUMMARIZED.
C  THOSE INCLUDED ARE SLOPE, DENSITY, AMPLITUDE, AND TIME.  IN ADDITION T
C  VALUES AND EXACT PROBABILITIES ARE ALSO OBTAINED BY COMPARING EACH OF
C  THESE PROPERTIES BY ACTOR AND HALF.
C
C
      DIMENSION D(56,14),X(1313),Y(1313),LB(27)
      DATA LB/'DYAD','F-F ','M-F ','M-M ','SUM ','ACTR','HALF','MONO',
     1 'POLY','+ ','- ','MESO','PTS ','SLOP','SD  ','TTPP','DENS','SD  '
     2,'T P ','AMPL','SD  ','T P ','TIME','SD  ','T P ','HF 1','HF 2'/
      DO 2 I=1,56
      DO 2 J=1,14
    2 D(I,J)=0.
C KTYPE: 0= F-F.  4=M-F.  8= M-M.
      DO 35 MM=1,70
      HALF=0.
      SEM=0.
      KMID=0
      READ(5,3) N1,N2,TIME
    3 FORMAT(6X,2I3,F4.1)
      KS=MOD(N1,2)+MOD(N2,2)
      KTYPE=KS*4
      KAD=2-(KS+1)/2
      DO 5 I1=1,1313,12
      I2=I1+11
      READ(5,6) (X(I),Y(I),I=I1,I2)
      IF(Y(I2).EQ.0.) GO TO 7
    5 CONTINUE
    6 FORMAT(12(F3.2,F3.3))
    7 DO 4 I=1,I2
      HALF=HALF+X(I)
    4 X(I)=X(I)*2.
      II=1
    8 I1=II
C SLOPE SCALE IS 0.0-1.00 FOR INTENSITY: 0.0-0.4 FOR TIME.
      IF(I1.GE.I2) GO TO 35
      DO 30 I=I1,I2
      IF(Y(I).EQ.0.) GO TO 35
      IF(X(I).NE.0.) GO TO 30
      SEM=SEM+X(I+1)
      IF(SEM.GT.HALF) KMID=1
      IF(X(I+2).GT.0.) GO TO 10
      II=I+2
      GO TO 8
   10 IF(X(I+3).GT.0.)  GO TO 12
      SEM=SEM+X(I+2)
      II=I+3
      GO TO 8
   12 KA=Y(I)/.0019
      KA=(KA/KAD)*2
      K=1+KA+KMID+KTYPE
      HYPT=0.
      MON=0
      SL=0.
      PTS=1.
      TIME=0.
      YMAX=0.
      YMIN=.98
C  ADJUSTMENTS: KTYPE=0,4,8 KA=0,2. KMID=0,1. (COLUMNS).
C ADJUSTMENTS: MON=0,28; NEG=0,14. (LINES).
      J1=I+2
      DO 20 J=J1,I2
      SEM=SEM+X(J)
      YMIN=AMIN1(Y(J),YMIN)
      YMAX=AMAX1(Y(J),YMAX)
      TIME=TIME+X(J)
      PTS=PTS+1.
      YD1=Y(J)-Y(J-1)
      YD2=Y(J+1)-Y(J)
      HYP=(X(J)*X(J)+YD1*YD1)**.5
      SL=SL+(YD1/X(J))*HYP
      HYPT=HYPT+HYP
      IF(J.EQ.J1) GO TO 14
      IF(X(J+1).EQ.0.) GO TO 14
      IF(YD1*YD2.LT.0.) MON=28
   14 IF(X(J+1).GT.0.) GO TO 20
      SL=SL/HYPT
      DEN=PTS/TIME
      AMP=YMAX-YMIN
      NEG=0
      IF(SL.LT.0.) NEG=14
      LK=MON+NEG
      D(1+LK,K)=D(1+LK,K)+1.
      D(2+LK,K)=D(2+LK,K)+PTS
      D(3+LK,K)=D(3+LK,K)+SL
      D(4+LK,K)=D(4+LK,K)+SL*SL
      D(6+LK,K)=D(6+LK,K)+DEN
      D(7+LK,K)=D(7+LK,K)+DEN*DEN
      D(9+LK,K)=D(9+LK,K)+AMP
      D(10+LK,K)=D(10+LK,K)+AMP*AMP
      D(12+LK,K)=D(12+LK,K)+TIME
      D(13+LK,K)=D(13+LK,K)+TIME*TIME
      II=J+1
      GO TO 8
   20 CONTINUE
   30 CONTINUE
   35 CONTINUE
      DO 37 I=1,56
      DO 37 J=1,11,2
      D(I,14)=D(I,14)+D(I,J+1)
   37 D(I,13)=D(I,13)+D(I,J)
      DO 50 M=1,43,14
      LL=M+1
      L1=M+2
      L2=L1+9
```

```
      DO 39 J=1,14
      IF(D(M,J).EQ.0.) GO TO 39
      D(LL,J)=D(LL,J)/D(M,J)
      DO 38 L=L1,L2,3
      D(L,J)=D(L,J)/D(M,J)
      D(L+1,J)=(D(L+1,J)/D(M,J)-D(L,J)**2)**.5
   38 CONTINUE
   39 CONTINUE
      DO 45 L=L1,L2,3
      L4=L+1
      L5=L+2
      DO 40 K1=1,13,4
      K2=K1+1
      DO 40 K=K1,K2
      K3=K+2
      IF(K1.EQ.13) K3=K+1
      XD=D(L,K)-D(L,K3)
      IF(D(M,K)*D(M,K3) .EQ.0.) GO TO 40
      SIG=(D(L4,K)**2/(D(M,K)-0.)+D(L4,K3)**2/(D(M,K3)-0.))**.5
      IF(SIG.EQ.0.) GO TO 40
      D(L5,K)=XD/SIG
      D(L5,K3) =PRBF(1.,D(M,K)+D(M,K3) -0.,D(L5,K)**2)
      IF(K1.EQ.13) GO TO 45
   40 CONTINUE
   45 CONTINUE
   50 CONTINUE
      DO 65 NNN=1,2
      DO 65 M=1,43,14
      KMON=8+M/29
      KPOS=10+MOD(M/14,2)
      IF(KPOS.EQ.11) GO TO 55
      WRITE(6,51)(LB(J),J=1,4),LB(26),LB(27),LB(6),((I,I=1,2),J=1,3),
     1  LB(7),((I,I=1,2),J=1,7)
   51 FORMAT('1GUY INTENSITY STUDY. SLOPE ANALYSIS OF MONOTONIC AND POLY
     1TONIC MESOWAVES.'//2X,A4,21X,A4,2(30X,A4),14X,2(4X,A4)/2X,A4,15X,
     2  3(I2,14X,I2,16X)/ 2X,A4,4X,3(4I8,2X),2I8//)
   55 M2=M+13
      IF(KPOS.EQ.11) WRITE(6,59)
      LL=11
      KM=0
      DO 62 I=M,M2
      KM=KM+1
      IF(KM.LT.3) GO TO 57
      WRITE(6,59)
      KM=0
   57 CONTINUE
      LL=LL+1
      IF(I.GT.M)   GO TO 60
      WRITE(6,58)   LB(KMON),LB(KPOS),LB(LL),(D(I,J),J=1,14)
   58 FORMAT(1X,A4,A2,A4,3(4F8.0,2X),2F8.0)
   59 FORMAT(1X,A4,A2,A4,3(4F8.3,2X),2F8.3)
      GO TO 62
   60 WRITE(6,59)   LB(KMON),LB(KPOS),LB(LL),(D(I,J),J=1,14)
   62 CONTINUE
   65 CONTINUE
      STOP
      END
      FUNCTION PRBF(DA,DB,FR)
      PRBF=1.
      IF(DA*DB*FR.EQ.0.) RETURN
      IF(FR.LT.1.) GO TO 5
      A=DA
      B=DB
      F=FR
      GO TO 10
    5 A=DB
      B=DA
      F=1./FR
   10 AA=2./(9.*A)
      BB=2./(9.*B)
      Z=ABS(((1.-BB)*F**(1./3.)-1.+AA)/(BB*F**(2./3.)+AA)**.5)
      IF(B.LT.4.) Z=Z*(1.+.08*Z**4/B**3)
      PRBF=.5/(1.+Z*(.196854+Z*(.115194+Z*(.000344+Z*.019527))))**4
      IF(FR.LT.1.) PRBF=1.-PRBF
      RETURN
      END
//GO.SYSIN DD *
//
```

```
//RFG7   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C  PHASE VIII:
C
C  THIS PROGRAM PRODUCES AN INTENSIVE ANALYSIS OF INTERACTOR AND INTRA-ACTOR
C  GAPS AND INTENSITY INTERVALS.  THE PROGRAM ESTABLISHES A FREQUENCY COUNT OF
C  ALL OCCURRING GAP SIZES OF BOTH TYPES.  THE PROGRAM ALSO CONVERTS THIS INTO A
C  PROPORTIONAL DISTRIBUTION.  THE PROGRAM ALSO ESTABLISHES A FREQUENCY
C  DISTRIBUTION OF ALL OCCURRING INTENSITY INTERVALS AND THE ASSOCIATED
C  PROPORTIONAL DISTRIBUTION.  IN ADDITION, THE PROGRAM ESTABLISHES THE MEAN
C  TIME TAKEN TO PRODUCE AN INTENSITY INTERVAL OF ANY GIVEN SIZE.
C
C*****************************************************************************
C  K=COLUMN CONTROL FOR INTRACTOR MESOWAVES
C  N=COLUMN CONTROL
C  L=LINE CONTROL  - IDENTIFIES ON WHICH LINE X INTERVAL IS ENTERED
C  KG=KODE WHICH IDENTIFIES INTERACTOR OR INTRACTOR GAP
C  KACT=KODE FOR ACTOR
C  HALF=VARIABLE INTO WHICH TIME IS STORED IN ORDER THAT SEM CAN BE DETERMINED
C  SEM=VARIABLE WHICH IDENTIFIES MIDPOINT
C  KMID=KODE WHICH IDENTIFIES WHICH HALF WE ARE IN
C  KD=KODE WHICH IDENTIFIES DYAD TYPE
C  KSEX=INTERMEDIATE OPERATORS USED TO LOCATE STORAGE LOCATIONS BY ACTOR AND
C  DYAD TYPE
C  KS=INTERMEDIATE OPERATORS USED TO LOCATE STORAGE LOCATIONS BY ACTOR AND
C*****************************************************************************
C
C
      DIMENSION X(1313),Y(1313),P(31,26),G(45,52),S(101,26)
C  LOOP WHICH ZEROES ALL MATRICES
      DO 4 J=1,26
      K=J+26
      DO 2 I=1,31
    2 P(I,J)=0.
      DO 3 I=1,45
      G(I,J)=0.
    3 G(I,K)=0.
      DO 4 I=1,101
    4 S(I,J)=0.
      DO 30 MM=1,70
C  KSEX    0=FF  1=FM   2=MM
C  LOOP WHICH READS IN ONE DYAD AT A TIME
      READ(5,6)N1,N2,TIME
    6 FORMAT(6X,2I3,F4.1)
      KSEX=MOD(N1,2)+MOD(N2,2)
      KS=2-(KSEX+1)/2
      KD=KSEX*8
      KMID=0
      SEM=0.
C  LOOP WHICH READS IN X AND Y VALUES ONE CARD AT A TIME
      DO 8 I1=1,1313,12
      I2=I1+11
      READ(5,7) (X(I),Y(I),I=I1,I2)
C  CONDITIONAL IF WHICH IDENTIFIES WHEN COMPLETE DATA SET HAS BEEN READ IN
      IF(Y(I2).EQ.0.) GO TO 9
    7 FORMAT(12(F3.0,F3.1))
    8 CONTINUE
    9 HALF=0.
      DO 12 I=1,I2
      HALF=HALF+X(I)
C  CONVERSION OF X VALUES TO SECONDS
   12 X(I)=X(I)*2.
      II=1
      KACT=Y(1)/.2
      KACT=(KACT/KS)*4
      ACT=Y(1)
   16 I1=II
   20 DO 29 I=I1,I2
      IF(Y(I).LT.0.1)GO TO 30
      IF(X(I).LT.1.) GO TO 21
      II=I+1
      GO TO 16
C  IDENTIFICATION OF ONE POINTER - IF ONE POINTER, ADD TIME AND PASS ON
   21 IF(X(I+2).GT.0.5) GO TO 22
      SEM=SEM+X(I+1)
      II=I+2
      GO TO 16
   22 KG=0
C  THIS SEGMENT IDENTIFIES INTERACTOR GAP
C  IF WHICH DETERMINES IF A POINT IS EMITTED BY SAME OR DIFFERENT ACTOR
      IF(ACT.EQ.Y(I)) GO TO 23
      ACT=Y(I)
      KACT=Y(I)/.2
      KACT=(KACT/KS)*4
      KG=26
C  DIVIDE .01 SECONDS BY 2. FOR LINE CONTROL
   23  L=X(I+1)/2.
      N=1+KG+KACT+KD+KMID
      K=N-KG
      IF((L.GT.20).AND.(L.LE. 50)) L=20+(L-20)/3
      IF((L.GT. 50).AND.(L.LE.100)) L=30+(L- 50)/5
      IF(L.GT.100) L=MIN0(40+(L-100)/50,43)
C  STORAGE OF FREQUENCIES IN ODD COLUMNS AND STORAGE OF TIME IN EVEN COLUMNS
      G(L,N)=G(L,N)+1.
      G(44,N+1)=G(44,N+1)+X(I+1)
      G(45,N+1)=G(45,N+1)+X(I+1)**2
      SEM=SEM+X(I+1)
      XMAX=0.
      XMIN=40.
       YMAX=0.
      YMIN=90.
      J1=I+2
C  HALF IS FOUND TO NEAREST MESOWAVE
      DO 27 J=J1,I2
      SEM=SEM+X(J)
      IF(SEM.GE.HALF+1.) KMID=2
      L=X(J)/2.
      IF(L.GT.20) GO TO 27
      P(L,K)=P(L,K)+1.
      L=ABS(Y(J-1)-Y(J))+1.
      IF(L.GT.97) GO TO 27
      AL=L
C  STORAGE OF FREQUENCIES IN ODD COLUMNS
      S(L,K)=S(L,K)+1.
```

```
      S(98,K+1)=S(98,K+1)+AL
      S( 99,K+1)=S( 99,K+1)+AL*AL
      IF(X(I+3).GT.0.1)GO TO 26
C   RECORDING OF TWO POINTERS
      P(25,K)=P(25,K)+1.
      P(25,K+1)=P(25,K+1)+X(J)
      P(22,K+1)=P(22,K+1)+X(J)*X(J)
      II=I+3
      GO TO 16
   26 P(26,K)=P(26,K)+1.
      P(26,K+1)=P(26,K+1)+X(J)
      P(22,K+1)=P(22,K+1)+X(J)*X(J)
C   LOADING TIME INTERVALS IN ROWS 28 TO 31
      LL=MINO(27+L/10,31)
      P(LL,K)=P(LL,K)+1.
      P(LL,K+1)=P(LL,K+1)+X(J)
      XMAX=AMAX1(XMAX,X(J))
      XMIN=AMIN1( XMIN,X(J))
      YMIN=AMIN1(Y(J),YMIN)
      YMAX=AMAX1(Y(J),YMAX)
      IF( X(J+1).GT.0.1)GO TO 27
      P(23,K)=P(23,K)+1.
      P(23,K+1)=P(23,K+1)+XMAX
      P(24,K+1)=P(24,K+1)+XMIN
      P(24,K)=P(24,K)+1.
      S(100,K)=S(100,K)+1.
      S(100,K+1)=S(100,K+1)+YMAX
      S(101,K+1)=S(101,K+1)+YMIN
      II=J+1
      GO TO 16
   27 CONTINUE
   29 CONTINUE
   30 CONTINUE
      DO 31 K=2,24,2
      S(101,K-1)=S(100,K-1)
   31 P(21,K)=P(25,K)+P(26,K)
      CALL PROP(G,45,52,43,1)
      CALL PROP(G,45,52,43,27)
      CALL PROP(S,101,26,97,1)
      CALL PROP(P,31,26,20,1)
      CALL MEAN(S,101,26,100)
      CALL MEAN(P,31,26,23)
      DO 90 N=1,4
      DO 80 M=9,21,4
      MMM=(M-5)/4
      GO TO (82,84,86,88),MMM
   82 CALL PRTS(P,31,26,20,1,M)
      GO TO 80
   84 CALL PRTS(S,101,26,97,1,M)
      GO TO 80
   86 CALL PRTS(G,45,52,43,1,M)
      GO TO 80
   88 CALL PRTS(G,45,52,43,27,M)
   80 CONTINUE
   90 CONTINUE
   75 CONTINUE
      STOP
      END
      SUBROUTINE PROP(X,MR,MC,NR,K1)
```

```
      DIMENSION X(MR,MC)
      NT=NR+2
      K2=K1+22
      K4=K2+2
      DO 2 L=1,NR
      DO 2 K=K1,K2,2
    2 X(L,K4)=X(L,K4)+X(L,K)
      DO 7 K=K1,K4,2
      DO 4 L=1,NR
    4 X(NR+1,K)=X(NR+1,K)+X(L,K)
      IF(X(NR+1,K).LT.1.) GO TO 7
      DO 6 L=1,NR
    6                        X(L,K+1)=X(L,K)/X(NR+1,K)
    7 CONTINUE
      N1=NT-1
      DO 8 L=N1,NT
      DO 8 J=K1,K2,2
    8 X(L,K4+1)=X(L,K4+1)+X(L,J+1)
      DO 9 J=K1,K4,2
      IF(X(N1,J).LE.0.) GO TO 9
      X(N1,J+1)=X(N1,J+1)/X(N1,J)
      X(NT,J+1)=SQRT(X(NT,J+1)/X(N1,J)-X(N1,J+1)**2)
    9 CONTINUE
      RETURN
      END
      SUBROUTINE MEAN(X,MR,MC,L1)
      DIMENSION X(MR,MC)
      DO 3 L=L1,MR
      DO 2 K=2,24,2
      X(L,25)=X(L,25)+X(L,K-1)
      X(L,26)=X(L,26)+X(L,K)
    2 IF(X(L,K-1).GT.0.) X(L,K)=X(L,K)/X(L,K-1)
    3 IF(X(L,25).NE.0.) X(L,26)=X(L,26)/X(L,25)
      RETURN
      END
      SUBROUTINE PRTS(X,MR,MC,L1,K1,M)
      DIMENSION LB(33),X(MR,MC)
      DATA LB/'ACT1','ACT2',' H1 ',' H2 ','FREQ','PROP','    ','TOTL',
     1'POIN','T IN','TERV','AL  ','INTE','N IN','TERV','ALS ','MESO',
     2'WAVE',' GAP','S   ','INTE','R-AC','TOR ','GAPS','MAX ','MIN ',
     3'2DUR','3DUR','<100','<200','<300','<400','>400'/
      K2=K1+25
      M2=M+3
      DO 7 N=1,2
      L=N+4
      KK=K1+N/2
      WRITE(6,2) (LB(I),I=M,M2),LB(L),((LB(I),I=1,2),J=1,3),((LB(I),
     1 I=3,4),J=1,6),LB(8)
    2 FORMAT(1H1,58X,4A4//2X,A4,17X,'F-F (16)',26X,'M-F (37)',26X,'M-M (
     117)'/14X,3(A4,12X,A4,14X)/9X,3(A4,4X,A4,4X,A4,4X,A4,6X),A4//)
      DO 7 I=1,L1
      GO TO (3,4),N
    3 WRITE(6,5) I,(X(I,J),J=KK,K2,2)
      GO TO 7
    4 WRITE(6,9)I,(X(I,J),J=KK,K2,2)
    7 CONTINUE
    5 FORMAT(I5,3(4F8.0,2X),F8.0)
    9 FORMAT(I5,3(4F8.4,2X),F8.4)
    1 FORMAT(I5,3(4F8.1,2X),F8.1)
```

```
      WRITE(6,6)
    6 FORMAT(1HO,'N,MEANS,AND STANDARD DEVIATIONS'//)
       I1=L1+1
      I2=I1+1
      WRITE(6,5) I1,(X(I1,J),J=K1,K2,2)
      WRITE(6,1) I1,(X(I1,J),J=KK,K2,2)
      WRITE(6,1) I2,(X(I2,J),J=KK,K2,2)
      IF(I2.EQ.MR) RETURN
      I1=L1+3
      WRITE (6,10)
   1C FORMAT(1HO,'FREQUENCIES AND MEANS'//)
      CO 8 I=I1,MR
      N=I-I1+25
      WRITE(6,12) LB(N),(X(I,J), J=K1,K2,2)
   12 FORMAT(1X,A4,3(4F8.0,2X),F8.0)
      WRITE(6,1) I,(X(I,J),J=KK,K2,2)
      WRITE(6,1)
    8 CONTINUE
      RETURN
      ENC
//GC.SYSIN DD *
//
```

```
//RFG11  JCB (11060,442-50-0299,1,,,90C1),'REBECCA GUY'
// EXEC FCRTGCLG
//FORT.SYSIN DC *
C
C
C  PHASE IX:
C
C  CN THE BASIS OF A CEVISED MATHEMATICAL FORMULA, THIS PROGRAM LISTS THE OB-
C  SERVED FREQUENCY OF THE OCCURRENCE OF ALL INTENSITY INTERVALS, THE
C  PRECICTED FREQUENCY OF OCCURRENCE OF ALL INTENSITY INTERVALS, AND THE
C  ERRCR RESULTING FROM THE DIFFERENCE BETWEEN THESE TWO.  THE PROGRAM
C  RETAINS THE ABSOLUTE MEAN ERROR AND THE CUMULATIVE MEAN ERROR.
C
C
      DIMENSION X(98,5),Z(98,5),LB(11),A(7,20),Q(98,13)
      CATA LB/'OBSE','RVED',' PRE','DICT','   E','RROR','EXPO','NENT',
     1  'MEAN',' ERR','OR  '/
      X(98,4)=0.
      X(98,5)=C.
      CO 55 I=1,13,2
      READ(5,1) (A((I+1)/2,J),J=1,20)
    1 FORMAT(20A4)
      I2=I+1
      DO 55 J=I,I2
      IF(I.LT.13) GO TO 55
      READ(5,52) (C(K,J),K=1,98)
   52 FORMAT(18F4.C)
      GO TO 60
   55 READ(5,54) (C(K,J),K=1,98)
   54 FORMAT(25F3.C)
   60 WRITE(6,11)
      DO 61 I=1,98
   61 WRITE(6,62)  I,(Q(I,J),J=1,13)
   62 FORMAT(I5,3(4F8.0,4X),F8.0)
      CO 75 J=1,13
      CO 66 I=1,97
   66 C(98,J)=C(98,J)+Q(1,J)
      DO 67 I=1,97
   67 Q(I,J)=Q(I,J)/Q(98,J)
   75 C(98,J)=0.
      WRITE(6,11)
      CO 76 I=1,97
   76 WRITE(6,77)  I,(C(I,J),J=1,13)
   77 FORMAT(I5,3(4F9.4,3X),F9.4)
      XLCG=0.
      YLOG=C.
      CO 8C I=1,6
      CC 80 J=1,12
      XLOG=XLOG+Q(I,J)
   8C YLOG=YLOG+Q(I+20,J)
      XLCG=ALCG(XLCG/72.)
      YLCG=ALOG(YLCG/72.)
      ACLCG=(YLCG-XLOG)/20.
      CO 90 J1=1,13,2
      CO 7 MM=1,2
      J=J1-1+MM
```

```
      EABS=0.
      E=0.
      IF(MM*J1.EQ.26) GO TC 9
      CC 2 I=1,97
    2 X(I,1)=C(I,J)
      X(1,2)=X(1,1)
      X(1,3)=0.
      X(1,4)=XLCG-2.*ACLCG
      X(1,5)=C.
      ZLCG=XLCG-2.*ACLCG
      CO 4 I=2,97
      C=I-1
      ZLCG=ZLCG+ACLCG
      X(I,2)=EXP(ZLOG)
      X(I,3)=X(I,2)-X(I,1)
      X(I,4)=ZLCG
      E=E+X(I,3)
      EABS=EABS+ABS(X(I,3))
      IF(X(I,1).GT.0.) X(98,2)=X(I,1)
    4 X(I,5)=E/D
      X(98,3)=EABS/96.
      X(98,1)=ADLOG
      IF(MM.EQ.2) GO TO 9
      CC 6 I=1,98
      CO 6 J=1,5
    6 Z(I,J)=X(I,J)
    7 CONTINUE
    9 J=(J1+1)/2
      WRITE(6,11) (A(J,K),K=1,20)
   11 FORMAT('1',2X,20A4//)
      WRITE(6,8) ((LB(I),I=1,11),J=1,2)
    8 FCRMAT(    5X,5(2X,2A4),A4,11X,5(2X,2A4),A4//)
      CC 1C I=1,97
   1C WRITE(6,12)  I,(Z(I,J),J=1,5),I,(X(I,J),J=1,5)
   12 FORMAT(I5,5F10.4,10X,I5,5F10.4)
   14 WRITE(6,15)(Z(98,J),J=1,3),(X(98,J),J=1,3)
   15 FORMAT(//2('  ADLOG=',F8.4,'   UNIT=',F8.4,' ABS ER=',F8.4,18X))
   9C CONTINUE
      STCP
      ENC
//GC.SYSIN DC *
//
```

```
//REG1C  JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C   PHASE X:
C
C   THIS COMPUTER PROGRAM PLOTS THE CURVILINEAR FUNCTION EXTRACTED IN PHASE IX.
C   INTENSITY SHIFTS ARE DELINEATED ON THE VERTICAL AXIS WITH FREQUENCY OF OCCUR-
C   RENCE ON THE HORIZONTAL AXIS.
C
C
      DIMENSION X(92),Y(92),Z(92),LB( 9),L1(2),L2(2),L3(2),L4(2)
      CALL PLOTS
      CALL PLOTC(0.0,-11.0,-3)
      CALL PLOTC(0.0,2.0,-3)
      READ(5,1) LB,L1,L2,L3,L4
    1 FORMAT(9A4,4(2A4))
      IF(M.EQ.13) GO TO 3
      READ(5,2) (Y(I),I=1,90)
    2 FORMAT(25F3.0)
      GO TO 5
    3 READ(5,4) (Y(I),I=1,90)
    4 FORMAT(18F4.0)
    5 DO 6 I=1,90
      A=I
    6 X(I)=A
      SUMY=Y(1)
      XLOG=(-2.7297)
      ADLOG=(-0.0686)
      Z(1)=EXP(XLOG)
      SUMY=SUMY+Y(I)
      XLOG=XLOG+ADLOG
   10 Z(I)=EXP(XLOG)
      PERCEN =SUMY/100.
      DO 12 I=1,90
      Z(I)=Z(I)/0.01
   12 Y(I)=Y(I)/PERCEN
      CALL SCALE(X,9.0,90,1)
      CALL AXIS(0.0,0.0,'INTENSITY INTERVAL',-18,9.0,0.0,X(91),X(92))
      CALL SCALE(Y,6.0,90,1)
      CALL AXIS(0.0,0.0,'PERCENT OF FREQUENCY',20,6.0,90.0,Y(91),Y(92))
      CALL SYMBOL(2.0,6.25,0.14,LB,0.0,36)
      CALL SYMBOL(6.50,2.8,0.14,L1,0.0,8)
      CALL SYMBOL(6.50,2.5,0.14,L2,0.0,8)
      CALL SYMBOL(6.50,2.2,0.14,L3,0.0,8)
      CALL SYMBOL(6.5,1.6,0.14,'N= ',0.0,3)
      CALL NUMBER(7.0,1.6,0.14,SUMY,0.0,-1)
      CALL SYMBOL(6.50,1.3,0.14,'OBSERVE ',0.0,8)
      CALL SYMBOL(7.75,1.4,0.14, 3,0.0,-1)
      CALL SYMBOL(6.50,1.0,0.14,'PREDICT ',0.0,8)
      CALL SYMBOL(7.75,1.1,0.14,75,0.0,-1)
      CALL LINE(X,Y,90,1,1,3)
      CALL SCALE(Z,6.0,90,1)
      CALL LINE(X,Z,90,1,-1,75)
   20 CALL PLOTC(12.0,0.0,-3)
      STOP
      END
//GO.SYSIN DD *
```

```
//RFG8   JOB (11060,442-50-0299,1,,,9001),'REBECCA GUY'
// EXEC FORTGCLG
//FORT.SYSIN DD *
C
C
C   PHASE XI:
C
C   THIS PROGRAM IS INSTRUCTED TO DESCRIBE THE BANDING EFFECT OF THE INTENSITY
C   INTERVALS.  THE PROGRAM IDENTIFIES THE INTERVALS LEVELS AT WHICH THE BANDING
C   EFFECTS OCCUR.  THE PROGRAM ALSO IDENTIFIES THE MEAN NUMBER OF LEVELS BETWEEN
C   EACH BAND.
C
C
      DIMENSION D(93,13),E(93,13),LB(5),LC(4,26),F(12,11),G(12,11)
      DATA BLANK/'    '/,ASTER/'****'/,LB/'NPTS','BAND','SD  ',
     1 ' Z',' P'/
      DO 1 I=1,90
      DO 1 J=1,13
      E(I,J)=BLANK
      IF(I.GT.3) GO TO 1
      D(I+90,J)=0.
      E(I+90,J)=0.
    1 CONTINUE
      DO 8 J=1,13
       K2=J*2
      K1=K2-1
      READ(5,3) ((LC(I,K),K=K1,K2),I=1,4)
    3 FORMAT(36X,8A4)
      IF(J.EQ.13) GO TO 4
      READ(5,5)   (D(I,J),I=1,90)
      GO TO 8
    4 READ(5,6) (D(I,13),I=1,90)
    5 FORMAT(25F3.0)
    6 FORMAT(18F4.0)
    8 CONTINUE
      DO 20 J=1,13
      BAND=0.
      LOWER=0
      DO 20 I=2,90
      BAND=BAND+1.
      IF(D(I+1,J).GT.D(I,J)) LOWER=1
      IF((I.EQ.90).AND.(D(I,J).GT.D(I-1,J)))GO TO 15
      IF(D(I,J).GE.D(I-1,J).AND.D(I,J).GT.D(I+1,J)) GO TO 14
      GO TO 20
   14 IF(LOWER.EQ.0) GO TO 20
   15 LOWER=0
      D(91,J)=D(91,J)+1.
      D(92,J)=D(92,J)+BAND
      D(93,J)=D(93,J)+BAND*BAND
      E(I,J)=ASTER
      D(I,J)=10000. * BAND+D(I,J)
      IB=BAND
      IF(IB.LE.4) E(89+IB,J)=E(89+IB,J)+1.
      BAND=0.
   20 CONTINUE
      DO 30 J=1,13
      D(92,J)=D(92,J)/D(91,J)
   30 D(93,J)=(D(93,J)/D(91,J)-D(92,J)**2)**.5
      DO 40 I=2,12
      J2=I-1
      DO 40 J=1,J2
      SM=(D(93,I)**2/D(91,I)+D(93,J)**2/D(91,J))**.5
      F(I,J)=(D(92,I)-D(92,J))/SM
   40 G(I,J)=PRBF(1.,1000.,F(I,J)**2)
      DO 58 M=1,2
      WRITE(6,50)
   50 FORMAT('1REGULARITY OF INTENSITY INTERVALS'//)
      DO 51 I=1,4
   51 WRITE(6,52) (LC(I,J),J=1,26)
   52 FORMAT(5X,13(1X,2A4))
      DO 58 I=1,93
      IF(M.EQ.2) GO TO 56
      IF(I.LE.90) WRITE(6,53) I,(D(I,J),J=1,13)
      IF(I.GT.90) WRITE(6,54)  LB(I-90),(D(I,J),J=1,13)
   53 FORMAT(1X,I4,13F9.0)
   54 FORMAT(/1X,A4,13F9.2)
   55 FORMAT(1X,I4,13(1X,2A4))
      GO TO 58
   56 IF(I.LE.90) GO TO 57
      K=I-89
      WRITE(6,53)
      WRITE(6,53) K,(E(I,J),J=1,13)
      GO TO 58
   57 WRITE(6,55) I,(E(I,J),E(I,J),J=1,13)
   58 CONTINUE
   59 WRITE(6,50)
      DO 70 M=1,2
      WRITE(6,62) (J,J=1,11)
   62 FORMAT(//'  Z SCORES AND PROBABILITIES FOR BAND DIFFERENCE'//
     I  3X,11I7/)
      DO 63 I=2,12
      J2=I-1
      IF(M.EQ.1) WRITE(6,65) LB(4),I,(F(I,J),J=1,J2)
   63 IF(M.EQ.2) WRITE(6,66) LB(5),I,(G(I,J),J=1,J2)
   65 FORMAT(A2,I3,11F7.2)
   66 FORMAT(A2,I3,11F7.3)
   70 CONTINUE
      STOP
      END
      FUNCTION PRBF(DA,DB,FR)
      PRBF=1.
      IF(DA*DB*FR.EQ.0.) RETURN
      IF(FR.LT.1.) GO TO 5
      A=DA
      B=DB
      F=FR
      GO TO 10
    5 A=DB
      B=DA
      F=1./FR
   10 AA=2./(9.*A)
      BB=2./(9.*B)
      Z=ABS(((1.-BB)*F**(1./3.)-1.+AA)/SQRT(BB*F**(2./3.)+AA))
      PRBF=.5/(1.+Z*(.196854+Z*(.115194+Z*(.000344+Z*.019527))))**4
       IF(FR.LT.1.) PRBF=1.-PRBF
      RETURN
      END
```

APPENDIX C

SAMPLE OUTPUT OF COMPUTER PROGRAMS

Digitized Audio Record

```
  1   0   1   2   3   2   0   0   2   3 991 912 803 685 616 546 717 932
931 917 855 758 866 765 917 840 924 917 843 730 656 577 514 568 500 443
443 394 352 709 940 936 929 921 852 757 901 910 822 727 642 569 506 452
452 404 604 864 872 766 677 597 523 468 418 374 370 999 763 685 670 744
744 773 864 770 674 602 531 471 991 547 554 591 688 727 827 850 733 641
420 372 379 347 402 366 322 286 257 365 461 412 362 321 342 432 423 401
401 352 422 371 336 296 262 235 211 188 166 148 134 122 109  96  86  79
 79  73  66  58  51  48  44  41 398 504 465 468 411 360 317 280 248 223
223 195 173 154 169 394 343 297 263 234 209 186 163 144 130 151 162 141
165 144 131 124 113 111 158 229 245 218 297 325 337 306 268 240 216 190
190 167 151 136 121 106 356 358 314 275 241 212 188 169 150 279 344 300
300 266 242 219 215 192 172 154 137 120 106 221 342 326 287 275 248 219
219 195 221 211 203 246 232 204 176 157 185 184 161 141 126 114 108  94
 62  56  48  43  40  37  34  29  26  24  23  22  18 249 308 279 244 210
210 186 164 147 132 117 103  90  83 243 309 272 237 210 187 166 145 127
127 114 352 422 474 454 406 360 318 279 246 218 196 175 154 136 121 110
110 194 318 274 272 295 303 268 232 206 185 165 147 129 114 263 278 244
163 145 127 112 239 208 184 161 141 125 229 999 681 598 528 467 413 365
365 322 284 254 227 202 178 158 142 129 172 149 131 117 106  96  84  74
 74  66  62  57  50  44  39  37  35  60 118 101  93  83  74  64  56  51
 51  47  43  86 188 166 991 189 180 172 151 137 122 114 103  90  83  74
 47  44  39  33  29  27  26  24  20  17  16  17  16  13  10   9  10  10
 10   8   6   5  90  91  79  68  59  54  49  43  37  32  31  91 139 196
196 199 174 157 138 120 105  94  85  76  78  68  60  56  51  44  38  33
 33  32  30  26  21  19  19  20  20  16  13  14  14  13   9   8   8   9
  4   6   6   4   3   2   5   5   4   2   1   4  96 305 492 446 399 411
411 392 366 354 340 355 332 302 265 234 210 187 165 145 129 117 106  93
 93  82  73  68  62  55  48  42  40  37  34  28  25  24  23  21  17  15
 15  15  15  14  11   9   9  10  12  39 213 308 274 246 215 188 165 148
 89  82  74 100  85  74  68  62  56  48  41  38  35  32  27  23  21  21
 21  20  17  14  12  13  13  12   9   7   9   9   8   6   4   6   7   7
  7  77 149 391 517 492 433 385 338 350 315 334 309 277 247 220 194 171
171 151 137 123 120 187 206 311 390 364 363 381 343 305 299 319 279 241
154 138 125 112  99  87  78  72  66  58  51  45  43  39  36  30  27  26
 26  25  24  21  28  38  45  57  50  46  50  51  53  48  58  69  63  61
 61  60  52  47  48  44  40  48  43  43  51  69  76  77  78  78  74  64
 64  55  50  46  42  35  54 992 152 244 223 274 309 295 272 244 213 189
119 105  95  93  87  81  72  66  61  60  56  48  44  41  37  32  27  63
 63 114 119 169 164 143 128 114 100 138 155 178 181 157 136 120 107  97
 97  86  74  65  59  55  49  42  37  33  32  30  25  21  19  19  18  16
 16  13  11  12  13  11   8  13  21  39 992 274 294 264 233 205 178 157
 97  85  77  71  64  56  48  43  41  38  33  28  25  24  23  21  17  14
 14  15  15  14  10   8   9  10   9   7   5   5   7   7   5   3   3   5
  5   6   4   2   1 370 319 274 240 210 187 166 147 128 112 101 116 117
178 158 139 123 112 102  91  80  71  65  60  55  48  44  42  51  46  40
 30  25  22  21  21  19  15  13  13  13  36  46  61  60  63  71  79  81
 81  95  97 136 119 104  90  82  74  65  56  49  46  42  38  32  28  26
 26  25  23  18  16  32  42  37  31  26  24  43  83  74  88  83  75  71
 71  61  54  48  45  46  51  43  38  36  33  30  25  21  21  23  21  17
 28  23  19  17  17  16  13  10   9  10  10   9   6   5   6   7   8   6
```

```
  6   5   6   7   8  29  24  22  21  19  15  22  20  19  18  15  12  10
 10  11  54 991 188 209 222 211 248 383 351 322 284 250 219 192 358 567
567 485 430 640 554 482 427 375 334 297 265 237 209 185 334 334 326 286
117 992 227 199 180 163 142 125 110 100  90  79  69  61  57  52  46  40
 40  35  77 156 168 164 218 236 263 239 228 197 174 157 140 142 124 109
109  99  90  80  69  61  56  51  47  40  35  32  31  29  24  21  18  19
 19  18  16  13  11  13  13  11   8   7   8 999   8   5   4   5   7   7
  5   5   3   2   2   4   4   3   1   1   3   4   3   1   0  74  64  56
 56  47  40  37  34  31  34 992 926 889 781 684 601 530 471 453 416 366
366 328 416 364 320 282 697 598 523 461 405 358 319 285 253 223 198 178
178 161 144 126 113 102  93  85  74  66  59  56  51  45  39  35  34  32
 22  53 100  84  74  67  61  55  47  43  93  83  74  63  60  76  73  72
 72  75  65  57  53  60  69  60  52  49  46  40  34  30  30  31  28  23
 23  20  19  19  17  13  11  11  12  12   9   7   6   8   9  16  13  11
 11  12  12  10   7   6   8   8   7   5  10  16  19  17  13  11  11  12
  6   7   7   5   4  21  40  57  48  41  35  34  31  26  22  19  18  18
 18  16  12  10  11  11  11   8   6   6   8   7   5   3   3   5  23  23
 23  19  16  19  18  15  12  10  11  11  10   7   5   7  13  14  10   8
  8   9  10   9   6   4   4   6  13  13  15  13  13  13  10   8   6   8
  3   5   6   5   3   2   5   6   8   5   3   4   5   8   5   3   3   5
  5   5   3   2   1   4   5   3   1   1  29  54  63  53  45  42  38  34
 34  28  23  30  73  65  55  47  42  39  36  30  25  22  22  20  17  14
 14  12  25  92  79  67  58  53  48  43  36  31  29  27  52  45  37  34
123 143 126 111  96  84  74  68  61  53  46  40  38  34  31  26  22  21
 21  21  19  15  13  13  13  12  28  88 208 243 259 327 333 354 381 363
363 334 302 258 235 256 223 200 212 207 184 163 144 123 114 199 297 256
256 222 195 177 157 137 121 108  98  88  77  69  65  65  70  63  55  48
 32  28  27  26  23  19  16  16  16  15  12   9   9  11  10 339 552 991
818 803 743 649 632 657 640 677 584 518 475 589 809 803 863 872 767 677
677 599 521 576 508 451 402 354 314 415 393 352 341 294 406 381 459 428
428 394 346 304 373 697 621 572 505 447 396 349 309 277 248 221 195 430
437 396 350 313 326 342 319 286 257 229 203 179 154 148 133 122 131 169
169 211 297 258 225 198 177 159 143 127 111 100  91  83  72  64 162 263
263 346 302 312 332 293 259 229 200 177 159 143 128 111 114 116 104  93
 93  81  71  65  60  54  47  41  37  36  33  29  24  22  22  21  18  15
 13  10   8  10  10   9   7   5   6   7   8   5   3   4   5   6   4   3
  3   4  16  15  12   9   8   9  10   9   6   5   6   8   7   4   3   4
  4   6   6   3   2   2   4   5   3   1   1   3   4   2   1   0   3   4
  4   3   1   0   2   3   3   1  43 117 102  90  80  69 992 229 205 179
130 113  99  87  80  72  63  54  48  60 106 126 114 100  90  81  72  62
 62  54  49  45  41  34  30  28  26  30 215 182 160 142 126 110  96  84
 84  77  69 326 373 322 283 249 225 292 317 278 246 219 191 991 649 590
590 529 464 408 361 322 286 588 920 854 727 792 709 622 549 488 434 389
363 322 282 268 304 270 238 243 214 191 172 154 180 454 465 453 403 404
404 361 318 284 253 225 198 176 999 384 449 485 471 455 401 354 312 275
275 245 258 228 201 177 158 143 129 114 101  90 237 206 180 157 139 126
126 113 101  88  78  72  66  59  51  45  42  41  37  56 131 122 109  97
 73  74 101 207 298 562 685 814 836 709 644 565 501 442 425 931 912 846
846 825 723 639 567 503 444 393 350 314 281 249 235 272 627 810 763 742
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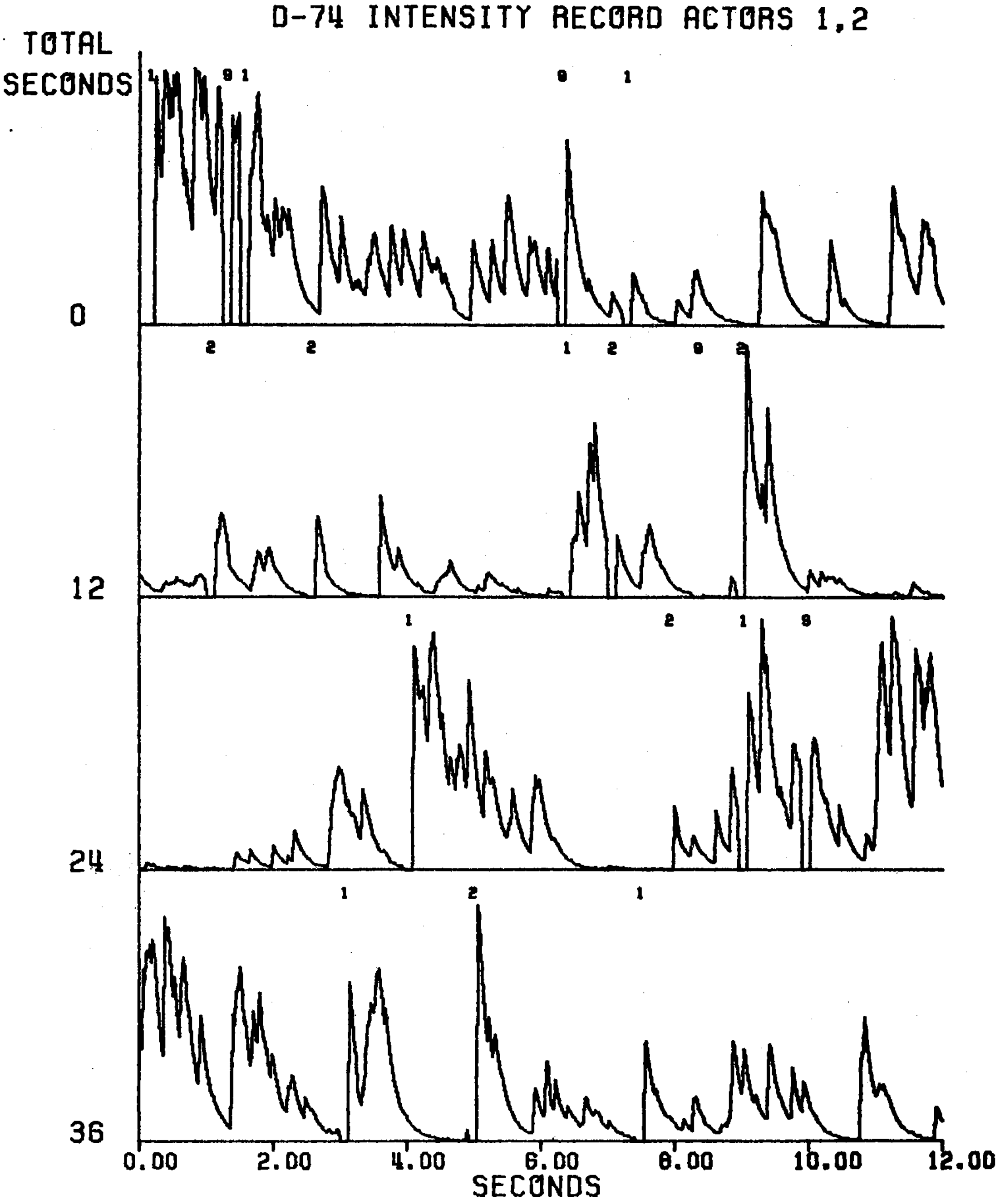
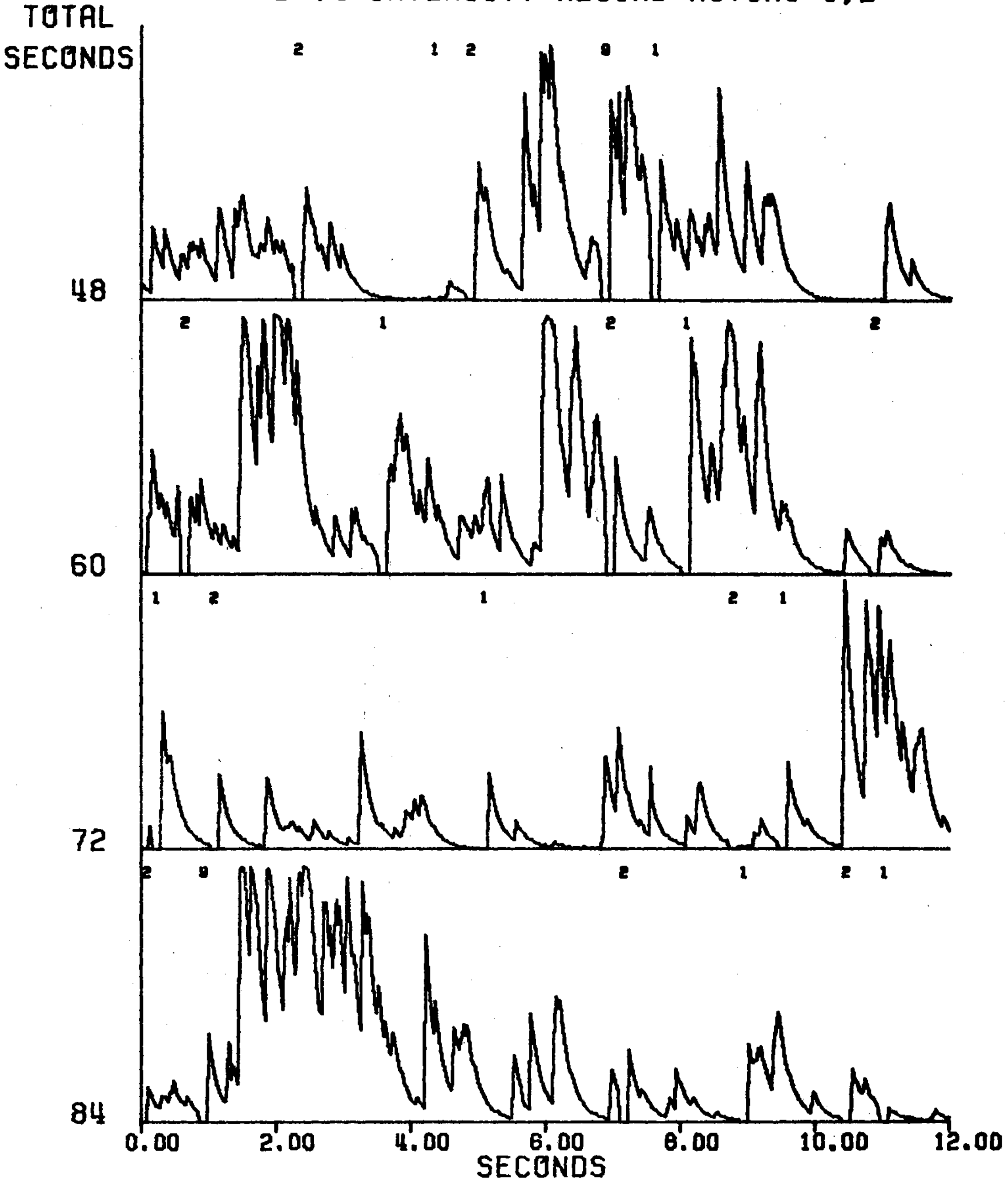
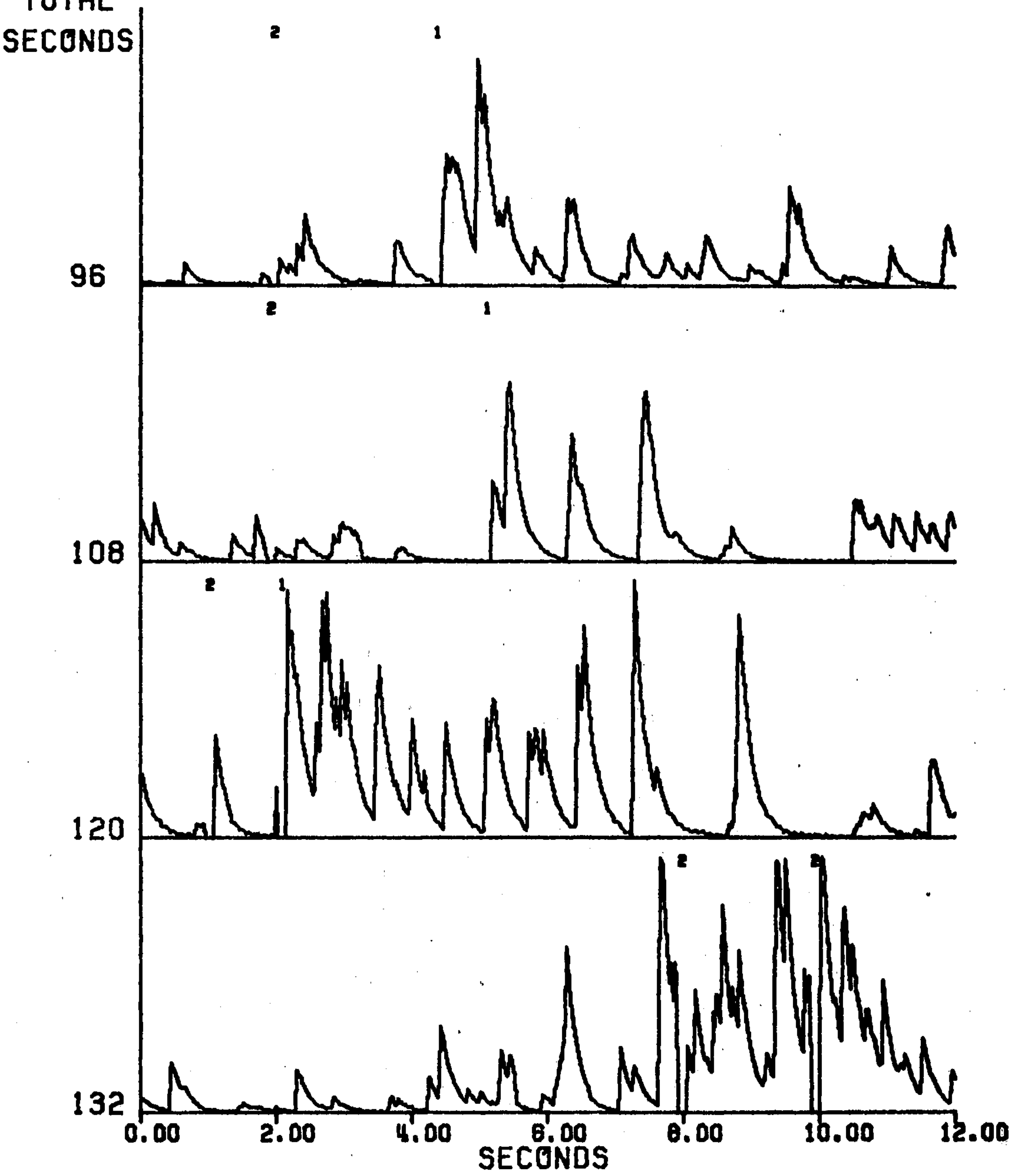


D-74 INTENSITY RECORD ACTORS 1,2

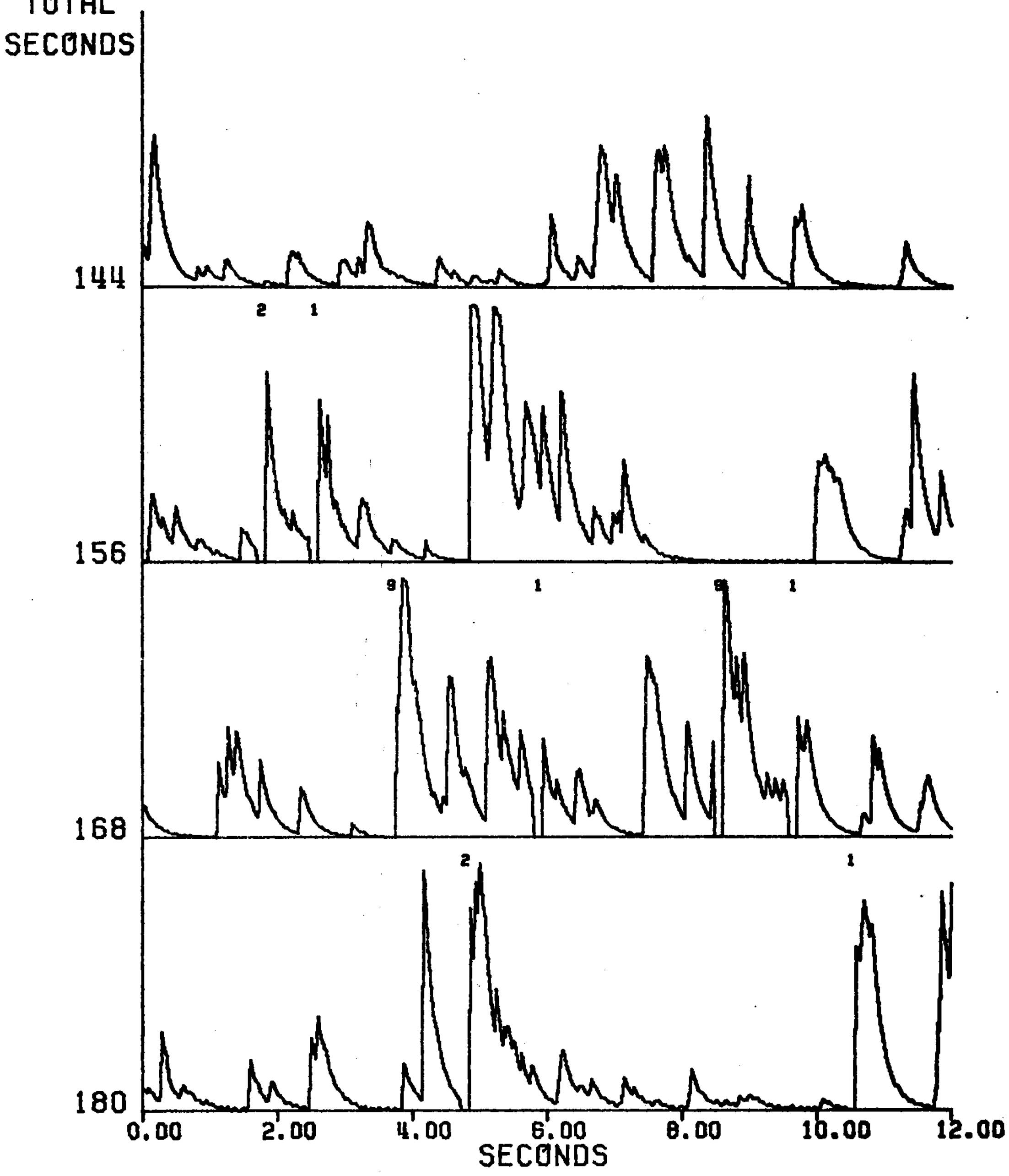
D-74 INTENSITY RECORD ACTORS 1,2



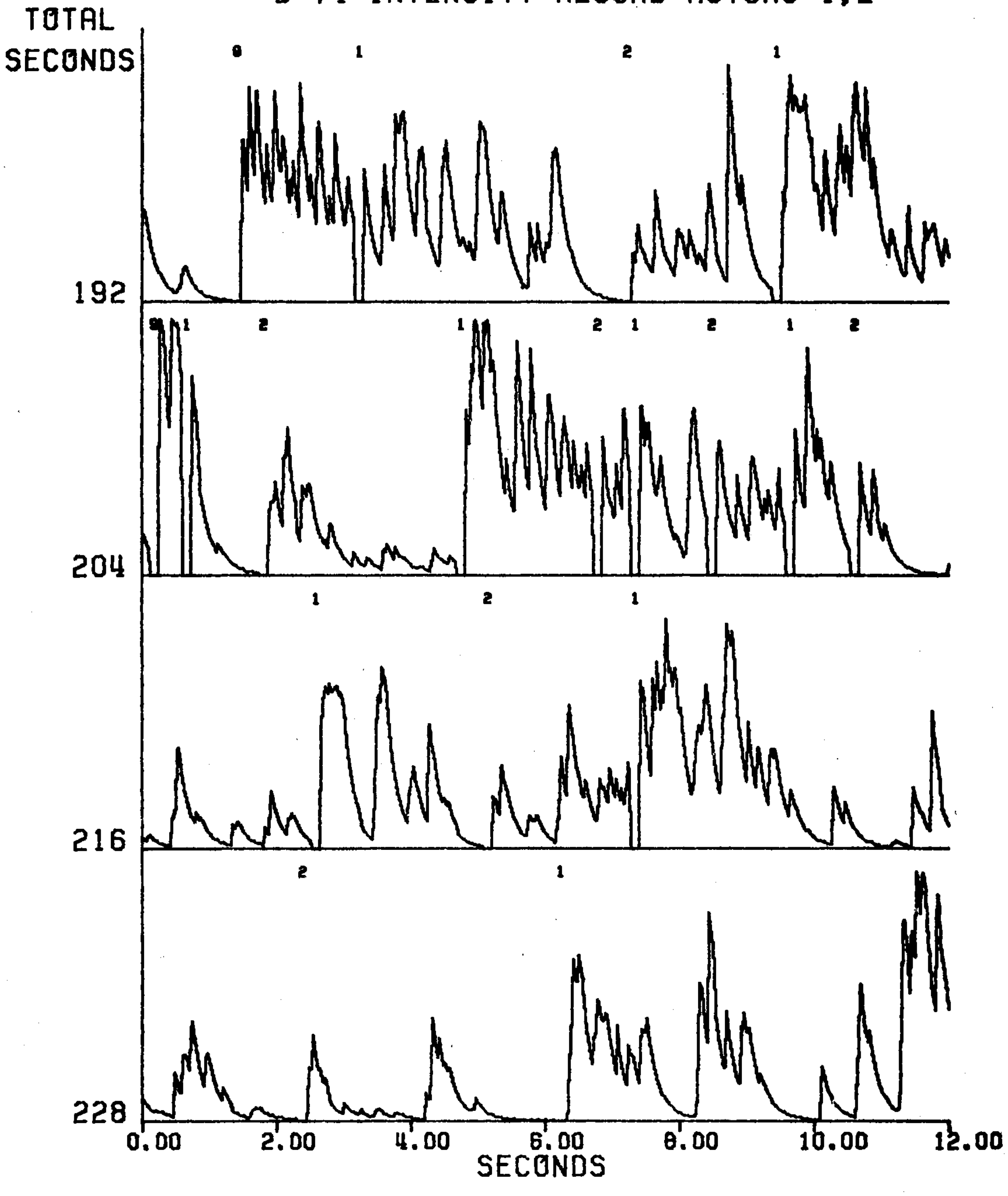
D-74 INTENSITY RECORD ACTORS 1,2

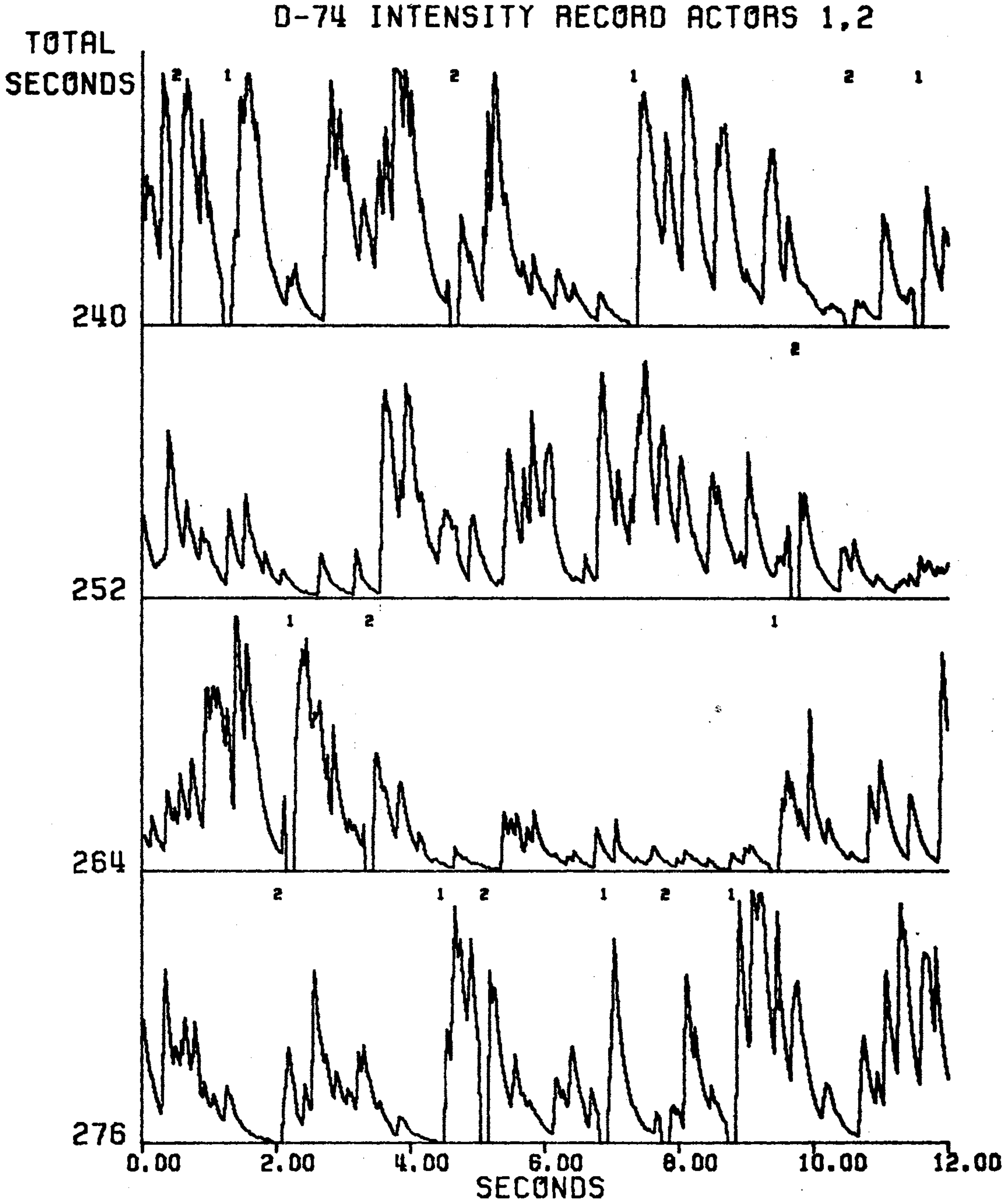


D-74 INTENSITY RECORD ACTORS 1,2



D-74 INTENSITY RECORD ACTORS 1,2

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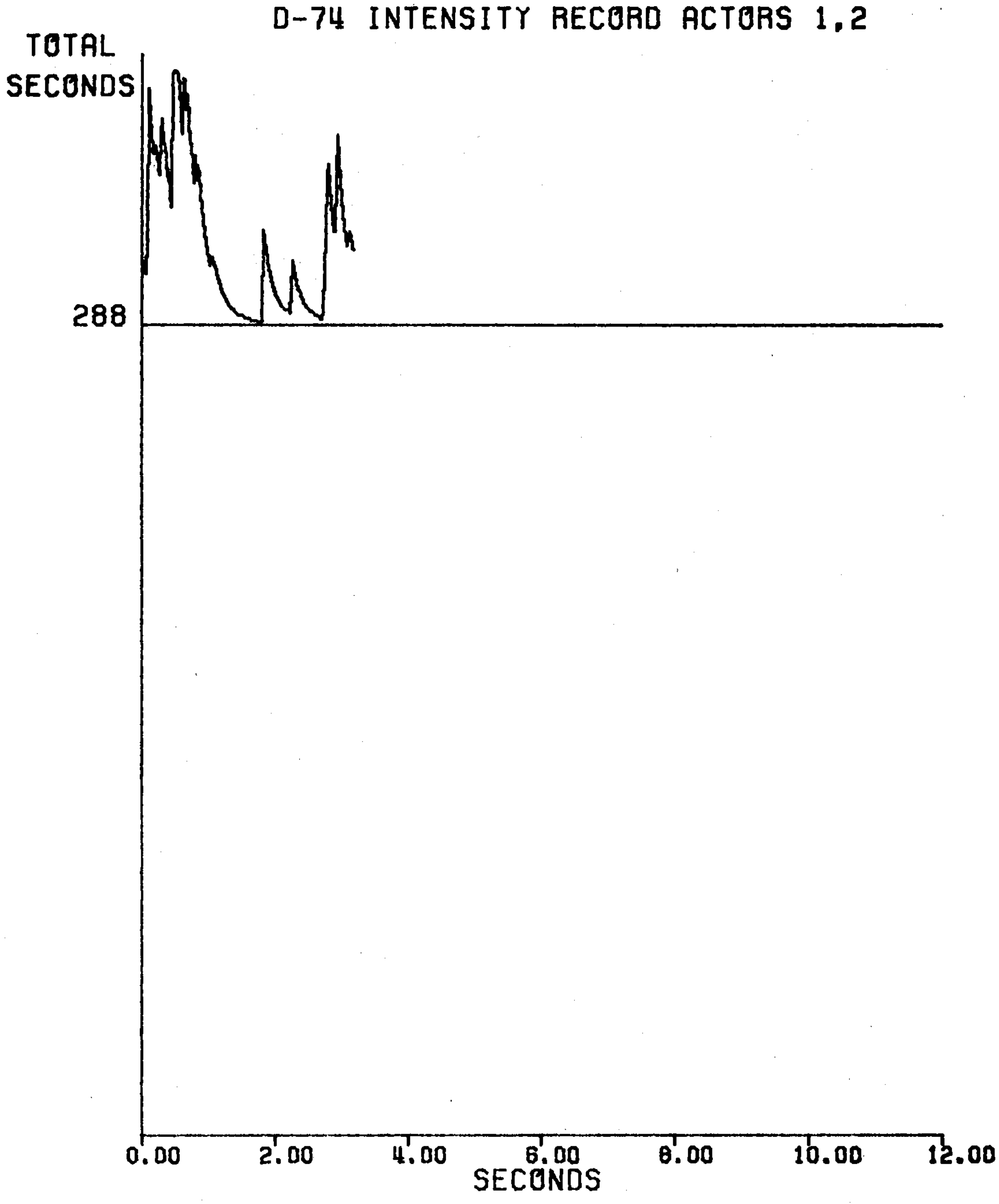
TOTAL SECONDS
240
252
264
276
0.00
2.00
4.00
6.00
8.00
10.00
12.00
SECONDS
1
2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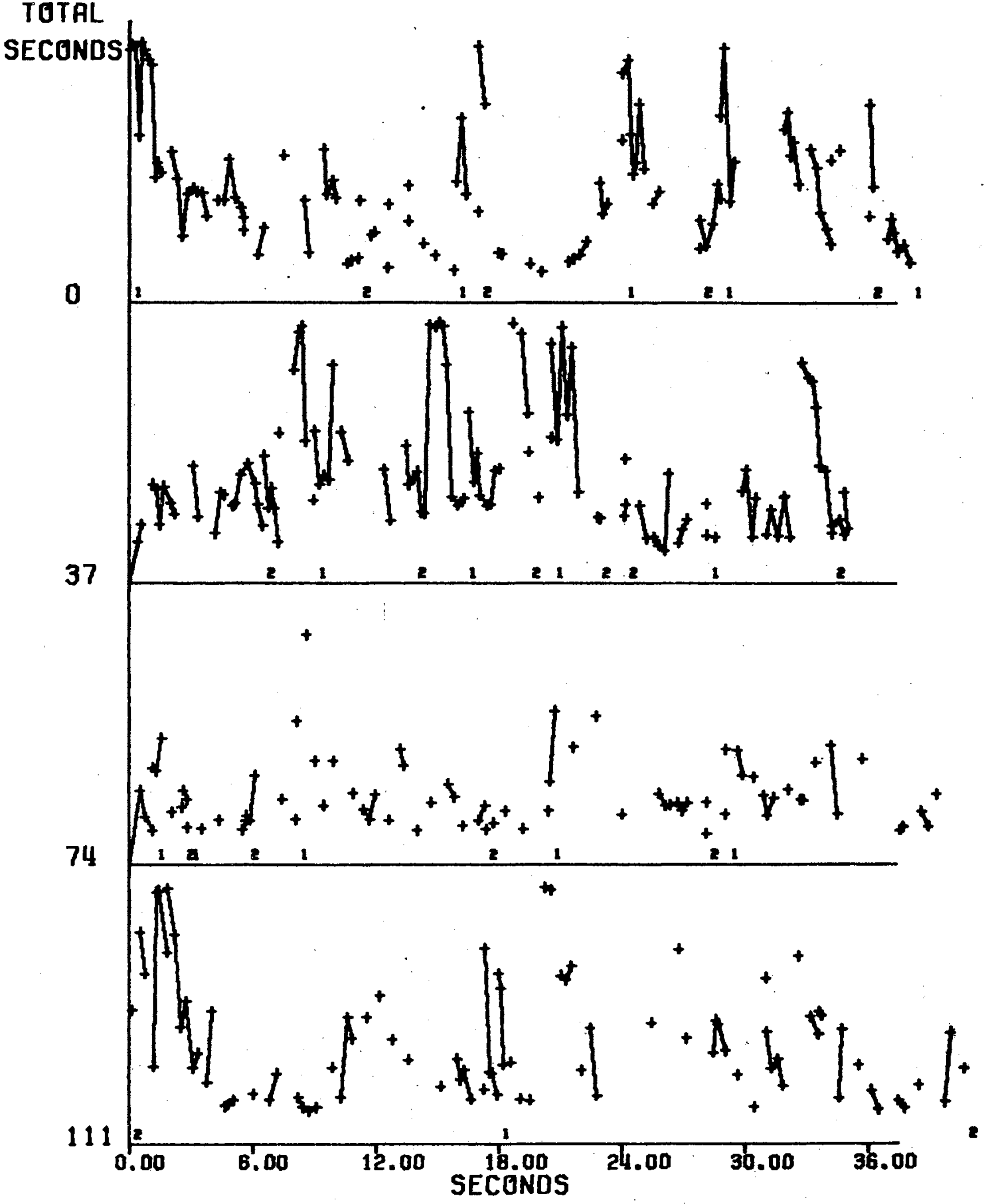
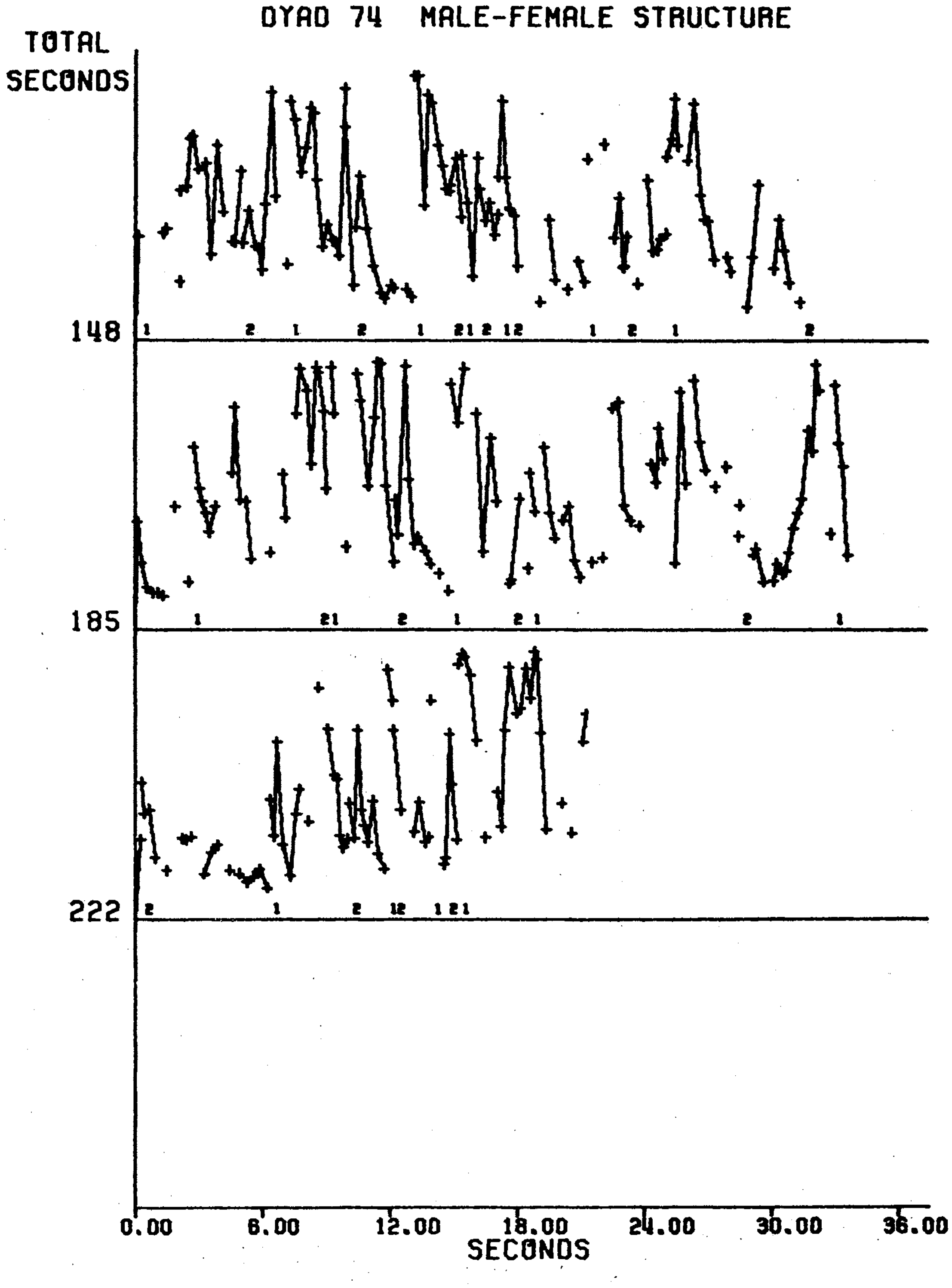
TOTAL SECONDS
288
0.00
2.00
4.00
6.00
8.00
10.00
12.00
SECONDS

DYAD 74 MALE-FEMALE STRUCTURE

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TOTAL SECONDS
148
185
222
0.00
6.00
12.00
18.00
24.00
30.00
36.00
SECONDS

VITA 2

Rebecca Faith Guy

Candidate for the Degree of

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