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Chapter 5

Temporal Patterns of Dialogue

Basic Research and Reconsiderations[1]

Stanley Feldstein

AN ANALOGY, drawn from crypotology, may serve to put the following research into some perspective and to convey some notion of the excitement that this research, and language research generally, affords the investigator. The analogy concerns cryptography in which the message that is to be disguised is called the "plaintext." The process of disguising the plaintext is called "encoding" or "enciphering," the distinction being related to the status of the plaintext unit replaced. Ciphers operate upon single letters of the plaintext; codes replace units larger than letters, such as syllables, words, phrases, etc. The disguised message is called the "codetext" or "ciphertext," and the process of reconstructing the plaintext by a person who has the appropriate key is called "decoding" or "deciphering." However, the process used to reconstruct the plaintext by a person who does not have the appropriate key is called "cryptanalysis."

It seems not too farfetched to view the study of spoken interpersonal communication as cryptologic. The speaker might be considered the encoder, and his verbal statements the codetext. The person to whom this codetext is directed, i.e., the intended listener, could be considered the decoder because he presumably has the appropriate keys. Unintended listeners, on the other hand, who are presumed not to have the keys, are in the position of cryptanalysts. The psycholinguist, *qua* psycholinguist, is most often in the position of an unintended listener; his job is codebreaking.

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It is not suggested here that the codetext generated by a speaker is totally incomprehensible, upon first hearing, to the unintended listener or, for that matter, that it is totally comprehensible to the intended listener. It seems unlikely that the plaintext reconstructed by the intended listener is anything more than a closer approximation of the original plaintext than is that reconstructed by the unintended listener (and not always that). What is suggested is that a spoken message is a quite complex phenomenon by virtue, in part at least, of having been encoded at a variety of levels. Few of these levels possess characteristics having consensually validated denotations and/or connotations. In this sense, they are codes that remain to be broken.

One more important point: the breaking of a code not only enables the cryptanalyst to reconstruct the plaintext, but also frequently enables him to reconstruct the device that generated the codetext. It is the latter operation in which many psycholinguists are particularly interested.

The code or level of interpersonal communication that my past and present colleagues and I have investigated is the temporal organization of the words and word groups used by the participants. Our primary efforts have been directed toward the development of a cogent description of the characteristics of this temporal organization. The characteristics referred to are the vocal sounds and silences of the interacting speakers. The semantic meanings of the sounds are not of concern at this level of analysis, and the only silences considered are those capable of detection by the human ear. That is not to say that the semantic and syntactic features of a conversation are unrelated to its sound-silence patterns, but simply that the relationships, in terms of information conveyed, are not one-to-one.

This chapter will briefly describe an instrument designed to sample automatically the temporal patterns of dialogue and present a descriptive classification of the patterns. It will then review a number of basic studies which examined the stability of the temporal characteristics with respect to people and time, and their modifiability as a function of certain situational and psychological variables. Finally, some problems raised by the descriptive classification will be discussed and a new model briefly explored.

The history of interaction chronography in psychology is little more than three decades old. It was Chapple (1939, 1940), an anthropologist, who first urged that the timing of interpersonal behavior provided an important methodological approach to the reliable assessment of personality. He devised the Interaction Chronograph (Chapple, 1949) to sample the interpersonal time

domain. Subsequently, he and a number of other investigators, using the Chronograph and other instruments (Verzeano and Finesinger, 1949; Hargreaves and Starkweather, 1959) made initial probes into the behavior of this domain in interviews with the mentally ill (Chapple, Chapple, Wood, Miklowitz, Kline, and Saunders, 1960; Matarazzo and Saslow, 1961), employment interviews (Chapple and Donald, 1946; Anderson, 1960; Matarazzo, Wiens, and Saslow, 1965), individual and group psychotherapy interviews (Lundy, 1955; Timmons, Rickard, and Taylor, 1960; Matarazzo, Wiens, and Saslow, 1965), and in relation to certain personality variables (Chapple, Chapple, and Rapp, 1954; Cervin, 1957; Matarazzo, Matarazzo, Saslow, and Phillips, 1958). Some effort was also made to assess its relation to semantic content (Kanfer, Phillips, Matarazzo, and Saslow, 1960). Only a minimal attempt, however, was made to explore the time patterns of free, unconstrained conversation (cf. Matarazzo, Saslow, and Matarazzo, 1956, pp. 356-7).

The excursion my colleague, Dr. Joseph Jaffe, and I made into interaction chronography grew out of general concern with psychopathology, our belief that a significant developmental component of psychopathology is disturbed interpersonal communication and our belief that *how* something is said is as important to effective communication as *what* is said. Our prior research had focussed upon such characteristics of language use as vocabulary diversity (Jaffe, 1958; Fink, Jaffe, and Kahn, 1960; Feldstein and Jaffe, 1962a; Feldstein and Jaffe, 1962b), speech disturbances and filled pauses (Feldstein, 1962; Feldstein and Jaffe, 1962a; Feldstein and Jaffe, 1963; Feldstein, Brenner, and Jaffe, 1963; Brenner, Feldstein, and Jaffe, 1965), and speech predictability (Feldstein and Jaffe, 1963; Weinstein, Feldstein, and Jaffe, 1965; Feldstein, Rogalski, and Jaffe, 1966). It was but another step to examining the unfilled pauses, or silences, and the vocalizations, or sounds, of speech.

Although our interest originated with psychopathological communication, it was decided to investigate the time patterns of "normal" communication in order to establish some sort of evaluative baseline. Moreover, we intended to look at relatively free conversational interactions, i.e., conversations that were not constrained by any obvious role or instructional differences between the participants, such as exist, for example, in interview situations. The expectation was that this approach would allow for the formulation of general rules of conversational time patterns. Special types of conversation, such as the interview or monologue, might then be described in terms of specific modifications of the general rules.

THE INSTRUMENT

Initial efforts went into devising an automated system of detecting and recording the sound-silence patterns of dialogue in computer-readable form. Two major reasons prompted this effort. On the one hand, a monumental amount of data processing was anticipated. Thus the use of a computer seemed inescapable and the collection of computer-readable data obviated the possibility of human transcription errors. On the other hand, the Interaction Chronograph was unsatisfactory because it required that a human observer decide when each of the participants was talking or silent. Thus the behavior recorded by the Chronograph confounded the effects of the semantic content of the conversation, the gestures of the participants, and the judgment and reaction time of the observer.

The engineering skill of a former colleague, Dr. Louis Cassotta, translated our requirements into an analogue-to-digital conversion system called the "Automatic Vocal Transaction Analyzer," or AVTA (Cassotta, Feldstein, and Jaffe, 1964; Cassotta, Jaffe, Feldstein, and Moses, 1964). In point of fact, AVTA includes two special components, only one of which will be discussed here.[2]

This component, designed to "listen" to live or audiotaped conversation and to detect and record the presence and absence of speech for each of the participants, is called, for convenience, the "Presence-Absence Component," or PAC. Originally designed to feed information to a cardpunch, PAC now "talks" directly to a small computer[3] which, in turn, provides a printed statistical summary of prespecified temporal characteristics and punches the dyadic sequence of sounds and silences plus the summary on paper tape.

It is important to note that PAC "listens" periodically. That is, it "inquires" about the state of the relay associated with each speaker at predetermined intervals which can range from 100 msec. to 1000 msec. We have always used a 300 msec. interval or, alternatively, a 200 times per minute inquiry rate for reasons that had to do originally with the limitations of the keypunch.

It should also be mentioned that the problem PAC was built to cope with was not simply that of generating a time pattern sequence of the speech of two people. Such a problem only requires two ordinary voice-activated relays with appropriate filtering. The real

[2]The component not discussed here is one called the "Vocal Intensity Component" (VIC) which detects and records in computer-readable form the vocal intensity, or loudness, of each participant's voice at regular time intervals of optional length, such as 300 msec.

[3]The computer used is a PDP8/S manufactured by Digital Equipment Corporation.

difficulty lay in achieving adequate voice separation of two speakers who, while talking into separate microphones, are sitting in a face-to-face position at a comfortable distance from each other. The solution utilized a network which electronically cancels the spill of each speaker's voice into the other speaker's channel. It enabled us not only to use vis-à-vis conversations in a naturalistic setting, but also to obtain an accurate account of simultaneous speech.

TEMPORAL PARAMETERS

An explicit effort was made to extract from the dyadic sequence of sounds and silences precisely definable indices that were descriptive rather than attributive. The indices, or parameters, are called "vocalizations," "pauses," "switching pauses," "simultaneous speech," "speaker switches," "utterances," and "floor time." An effort was also made to define all the parameters but simultaneous speech and speaker switches solely in terms of their boundary conditions. Together, these parameters form what we have called a "descriptive classification."

1. A *vocalization* is a segment of continuous sound, i.e., speech, by one speaker that is bounded on each end by either silence or a vocalization of the other speaker.

2. A *pause* is an interval of silence bounded on either end by a vocalization of the same speaker.

3. A *switching pause* is an interval of silence bounded on one end by a vocalization of one speaker and on the other end by a vocalization of the other speaker.

4. Finally, temporally concurrent vocalizations of the speakers are categorized as *simultaneous speech.*

An "utterance" can now be defined as a sequence, or string, of the pauses and vocalizations of one speaker that is bounded on either end by switching pauses or, if there are no switching pauses, by the vocalizations of the other speaker. The parameter rather awkwardly called "floor time" refers to a speaker "having the floor." Each speaker is considered to have the floor until the other speaker takes it. In other words, a single "floor time" is equal to an utterance plus the switching pause that follows it. The number of "floor times" a speaker accrues during the course of a conversation is equal to the number of speaker switches in the conversation, i.e., the number of changes from one speaker to the other.

Immediately following the termination of a dialogue, the AVTA system prints and punches frequencies, average durations, and pro-

portionality constants of all but the utterance parameter. For the present discussion, the definition and implication of a proportionality constant can be ignored.[4] Prior to processing a dialogue, the AVTA

TABLE I.

Sample Output of AVTA System Summarizing a Fifteen-Minute Conversation in Terms of the Temporal Parameters of the Descriptive Classification

Study Name QT6 Dyad No. 271	Sub Dyad No. 1	Condition 066	Occasion 007
Participant 024		**Participant 023**	
Parameter: Pauses			
Frequency = 0079 Summed Durations = 0140 Average Duration = +1.77215 Proportionality Constant = +0.43571		Frequency = 0096 Summed Durations = 0188 Average Duration = +1.95833 Proportionality Constant = +0.48936	
Parameter: Switching Pauses			
Frequency = 0035 Summed Durations = 0108 Average Duration = +3.08571 Proportionality Constant = +0.67593		Frequency = 0025 Summed Durations = 0058 Average Duration = +2.32000 Proportionality Constant = +0.56897	
Parameter: Vocalizations			
Frequency = 0165 Summed Durations = 1119 Average Duration = +6.78182 Proportionality Constant = +0.85255		Frequency = 0169 Summed Durations = 1455 Average Duration = +8.60947 Proportionality Constant = +0.88385	
Parameter: "Floor Time"			
Frequency = 0064 Summed Durations = 1258 Average Duration = +19.6562 Proportionality Constant = +0.94913		Frequency = 0064 Summed Durations = 1726 Average Duration = +26.9688 Proportionality Constant = +0.96292	
Parameter: Simultaneous Speech			
Participants 024 and 023			
Frequency = 0054 Summed Durations = 0069 Average Duration = +1.27778 Proportionality Constant = +0.21739			

[4] A proportionality constant is simply a transformation of the mean duration [(M-1)/M] which characterizes a particular distribution shape, i.e., a negative exponential.

system can be told to divide the dialogue into segments of equal duration. It will then summarize each segment separately after termination of the dialogue (Table I).

These, then, are the parameters of our descriptive classification. They are objective; their definitions are unencumbered by preconceptions about the intentions of the speakers and their measurement excludes observer reaction time. Moreover, their delineation by PAC is highly reliable, i.e., the processing by PAC of the same dialogues on different occasions yields strikingly high reliabilities regardless of the complexity of the dialogues.

At first blush, this descriptive classification seems to offer a structure which provides an unbiased and rather simple description of the actual temporal behavior of dyadic verbal interactions. That in fact it fails to do so is a result of certain constraints built into the hardware and software of the AVTA system and of certain definitional ambiguities. This criticism may be somewhat unfair in that it hinges partially on the use of the word "actual." The system was not designed to examine the actual time patterns, if by "actual" is meant "true." It was mentioned earlier that the only silences considered to be of interest are those capable of detection by the human ear. It is this constraint, introduced into the processing controls of the system, which renders the output of the system a description of the *perceived* temporal patterns of dialogue. As such, however, the description is eminently defensible and furnishes a set of characteristics that are beginning to appear quite useful.

The definitional ambiguities represent a different order of difficulty. In part, they reflect the inherent electronic constraints of the AVTA system. More importantly, they highlight the lack of sufficiently general rules for the categorization of seemingly anomalous configurations or for the unambiguous assignment of all the categories to speakers. As is often the case, it is the consideration of just such problems and their implications that is so provocative and frequently so fruitful. They will be considered further after a discussion of the categories as they now stand. The problem raised need not, at this point, impede an examination of the categories as potentially meaningful psychological variables. The questions initially relevant here concern the reliabilities of the categories and the relations among them. Two experiments were conducted to investigate these questions.

EXPERIMENTAL STUDIES

INDIVIDUALS IN INTERVIEWS

The first experiment was a study of individual differences with respect to four of the parameters of the classification (Cassotta, Feldstein, and Jaffe, 1968). The primary intent was to explore the individual consistency of the parameters, their stability over time, and their modifiability. Because of this focus on the vocal behavior of individuals, the study used an interview format as its conversational paradigm. The subjects were 50 white female students from an urban college whose ages ranged from 17 to 23 years and averaged 19.3 years. They were interviewed on two occasions, each occasion separated by approximately two weeks. On the first occasion, a 16-minute interview was conducted with each subject by one interviewer. On the second occasion, three successive 16-minute interviews were conducted, the first by the interviewer of the first occasion and the remaining two by another interviewer. The interview of occasion one and the first two interviews of occasion two were of the question-and-answer type and dealt with factual biographical information. The last, or fourth, interview was a stress interview.[5] That is, an effort was made in the last interview to ascertain what areas of discussion appeared to arouse anxiety by asking a series of open-ended questions. The subject was then questioned in detail about these areas, with the interviewer displaying reactions calculated to increase the subject's stress. The stress interview was utilized to evaluate the modifiability of the parameters.

All the interviews were tape recorded and the tapes were processed by the AVTA system. It became obvious upon inspection of the data that there were too few occurrences of simultaneous speech to permit an evaluation of its reliability. The analyses, therefore, were concerned only with pauses, switching pauses, and vocalizations. It is important to note that here and in the following study the switching pauses were assigned to the speaker by whom they were terminated. This assignment decision was based upon the assumption that the switching pause represents a reaction, or response time. The results reported are of the analysis of proportionality

[5]The interpretation of the interview as stressful is inferential and a more parsimonious interpretation may be possible [e.g., in terms of the differing degrees of ambiguity of the question sets used in the fourth interview as compared with each of the other interviews (Siegman and Pope, 1965)]. The important point is that, by independent assessment, the fourth interview represented a different interview condition.

constants of the parameters rather than of their average durations.[6]

Intercorrelations among the parameters (using only the subjects' data) yielded average coefficients of .40 for the comparison of pauses and switching pauses, —.47 for pauses and vocalizations, and —.36 for switching pauses and vocalizations. While the parameters were obviously not orthogonal in this study, each was considered to carry enough unique variance to remain a separate parameter.

The reliabilities of the parameters were estimated by computing correlation coefficients of the subjects' data among the six possible pairs of the four interviews. The average of the six correlations for each parameter was .68 for pauses, .61 for switching pauses, and .62 for vocalizations. All the coefficients are significant. There were, moreover, no significant differences among the coefficients of the interview pairs. These results indicate that the parameters reliably differentiated individuals and remained stable over time, across interviewers, and even from non-stress to stress conditions. Comparison of the non-stress and stress interviews revealed that, on the average, significantly longer pauses and switching pauses were emitted during the stress interview. Thus pauses and switching pauses appear to be not only stable but modifiable parameters, at least under the impact of stress.

Similar comparisons of the interviewers' data yielded average coefficients of .29 for pauses, .49 for switching pauses, and a non-significant .16 for vocalizations. These results suggest that, with regard to pauses and switching pauses, the interviewers tended to behave in consistently different ways with different subjects. Furthermore, since there were no real differences between the coefficients of those interview pairs which had the same or different interviewers, it appears as if the subjects affected the vocal behavior of the interviewers similarly. These results are pertinent to a consideration of interspeaker influence, a topic that will be discussed later.

The results of this study suggested that the temporal parameters, pauses, switching pauses, and vocalizations are stable individual characteristics. The study did, however, elicit conversations within the structure of an interview. Would conversations unconstrained by an imposed structure and explicit role differences between the participants yield similar results? These issues were pursued in a second experiment (Feldstein, Jaffe, and Cassotta, 1966, 1967) which utilized task-oriented, but otherwise free conversational interactions.

[6]Since the proportionality constant is a simple transformation of the mean (see footnote 4), it is highly unlikely that correlations of the transformed scores would be markedly different from those of the mean durations.

CONVERSATIONS BETWEEN PEERS

The subjects of the study were 32 white male and 32 white female students, again from an urban college. The average age of the group was 20.6 years, with a sigma of 3.6 years. The experimental design required the participation of each subject in three 40-minute dialogues, each separated by about a three-week interval. Each subject conversed with a member of his own sex on one occasion, a different member of his own sex on a second occasion, and a member of the opposite sex on a third occasion. The task of the participants of each dyad was to attempt to resolve their differences on a questionnaire concerned with the attitudes of white Americans toward Negroes (Collins, 1964). In addition, the 40-minute dialogues were divided into two conditions; namely, during the first or second 20 minutes an opaque screen was placed between the participants in order to eliminate visual communication.

Assessment of the relations among the average durations of the four parameters are presented in Table II. Note that in this study, the

TABLE II.

Product Moment Correlation Coefficients for Comparisons Among Vocalizations (V), Pauses (P), Switching Pauses (SP) and Simultaneous Speech (SS) Averaged Over Occasions and Conditions

	P	SP	SS
V	-.05	-.07	.18
P		.54	-.07
SP			-.05

Note—The N for the individual comparisons was 62.

average correlations between vocalizations and each of the two silence parameters are approximately zero, whereas that between the two types of silence increased by comparison with their correlation in the interview study. Note also that simultaneous speech is statistically independent of the other parameters.

Comparisons of the average durations of pauses, switching pauses, vocalizations, and simultaneous speech of the two 20-minute conditions over occasions yielded average correlation coefficients of .67, .68, .66, and .53, respectively. Note that the individual consistency estimates of the first three parameters are as high as those obtained in the initial study. Moreover, the stability of the parameters remained high over two conditions that have been shown to

differentially affect the durations of the parameters (Feldstein, Jaffe, and Cassotta, 1967), indicating again that the parameters are both stable and modifiable.

Thus far, the results of the two studies suggested that the temporal style of an individual's conversational behavior remained consistent so long as he interacted with the same conversational partner. But what if he changed his partner? To answer this question comparisons among the three occasions were made and yielded average stability estimates of .29 for pauses, .30 for switching pauses, .47 for vocalizations, and .27 for simultaneous speech. The stability of the parameters from occasion to occasion was considerably lower than that between conditions, but still significant. Within the context of the experiment, this lowered stability makes sense only if it is seen as resulting from the impact of a different temporal style. The implication here is that an individual's conversational style varies as a function of the style of the person with whom he interacts. There is, in fact, from this and the initial study, evidence of appreciable interspeaker influence. It should be recognized, however, that concern about the parameters as indices of interspeaker influence goes beyond the issue of stability to approach the more interesting question of whether the parameters vary in ways that appear psychologically meaningful.

INTERSPEAKER INFLUENCE

A comparison of the subjects' data in the initial study with those of the interviewers yielded average correlation coefficients of .39 for pauses, .42 for switching pauses, and .32 for vocalizations, all of which are statistically significant. Apparently, the participants in the interviews tended to match each other's average parameter durations. That the correlations are low probably reflects the fact that one of the participants in all the interviews was the same person, namely, the interviewer. In the second study, in which the dyads are all different within each occasion, the average correlations (over occasions) between the average durations of pauses, switching pauses, and vocalizations of dyad participants were .59, .70, and a non-significant -.04, respectively. Obviously, a similar comparison for the average durations of simultaneous speech would be meaningless since both participants in a dyad have the same average duration. The average duration of vocalizations does not appear to be subject, in conversational interactions, to the same degree of modification as are those of pauses and switching pauses. That the duration of vocalizations was as modifiable as those of pauses and switching pauses

in the interview study may reflect the different interactional rules of an interview and/or the fact that all the subjects spoke to the same interviewer. Nevertheless, a comparison of the average utterance durations, which include pauses and vocalizations, of the dyad participants yielded significant intraclass correlations of .43, .60, and .44 for the three occasions (Feldstein, 1968), revealing again a considerable degree of what might be called pattern matching, or congruence. Indeed, it may be useful to call these correlation coefficients which compare the behavior of the participants in a conversation, coefficients of "congruence." It may also be useful to emphasize that the coefficients of congruence being discussed are obtained by correlating the average parameter values of one participant in a dyad with the average parameter values of the other participant over many dyads. To put it another way, consider one of the participants in a dyad the speaker and the other participant the partner. A coefficient of congruence is computed by correlating the average parameter values of all the speakers with those of all the partners.[7] This kind of comparison should be distinguished from a comparison of the temporal patterns of a speaker and partner *within* a conversation. The latter comparison is much more concerned with what might be considered the moment-to-moment tracking of each participant by the other. Thus, for example, were a correlation of the utterance durations used by two participants during the course of a conversation found to be significant, it would indicate that the sequential pattern of the utterance durations of each participant was matched by that of the other. As a matter of fact, an approximation to this comparison was used with eight of the dialogues from the second study (Feldstein, 1968). The length of an utterance was defined by its number of words rather than by its temporal duration. None of the eight correlation coefficients even approached significance. This finding may be a function of the utterance definition, or it may be that utterance-by-utterance tracking does not occur in relatively unstructured dialogues. On the other hand, Ray and Webb (1966), using a similar lexical index, failed to find the occurrence of such tracking in the question-and-answer press conferences of the late President Kennedy.

As another aspect of interspeaker influence, one might examine the consistency of the effects that the temporal style of one speaker has upon the temporal styles of all other speakers with whom he

[7]Inasmuch as all speakers can be considered partners and vice versa in dyads in which the participants are not explicitly differentiated (as, e.g., by role), an intraclass correlation (Haggard, 1958) must be used for comparisons.

interacts. In the second study, each subject conversed with three other subjects or, in the jargon introduced earlier, each speaker conversed with three different partners. The consistency of the speakers' influence on their partners was evaluated by intercorrelating the temporal characteristics of the partners. The average coefficients of these comparisons were .39 for pauses, .37 for switching pauses, and .11 for vocalizations. The first two are low but significant, suggesting that to a discernible degree, at least in terms of silence patterns, a speaker exerts a similar influence upon different conversational partners.

Together, then, the two studies suggest that the temporal patterning of an individual's conversational behavior is a stable characteristic of that individual and, in addition, is capable of modifying and being modified by the temporal patterning of other individuals with whom he interacts.

OTHER QUERIES, OTHER STUDIES

It would seem that the results of these experiments lay a firm foundation for the study of dialogic time patterns as representative of the participants' characteristic modes of interpersonal behavior. A series of questions may clarify this notion. It might be asked, for example, whether it is possible to specify the time it takes for conversationalists to develop congruent temporal behavior. Does this time vary systematically from dyad to dyad and, if so, as a function of what? Can it be demonstrated that the temporal patterns of two conversationalists grow more congruent as they engage in more and more dialogues or, to put it another way, do their patterns tend to converge[8] over dialogues?

The magnitude of the coefficients of congruence obtained in the second study does suggest that the participants in a conversation to some degree mutually modify their temporal behavior in the direction of achieving similarity. Does the extent of this modification vary with individuals? What are the consequences of invariance in this regard? Is such invariance reflective of a more general inflexibility in the face of environmental demands? Similar questions may be asked about the significance of the degree to which individuals exhibit *consistent* temporal behavior, while recognizing that consistency and congruence are not entirely independent phenomena. Is, for example,

[8]The use of the term "convergence" rather than "congruence" is arbitrary. My preference is to use "congruence" to describe the degree of interspeaker influence that occurs in a single dialogue, and "convergence" to describe the degree of interspeaker influence that develops over a series of dialogues by the same participants.

the extent to which an individual displays consistent temporal patterns of interaction related to the extent of his consistency in other behavioral domains?

A number of dissertations have investigated the generalizability of certain aspects of temporal behavior. It may be recalled that one finding of the second study was that the absence of visual-gestural communication significantly altered, in complex ways, conversational time patterns. One dissertation (Rogalski, 1968) found a significant, although weak, relationship between the pattern of this altered temporal behavior and cognitive style, i.e., an individual's style of processing environmental input. Another dissertation (Marcus, 1970) found that the extent to which the temporal patterns of interacting speakers converge depends upon the interaction of their cognitive styles.

There are still other interesting questions now under investigation. Is degree of congruence and/or convergence related to the extent to which the participants perceive each other as similar? Or is it related to their actual similarity, as measured by a profile of tests? Or is it related to the similarity of their value systems? Or, finally, is it related to the extent to which they are mutually attracted to each other?

PROBLEMS OF THE DESCRIPTIVE CLASSIFICATION

As stated earlier, all but two of the parameters, or categories, of the classification were defined solely in terms of their boundary conditions. It soon became apparent, however, that such definitions were not always adequate. Among the gritty actualities of real data, there occasionally occur ambiguous temporal configurations, configurations which cannot be categorized solely on the basis of their boundary conditions. Consider, for example, the following case in which an interval of silence is bounded by simultaneous speech which terminates synchronously prior to the silence and begins synchronously subsequent to the silence as in Figure 1. How is the silence to be categorized?

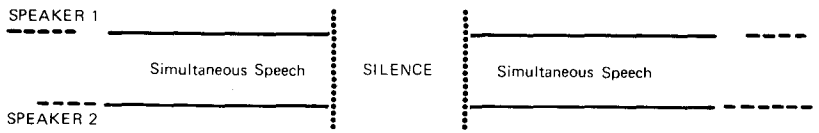

Fig 1. Diagrammatic representation of a silence bounded by two segments of simultaneous speech.

As two switching pauses? As two pauses? Inasmuch as utterances are determined by switching pauses, the decision made in this case affects three of the classification categories.

Apart from the problem of categorization is the problem of assigning switching pauses to a speaker. The definition of an utterance leaves the switching pause unassigned. In the studies reviewed, the switching pauses were arbitrarily assigned to the speaker of the subsequent utterance on the unsupported notion that a switching pause was the response time of the subsequent speaker. It is likely that the electronic constraints of PAC and the inquiry rate utilized are at least partially responsible for generating ambiguous configurations. Nevertheless, such instances, together with the assignment difficulty, uncover the not immediately obvious fact that, within the context of the descriptive classification, the boundary condition of a switching pause is a necessary but not sufficient definition. Put another way, the dependence of a switching pause extends beyond its boundary events. If the parameter "floor time" is now introduced, as it was when the delineation of utterances and switching pauses required too many arbitrary decisions, it becomes possible to resolve most ambiguities. Moreover, the parameter assigns switching pauses to the preceding speaker, on the assumption that a speaker "has the floor" until the other speaker takes it from him.[9] What it does not do is reduce the dependency of a switching pause to its boundary events.

This difficulty of non-arbitrarily categorizing all temporal configurations is a consequence, it would seem, of the lack of an explicit theory that would provide for a coherent integration of the classification categories. It is this kind of integration that is implied in the use of the categories to describe the temporal "pattern" or "organization" of dialogue. Another important consequence is the lack of predictive power. Parenthetically, it might also be suggested that a model frequently serves as the type of challenge that stimulates productive contention.

Although a mathematical model of dyadic temporal interaction has been proposed,[10] it utilizes not the categories of the classification model but the sequence of momentary dyadic states generated by the

[9]It might be pointed out that, although its analysis is not dealt with at length in the reported studies, speaker switching could be regarded as the single behavior that most aptly characterizes a dialogue. This view is inherent in a paper by Jaffe, Feldstein, and Cassotta (1967b) and in a recent monograph (Jaffe and Feldstein, 1970), although they have not considered the behavior to be capable, by itself, of determining parameter assignment.

[10]The model was suggested by Jaffe and Norman (1964) and is described succinctly in a more recent report (Jaffe, Feldstein, and Cassotta, 1967a) and at length in the monograph referred to in footnote 9.

instrument, PAC, as its elements. I should like to propose here, and but briefly outline its beginning steps, a recursive model which concerns itself with the categories of the descriptive classification.

A RECURSIVE MODEL: INITIAL STEPS

What are the basic elements which such a model might require? As was said toward the beginning of this discussion, of concern are the sounds and silences of human speech and the time in which and at which they occur.[11] These elements are introduced by the initial expressions of the model. The first expression,

[1] $x_1, x_2, \ldots, x_n$

represents the names of a set of individuals and the second of a set of vocalizations (V) made by individuals,

[2] $Vx_1, Vx_2, \ldots, Vx_n$

The temporal sequence of such vocalizations is indicated by the subscripts of the 'V's in conjunction with the subscripts of the 'x's, as in the expression,

[3] $V_1x_1, V_2x_1, \ldots, V_nx_1$

If silence is considered the *absence* of vocalization, such absence can be specified by negation. Finally,

[4a] 't' names any time, infinitesimal or not (i.e., an interval) (specified as either by use of the notations defined in [4b], [4c], and [4d] as subscripts).

[4b] 't_p', where 'p' is equal to specific infinitesimal times (i.e., clock times).

[4c] 't_e', where 'e' is equal to a non-specific infinitesimal time (e.g., the time constant of PAC).

[4d] 't_i', 't_j', and 't_k', where 'i', 'j', and 'k' stand for temporal intervals of any duration with the constraint that $e < i < j < k$.

[4e] 't_m', where 'm' equals any member of the set e through k, i.e., any time no matter what its duration.

The recursive model of the elements is completed by premises [5] and [6]. The first,

[5] $(x)\,(V)\,(\exists t)\,[Vxt \vee \overline{V}xt]$

assumes as true for all individuals and all vocalizations that at any given instant of time, or for any given interval of time (or both), an individual either vocalizes or does not vocalize, but not both. Put another way, it is not possible for individuals to both vocalize and not vocalize at the same time. The second premise,

[6] $(V)\,(p) -(\exists x)\,[V_1x_1t_p \cdot (V_2x_1t_p \vee V_2x_1t_{(p+m)})]$

is that the occurrences of any one individual's vocalizations are temporally unidirectional.

The sign '$\rightarrow$' is used to indicate both temporal contiguity and direction. Vocalizations and non-vocalizations can now be further characterized.[12] Thus the statements

[7a] $(V)\,(\exists x_1)\,[Vx_1 \rightarrow Vx_1 = Vx_1]$

and

[7b] $(\overline{V})\,(\exists x_1)\,[\overline{V}x_1 \rightarrow \overline{V}x_1 = \overline{V}x_1]$

are illustrations of the idempotency principle and say, in effect, that contiguous vocalizations by the same individual are the same as (or equivalent to) one vocalization, and similarly for non-vocalizations. Furthermore,

[8] $t_i + t_i = t_{(i+i)}$

states that the durations of two elements are additive. It follows that while it is not possible, by virtue of [7a], to have contiguous vocalizations of one individual, whatever their duration, i.e.,

[9] $(V) -(\exists x_1)\,[V_1x_1 \rightarrow V_2x_1]$,

it is possible to have vocalizations of varying durations that are separated by a non-vocalization,

[10] $Vx_1t_i \rightarrow \overline{V}x_1t_j \rightarrow Vx_1t_k \neq 0$,

and, in such cases, the durations of the vocalizations and non-vocalizations can be summed.

Pauses (P) may now be defined as a non-vocalization that intervenes between the vocalizations of one individual:

[11] $(V)\,(P)\,(t)\,[(\exists x_1)\,(V_1x_1t_i \rightarrow \overline{V}x_1t_i \rightarrow V_2x_1t_i) \equiv (\exists x_1)\,(V_1x_1t_i \rightarrow Px_1t_i \rightarrow V_2x_1t_i)]$.

The expression states simply that within the context of vocalizations, 'V', a non-vocalization, '$\overline{V}$', is considered a pause, 'P'.

What has been said thus far applies to the speech of a single individual. The verbal interaction of two speakers can be approached by initially describing a speaker switch,[13]

[12] $(\exists x_1)\,(\exists x_2)\,(\wedge p)\,[Vx_1t_{(p-i)} \rightarrow \overline{V}xt_{(p\pm e)} \rightarrow Vx_2t_{(p+i)}]$,

i.e., for any two individuals, there is the specific infinitesimal time, p (e.g., 12 o'clock), such that the end of one individual's vocalization at time p is followed, after a silence of a non-specific infinitesimal duration, by the beginning of the other individual's vocalization.

'$\overline{V}t_{(p\pm e)}$' is not to be thought of as a discernible silence; the subscript 'e' could take zero as a value, or have a minus value in

[11] The representation of the model will utilize the conventions of elementary quantification theory (Quine, 1959).

[12] The sign '$\rightarrow$' is not to be interpreted as representing strict implication.

[13] Hereafter, universal quantification is omitted.

certain cases. In the case in which '$\overline{V}xt_{(p\pm e)}$' does become a discernible silence, it is defined as a switching pause as in statements [13a] and [13b]:

[13a] $(\exists x_1)\ (\exists x_2)\ (Vx_1t_i \longrightarrow \overline{V}xt_i \longrightarrow Vx_2t_i) \equiv$
$(\exists x_1)\ (\exists x_2)\ (Vx_1t_i \longrightarrow SPx_1x_2t_i \longrightarrow Vx_2t_i)$

and

[13b] $(\exists x_1)\ (\exists x_2)\ (Vx_2t_i \longrightarrow \overline{V}xt_i \longrightarrow Vx_1t_i) \equiv$
$(\exists x_1)\ (\exists x_2)\ (Vx_2t_i \longrightarrow SPx_2x_1t_i \longrightarrow Vx_1t_i)$

Observe that, by virtue of the assumption of temporal unidirectionality, a switching pause is assigned to the previous speaker. The relational three-place predicates, 'SPx_1x_2t' and 'SPx_2x_1t', translate as "speaker 1's switching pause to speaker 2 for time t" and, similarly, "speaker 2's switching pause to speaker 1 for time t." In effect, what the definitions imply is that a switching pause is simply a pause of the preceding speaker until it is terminated by the other speaker. What immediately follows from the definitions is a clarification of the categorizing of switching pauses. The configuration diagrammed in Figure 1, for example, presents no categorization problem for the model. If

[14] $(\exists x_1)\ (\exists x_2)\ (\curlywedge p)\ [Vx_1t_{(p+i)} \cdot Vx_2t_{(p+i)}]$

defines simultaneous speech, the configuration may be described by the statement,

[15] $(\exists x_1)\ (\exists x_2)\ (\curlywedge p)\ [(Vx_1t_{(p-j)} \cdot Vx_2t_{(p-j)}) \longrightarrow (\overline{V}x_1t_{(p-i)} \cdot \overline{V}x_2t_{(p-i)}) \longrightarrow (Vx_1t_{(p+j)} \cdot Vx_2t_{(p+j)})]$

Namely, there are two individuals, "1" and "2" and a specific infinitesimal time p (a clock time), such that the two individuals speak simultaneously for time p-j, are both silent for time p-i (where $i < j$), and again speak simultaneously for time p+j. While it is possible to define the '$\overline{V}x_1t_{(p-i)}$' and '$\overline{V}x_2t_{(p-i)}$' of statement [15] as '$SPx_1x_2t_{(p-i)}$' and '$SPx_2x_1t_{(p-i)}$' by virtue of statements [12], [13a], and [13b], they can more straightforwardly, i.e., by virtue of only [11], be defined as '$Px_1t_{(p-i)}$' and '$Px_2t_{(p-i)}$' thusly:

[16a] $(\exists x_1)\ (\curlywedge p)\ [Vx_1t_{(p-j)} \longrightarrow Px_1t_{(p-i)} \longrightarrow Vx_1t_{(p+j)}]$

and

[16b] $(\exists x_2)\ (\curlywedge p)\ [Vx_2t_{(p-j)} \longrightarrow Px_2t_{(p-i)} \longrightarrow Vx_2t_{(p+j)}]$.

Another consequence of the model's definition of a switching pause is at least one clear distinction between the time patterns of unstructured conversations and interviews. Remember that, in the second study, the relation between pauses and switching pauses, with the latter assigned to the subsequent speaker, yielded an average coefficient of .54. If, instead, switching pauses are correlated with the pauses of the previous speaker, the coefficient increases to .65. On the other hand, if the switching pauses of the interview study are reassigned according to the definition of the model, the average coefficient of the correlation between the interviewees' pauses and switching pauses decreases from .40 to .24. Although the difference between .54 and .40 is not significant, the difference between .65 and .24 is significant at about the .025 level. If it can be agreed upon other grounds that an interview and an unstructured conversation are different types of dialogue, then the model, by virtue of its assignment of switching pauses, accounts for at least one aspect of this distinction. One prediction suggested by the model's definition of switching pauses is that, in unstructured dialogues, an appreciable number of the total frequency of simultaneous speech will occur at the termination of the switching pause. This prediction has yet to be tested.

SUMMARY AND FUTURE DIRECTIONS

The development of a methodological approach to the study of dialogue has been reviewed. It is an approach which presumes that the temporal patterning of a verbal exchange represents a source of important information about the communication and communicators. Moreover, it is an approach which offers a set of behaviorally defined parameters for the description of such temporal patterning. Finally, it is an approach which has achieved a fully automated system for the processing of dialogues and has, thereby, resolved the usual difficulty in verbal behavior research of accumulating sufficient data upon which to base conclusions.

There was a twofold purpose in presenting this approach. The first was to demonstrate: (a) that the average durations of the sounds and silences of each participant in a dialogue may be considered characteristic of that participant and, at the same time, a function of his interaction with the other participant; and (b) that the temporal patterning of an individual's speech is capable of reflecting the influence, not only of the pattern of another speaker, but also of changes in the psychological context of a dialogue. The second was to describe some of the ambiguities and limitations inherent in a purely empirical parameterization of such sounds and silences, to propose a recursive model for redefining the parameters, and to note a few of the consequences of using the model.

It would seem that further investigations of dialogic time patterns can move in at least several directions. An obvious direction—the one which originally motivated this research—is an exploration of the interaction patterns of individuals considered mentally ill.

Another direction has to do with examining the use of the temporal parameters as personality variables. It seems clear, simply from the results of the studies reviewed here, that the temporal organization of dialogue offers a set of potentially rich descriptors for behaviorally characterizing individuals and the patterns of their interpersonal relationships. Still another direction would involve studying the role of dialogic time patterns in the communication of affect. There are both experimental (Fairbanks and Hoaglin, 1941; Feldstein, 1964) and experiential reasons for believing that the role is a significant one.

A perhaps more basic level of inquiry would be concerned with explicating the interdependence of the temporal and lexical codes of a verbal exchange. Such an inquiry might, for instance, examine the hypothesis that dialogic time patterns are related to semantic content such that there are some patterns and content that frequently co-occur and others that rarely co-occur.[14] At the same time, the inquiry might profitably explore the relations between the temporal and syntactic structures of dialogue. An initial effort in this direction investigated the relative potency of syntactic boundaries (points of linguistically permissible phrase ending) and of silences as cues to speaker switching (Gerstman, Feldstein, and Jaffe, 1967).

The importance of the proposed recursive model is that it provides the basis for a theory of the conversational time patterns of two-person and multi-person groups. If only for heuristic reasons and for the structure it offers, such a theory should be useful in conceptualizing and integrating the research directions mentioned above. Beyond that, it may ultimately be capable of serving as a point of articulation between theories of linguistic competence and performance.

[14]An illustration may clarify the point of this hypothesis. Whatever efficacy is attributed to the psychiatric and/or psychotherapeutic interview is associated with its semantic content (i.e., with what the patient and doctor discussed), while the relevance of its demonstrably characteristic temporal configuration has received only passing recognition. Interestingly, the most (although not the only) recognition is implied by the psychoanalytic position, which requires of the therapist that "his predominant reaction is one of silent listening" (Menninger, 1958, p. 86). The rationale underlying this position is that the extended silences of the therapist allow the patient to talk about topics considered therapeutically useful. The important point here is that the semantic content of the dialogue is assumed to be at least somewhat dependent upon its temporal structure.

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