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Excerpt

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Part I

Introduction

1

ADVERTISEMENT

This chapter is essentially an advertisement for the sequential and time-series analysis of observational data. We would go so far as to make the statement: *Anyone who has collected data over time and ignores time is missing an opportunity.* We would like to back up this statement with several examples and with a discussion of conceptual issues.

The substantive theoretical discussion in this chapter concerns the analysis of marital and family interaction. Perhaps the most exciting area in which sequential analysis has been applied is social interaction. Sequential analysis, we will see, has supplied a great many analytic tools for researchers studying social interaction. It is not a mere data analysis option. It is a whole new way of thinking about social processes. The dimension of time is so central to conceptualizing social interaction that its use will lead us *to think of interaction itself as temporal form.*

We will begin with a few examples. The first is metacommunication, a concept introduced in what has become known as the “double-bind” paper (Bateson et. al., 1957). A metacommunication qualifies or comments on communication. It can be a nonverbal act that says “all that follows is really play,” or it can be a statement that comments on the process of communication, such as, “you’re interrupting me,” or “that’s not what we were discussing.” Bateson and his colleagues proposed that the schizophrenic has precisely this deficit, that is, an inability to metacommunicate, which is the way out of the classic double-bind message. In a double-bind message there are two conflicting messages, such as “approach” and “go away.” A metacommunication, which would comment on this conflict rather than pursue either alternative, is potentially a solution to the double-bind conflict. Because double-bind messages were hypothesized as characteristic of schizophrenic families, metacommunication was catapulted to a prominent position in the study of social interaction in families. The hypothesis never achieved comparable visibility in the study of marriages.

Gottman (1979a) studied how satisfied and dissatisfied couples differ in the way they try to resolve an important current issue about which they disagree. The discovery was that there was no significant difference in the relative frequency with which satisfied and dissatisfied couples used metacommunication. This was not a sequential analysis. However, the sequential analysis (Gottman, 1979a) showed dramatic differences in the way metacommunication was used by the two groups of couples. Satisfied couples relatively frequently used short chains of metacommunication that functioned as a repair mechanism for the interaction. The metacommunication was usually followed by an agreement by the partner. For example,

A: You're interrupting me.

B: Sorry, what were you saying?

Then the conversation would return to the issue under discussion. The metacommunication was usually delivered with neutral affect, even if the conversation itself had become negative. For dissatisfied couples, metacommunication tended to be delivered with negative affect and followed by a "counter-metacommunication" with the same affect, rather than by an agreement. For example,

A: You're interrupting me.

B: I wouldn't have to, if I could get in a word edgewise.

A: Oh, now I talk too much, is that it?

B: You could say that you do rattle on and on about nothing ...

and so on, almost indefinitely. For dissatisfied couples, metacommunication was like an "absorbing state," to use the language of Markov chains; it was difficult to exit once entered. Furthermore, the affect from the conversation tended to transfer (sequentially) to the metacommunicative chain, so it could not function as a repair mechanism.

Several points should be made about the preceding set of results. First, the sequential analysis revealed differences between the two groups of couples that were not revealed by the analysis that ignored sequence — reason enough to employ sequential analysis. Second, the sequential analysis revealed patterns not even dreamed of by the original paper that drew attention to metacommunication. The implication of this second

point is that sequential analysis is an important tool for *generating* theory with good description as well as for testing theory.

This example of metacommunication showed no base rate or unconditional probability differences in metacommunication between couples. Let us now consider an example in which base rate differences do exist and imply a host of differences in social processes, which can only be revealed by sequential analysis. In a monograph on how young children become friends, Gottman (1983) reported that there were large differences between unacquainted children who did and did not “hit it off” (indexed by a questionnaire completed by the mothers about the children’s progress toward friendship after the experiment) in the amount of agreement displayed by the guest child. A low level of agreement indexes a staccato rhythm. This rhythm is characteristic of the play of children who do not hit it off. Children who do not hit it off will play for a relatively few number of turns before they escalate by making the play more demanding. They are less likely than children who do hit it off to engage in extended fantasy play, and more likely to have conflict. Here base rate differences between groups do exist and these differences can be *understood* by sequential analyses that illuminate a set of social processes that the base rate differences entail.

A third example is useful for a new reason. Many married couples who attempt to resolve an issue go through a middle phase in which they disagree a great deal. Such disagreement seems to pave the way for later compromise on the issue because they discover the areas of agreement and disagreement in the middle phase. Couples who *avoid* conflict during this middle phase of the discussion often have greater difficulty with compromise, which usually occurs in the last third of the conversation.

Notice how natural this description was, and how rich it is theoretically. It is also consistent with other literature on decision making in areas other than marital interaction. Also notice that this discussion is not even possible without sequential analysis. Furthermore, the sequential analysis needs to be of a certain character, called *nonstationary*. This word is used because the second third of the discussion (in which the couples argue or avoid conflict) is *intrinsically different* from the last third of the discussion, for which the goal is compromise.

Finally, in this advertisement we want to mention the great *conceptual* clarity thinking about social interaction in terms of sequences affords. Just about all of the interesting hypotheses we have about how social systems function imply at their base an imagined scenario of interaction, a scenario invariably sequential in character. In short, since

we tend to think sequentially, why not give free rein to this thinking with analytic tools that supplement it?

To illuminate the conceptual clarity to be gained by sequential analysis, let us consider one example from the literature on nonverbal behavior in family interaction, the notion of channel inconsistency, which was also inspired by the double-bind hypothesis. The idea is that one channel communicates a message such as “come hither” while the other channel communicates a message such as “get away from me.” The result is supposedly a double bind for the receiver of the inconsistent message. If this hypothesis were true, the *consequences* of the inconsistent message would be predictable. The receiver would act like someone who has been placed in a double bind. On the other hand, it is possible that whenever one channel contains negative affect (e.g., “go away”) this is the channel listened to, and the overall message is not at all inconsistent. If anything, the overall message may be interpreted as “this person is negative but trying to qualify, constrain, or temper the negativity.” The continuing work of Daphne Bugental in this area supports this latter interpretation. However, a direct test of the hypothesis would be provided by a sequential analysis. This is an example in which theoretical clarity about the anatomy of messages would be gained by thinking in sequential terms.

Another example of the conceptual clarity provided by thinking in sequential terms involves concepts of reciprocity. The reciprocity of self-disclosure has been implicated as the *sine qua non* of acquaintance-ship and close friendship by researchers interested in self-disclosure. In experimental research this reciprocity hypothesis took a temporal form: a self-disclosure by one person would make a subsequent self-disclosure by the other more likely, and, in fact, the intimacy of the self-disclosures would match in more satisfying relationships, or ones in which attraction was high. Despite the temporal nature of this hypothesis it had never been treated sequentially until Dindia’s (1981) work that employed Sackett’s lag sequential technique (discussed in our Chapter 7). Instead, before Dindia’s research, the amounts of self-disclosure by both people were correlated across dyads. This is not a logical test of the reciprocity hypothesis, which by its very nature argues for *contingency*, and hence compares conditional probabilities with unconditional probabilities. The correlation examines only unconditional probabilities. Dindia found no evidence for the reciprocity of self-disclosure using sequential analysis.

Ginsberg and Gottman (1986) studied the importance of the reciprocity of self-disclosure in accounting for variance in the relationship

satisfaction of college roommates. Once again, there was no evidence that reciprocity was important.

Why should this be the case? The answer is that so many things happen in a natural conversation other than reciprocal self-disclosure, such as laughing, disagreeing, giving advice, support, and so on, that reciprocal self-disclosure is unusual. In fact, it is difficult to write a script of purely reciprocal self-disclosure that does not seem absurd. No doubt most good friends do find out about one another, but it may, in fact, be important that this mutual discovery be *noncontingent* in many friendships. Self disclosure in children past middle childhood, for example, usually entails support, understanding, and problem solving. Even in adolescents' conversations with their friends in which mutual self-exploration is important, only one problem at a time tends to be discussed (Gottman & Mettetal, 1986).

The importance of the lack of sequential structure in specific interaction situations ought to be noted for family interaction researchers. Lederer and Jackson's (1968) quid pro quo hypothesis of marital functioning is a good example. They proposed that satisfying marriages were characterized by a reciprocal exchange of positive events or actions, a hypothesis that led to a new form of marital therapy called "reciprocal contracting" (e.g., Stuart, 1969).

However, there was never any empirical evidence for the quid pro quo hypothesis, and some evidence (Murstein, Cerretto, & MacDonald, 1977) that the extent to which people held such a philosophy of marriage predicted marital *dissatisfaction*. A series of studies reported in Gottman (1979) found no evidence *within one problem-solving interaction* for positive reciprocity being a variable that discriminated satisfied from dissatisfied couples. Negative reciprocity, on the other hand, did discriminate. Dissatisfied couples were more likely to reciprocate negative affect than were satisfied couples. There was even some evidence for the contention that dissatisfied couples were *more* likely to reciprocate positive affect than were satisfied couples. Gottman proposed the hypothesis that temporal linkage itself was an index of distress.

To understand this result, we can think of the early stages of acquaintanceship. When we first meet someone and are invited for dinner, we want to reciprocate because it shows we are responsive. Similarly, if we are in distressed marriage after a fight, if our spouse is positive we want to reciprocate because it shows we are being responsive. To *not* reciprocate in the context of prior negative affect communicates a great deal. So a positive quid pro quo may make much more

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sense in unhappy marriages than in happy ones. In a satisfied marriage people tend to be positive fairly independently of their partner's prior actions and based more on their own prior behavior; to use sequential language, autocontingency will probably be more predictive here than will cross-contingency.

Note that the sweeping nature of the original Lederer and Jackson hypothesis has never received an adequate test. Only short time spans have been considered, and primarily problem-solving conversations. It is possible that some form of the hypothesis is true. Our point is that conceptual clarity is added to the hypothesis by thinking sequentially.

We hope we have convinced readers that it would be useful to learn about sequential techniques. The Talmud says, "We are given life. The only question is how to live it." What we are saying is that we are endowed with the ability to think about sequences, the only question is how best to conduct the necessary analyses.

2

HISTORY

This chapter covers the history of sequential analysis, limited primarily to those applications that have bearing on the observation of social behavior in psychology. Readers should not worry too much about undefined terms. We will begin defining terms in Chapter 3.

Initially, interest in the mathematics of sequential analysis had to do with a concern about how to characterize *change*. In a seminal paper in 1952, George Miller introduced Markov processes into psychology by noting that probabilistic methods had proved themselves in sensory psychology and test construction, both of which rely heavily on the independence of observations and on invariance over time. He wrote,

The basic parameters can be explored at length because sequential effects of measurement are secondary and can be ignored or randomized. (p. 149)

However, for areas of psychology, such as learning, that are essentially concerned with change

...it is intrinsic in the very notion of learning that successive measurements are not independent; attempts to use a theory of independent variables must either fail or misrepresent the basic process. Such failures may lead to a rejection of statistical concepts as inadequate; a more proper attitude is to abandon the assumption of independence and ask what help can be had from dependent probabilities. (p. 149)

It is important to note that Miller was writing in the postwar context of the work of Norbert Wiener and his student Claude Shannon, and that the work of both was concerned with change and dependent data.

Before World War II, Wiener had been involved with attempting to model networks of neurons that have some capacity for control and self-regulation. He coined the term “cybernetics” and introduced many engineering terms that eventually made their way into biology and psychology, such as “channel,” “feedback,” and “homeostasis.” Wiener used time-series models to simulate the behavior of neuronal networks.

When the war came Wiener worked on a project of his own invention that also involved these notions of dependency and change. Instead of using flak methods against aircraft, in which it is hoped that a plane will unavoidably hit a piece of flak, Wiener went to work on a gun that could track and anticipate its target. This could only be done by a form of “forecasting” based on some assumption about the past behavior of the target. Thus, information about the *dependent* nature of the data would be used to forecast where to shoot. Time-series analysis was ideal for this task, and Wiener developed many of the central techniques.

Shannon was also involved in some cloak-and-dagger war work in the decoding of secret messages and the cracking of codes. The basic problem was reduced by Shannon to one of communicating a known code (e.g., English) through a noisy channel that lost some information. The key to solving the problem was the discovery of the importance in any code of redundancy, the anatomy of which was central to cracking the code. Terms such as “information,” “redundancy,” and “structure” were introduced by this thinking. The anatomy of the redundancy in any code is the central subject of sequential analysis.

It is fair to say that initial interest in these techniques in the social and biological sciences was limited to the study of the patterning of behavior within *single* individuals (see Quastler, 1958; Attneave, 1959). Fortunately, however, Gregory Bateson was invited to the 1949 Macy Foundation Conference organized by Norbert Wiener and he immediately took the notions of “communication” to imply communication between people, and notions of “system” to imply interacting social systems such as cultures and families. Unfortunately, although Bateson saw the value of these mathematical tools, he could not apply them.

In a 1976 interview, Bateson and Mead spoke about their reactions to the mathematicians led by Norbert Wiener at the 1946 Macy Conference on cybernetics. Mead said, “All you could ever get out of people like Wiener was ‘You need a longer run.’ We used to drive them absolutely out of their minds because they were not willing to look at pattern, really. What they wanted was a terribly long run of data.” Bateson

added: “Of quantitative data, essentially.” Neither Bateson nor Mead had any idea how to respond to these requests by the mathematicians. Nor did they see the value in responding.

The classic introductory piece in psychology was Fred Attneave’s 1959 monograph *Applications of information theory to psychology*. In this monograph, Attneave introduced the notions of temporal structure. His example had to do with whether someone inventing a random sequence of draws (with replacement) from an urn containing white and black balls is actually inventing a random pattern, or if, on the other hand, there is some temporal patterning to the guesses. For example, if the person has guessed white and then white again, is a black now more likely than it would have been if we knew only that a white had just been guessed? By the way, it turns out that people are not very good at simulating randomness. But this is not the point here. The point is that initial applications of sequential methods had to do with the study of response stereotypy within *one* individual (see Miller & Frick, 1949).

It is interesting that Attneave was apparently unaware of some of the important mathematical papers in the statistics of this field that had emerged since Shannon’s classic 1949 work on information theory, particularly Anderson and Goodman’s (1957) paper on asymptotic distribution theory of the contingency-like tables derived from Markov matrices.

Actually, the major mathematics for sequential analysis were derived between 1957 and 1962. The Anderson and Goodman paper derived maximum likelihood estimates for transition probabilities in a Markov chain of any order. It also used both likelihood ratio and chi-squared tests for contingency tables to examine the following hypotheses: (1) the transition probabilities of a first-order chain are constant; (2) that when they are constant they are certain specified numbers; and (3) that the process is a chain of a certain order and not another order. The paper developed an asymptotic theory for these inferences when the number of observations increases. The problem of estimating transition probabilities and testing goodness-of-fit and the order of the chain had previously been studied by Bartlett (1951) and by Hoel (1954), in situations where only a single sequence of states is observed, rather than several sequences. The Anderson and Goodman paper generalized these results and provided the basis for the asymptotic statistics used in this book.

Kullback, Kupperman, and Ku (1962) used a statistic called the “minimum discrimination information statistic” (m.d.i.s.) and derived its asymptotic properties. For categorical data that follow a multinomial