UNDERSTANDING GROUP BEHAVIOR

Consensual Action by Small Groups

Volume 1

Edited by
Erich Witte
James H. Davis

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CONTENTS

PREFACE

The project that was to become the two volumes, *Understanding Group Behavior*, began as a conference, emphasizing theory and conceptual issues in empirical research on small group behavior. Held at the University of Hamburg, November 1992 (and sponsored by the Deutsche Forschungsgemeinschaft), conference presentations were later amplified and considerably expanded as a consequence of discussion among participants and subsequent exchanges. The two volumes present original theoretical works that address a variety of important current problems, both applied and basic. Contributions to both volumes are up-to-date accounts of original theory: Those comprising Volume 1 tend to be rather specific in character; those of Volume 2 are similar, but the work described is of a more general conceptual nature.

The special emphasis of Volume 1 is on "consensual action by small groups." Juries, panels, and committees of many kinds are ubiquitous in the affairs of societies, and have been the target of considerable research by social psychologists, as well as researchers from a variety of other disciplines. The chapters collected in Part I present theories and models stressing the process of *aggregating* preferences and *combining* member contributions in achieving consensus. Part II contributions emphasize the social processing of information and interpersonal exchanges, as well as member reactions, during the consensus process. Together, these chapters offer a wide range of theoretical perspectives on the process of "individual-into-group" behavior characteristic of consensus.

Small groups (two to a dozen or so) are not only primary agents for performing many of the tasks of organizations and institutions, within which they are embedded, but they can play a major role in promoting subsequent acceptance of their actions. In any event, whatever the interpersonal phenomenon of interest, the small group is surely one of its primary habitats. Although many research problems of social behavior have been abstracted from that "natural setting," and reformulated as intraindividual problems for close experimental study, research on the intact group continues to be of fundamental importance. The aim of the two volumes comprising *Understanding Group Behavior* is to provide a picture of relevant current theory.

Erich H. Witte
James H. Davis

PART

I

INTRODUCTION

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CHAPTER

1

SMALL-GROUP RESEARCH AND THE STEINER QUESTIONS: THE ONCE AND FUTURE THING

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The very notion of social behavior implies more than one person. Both the individual and interacting individuals have been a focus of research in social psychology, although the study of very large assemblies and social movements were generally the province of sociology and anthropology. For some years, the concentration on mental phenomena has increased throughout psychology, including within social psychology. The result of this shift in emphasis has been an ever increasing focus of research effort not on interpersonal behavior per se, but on cognitive representations and stored information *about* interpersonal behavior and associated cognitive mechanisms within the individual.

BRIEF AND RECENT HISTORY

Against such a background, a closer look at research developments in social psychology suggests the unfolding of two major trends in the study of social behavior, and both beginning, roughly, just after midcentury. The first trend, as implied earlier, has been a great conceptual turning inward such that questions about *intra*individual life became paramount. Part of this inward shift was surely due to the change in psychology at large where behaviorism was being rejected and a reawakening of interest in mental life was gaining in popularity. Indeed, cognitive conceptual notions had never altogether vanished from social psychology, and it can be fairly said that cognitivism lived on in social psychology after its defeat elsewhere by the behaviorist revolution early in the twentieth century. Norms, values, attitudes, intentions, and so on endured and prospered at the hands of social researchers even during the period in which such ideas were anathema to experimental psychology at large.

Ironically, it may have been the preeminent group dynamicist himself, Kurt Lewin, who actually laid the foundation for the great turning inward of social psychology. For example, much of the import of Lewinian (e.g., 1958) experiments on groups can be traced to the subsequent consequences for individuals (e.g., attitude change) attributable to exmembers' participation in group decision making. (Actually, Lewin's groups rarely made explicit, collective decisions in these experiments—e.g., Lewin, 1943; rather, discussion revealed the prevailing consensus, providing, in a sense, "group" decision by implication; Bennett, 1955.)

Considered loosely, *commitment* (cf. Kiesler, 1971) was the label for these postgroup phenomena, and the "group-induced-change" research tradition itself soon led to an entire social movement (some might say industry) emphasizing personal change through (guided) group interaction (see the review of "T-groups" and derivatives by Back, 1972). However, commitment was soon followed by the theory of *cognitive dissonance* (e.g., Festinger, 1957) that focused even more closely on the individual, and researchers in the associated research tradition quickly dispensed with an actual group setting altogether in the experimental operations that generated the relevant data (e.g., see Aronson & Carlsmith, 1968). Cognitive dissonance was in turn succeeded by *attribution theory* (e.g., Jones & K. E. Davis, 1965; Kelley, 1967), a conceptual approach that, although initially emphasizing *perception*, subtly introduced additional cognitive operations, especially inferential processes, thereby enlarging the span of cognitive mechanisms to be considered. Finally, the emergence of *social cognition* (e.g., see Wyer & Srull, 1984), the most recent development in this conceptual line, signaled the emergence of a very general concern with social phenomena as intraindividual events, and indeed, has at the same time come increasingly to encompass many of the traditional topics of personality—such as emotion and motivation. In fact, under the social cognition umbrella, various theories large and small now address virtually all intraindividual phenomena that have much of a social referent, and exclude only actual social/interpersonal behavior.

The second trend was the rise of a general behavioral science on a broad front. The kind of empirical (often experimental) methodology and theoretical style typical of science in general were increasingly employed in a variety of disciplines that were necessarily concerned with social and interpersonal behavior: organizational behavior, speech communication, administrative science, and systems analysis, to name only a few. Even some areas of economics have come to use experimental methods for gathering data (e.g., D. D. Davis & Holt, 1993). Although it seems fair to say that psychologists pioneered many behavioral science research methods (especially experimental techniques) and approaches to the study of human cognition and behavior, many disciplines now pursue similar research agendas in similar ways, albeit often in pursuit of highly pragmatic goals.

The preceding scenario is worth noting, because the disciplines at issue generally consider task-oriented groups of various sizes and types as among their fundamental objects of study, although surveys and other individually oriented research methods are not unknown. After all, committees, panels, and many other kinds of small groups are fixtures of organizational and institutional life. It should have come as no surprise when Levine and Moreland (1990) concluded their incisive literature review by asserting that small-group research was "alive and well" after all, but much of the work was now located in organizational studies of one sort or another, rather than in its ancestral home, psychology. A number of disciplines now share an interest in group research, and are actively investigating small-group behavior in many contexts.

Finally, it is worth asking after the engines that might be driving these two trends. First, the immediately preceding discussion makes fairly obvious that the *conceptual* and *practical needs* of the areas in question made inevitable their eventual focus on small, task-oriented groups, and in time the effort came to rely heavily on empirical research.

Second, it is important to note that the progression of rich *theoretical* developments, outlined earlier, fueled much of the evolution toward the intraindividual, in contrast to empirical discoveries or practical problems. Of course, it is difficult to imagine that extraordinary empirical events did not sometimes figure in the evolution of intraindividual conceptual approaches. Consider the theory of cognitive dissonance and its early relation to the famous study by Festinger, Riecken, and Schachter (1958) of an end-of-the-world cult whose members displayed a paradoxical increase in a belief, following its apparent disconfirmation. Moreover, these theories, of which cognitive dissonance is highly typical, are clear, uncomplicated, and parsimonious constructions that are immediately available to the researcher, even those without a substantial background. That is, such theories are highly compelling prima facie, and fit well with conventional conversational explanations of human behavior, among other appealing features. We return later to theoretical considerations, because theory is the main thrust of this volume.

A third intraindividual trend engine is the less intellectually lofty, but very serious, problem of subject costs in group research. Sample sizes adequate for research on individuals are increased by a factor of group size. A simple, commonplace experiment of 2×2 cells containing 20 subjects each means a total of 80 required for research on individuals, but 400 subjects are needed if five-person groups are the research target. Actually, the problem is more serious than the foregoing implies. Imagine a reasonably high individual show-up rate at the laboratory—for example, suppose that .80 is the probability of assignees actually showing up. Under typical random assignment of subjects to experiments, conditions, locations, and times, subject arrivals at the laboratory are independent events; the probability of staffing a five-person group is thus only $(.80)^5 = .33$. (The tempting strategy of overscheduling subjects is not only potentially wasteful, assuming no backup projects can use overflow, but likely to irritate research colleagues.)

Such mundane facts are as unpalatable as they are intellectually dreary. Yet, it seems highly plausible that the subject-shortage problem, worsened by ever more competition from other topic areas of the discipline that have been increasing their use of human subjects, is at least as serious a damper on group research within the typical psychology research department or institute as any (more intellectually interesting) conceptual features associated with the two trends themselves. Because subject availability appears to be a problem unlikely to resolve itself, and creative solutions are not now evident, research using actual groups of actual subjects will face major challenges for some time to come. In the meantime, the appeal of research strategies that concentrate on simulating others or addressing those group-related concepts and phenomena that do not immediately require multiple sets of subjects, is likely to endure. (See J. H. Davis & Kerr, 1986, for a discussion of simulation within the subject-shortage context.)

Summary. The proposal here is that the *relative* incidence of group-level research in social psychology has declined over the past 40 years or so, because (a) Straightforward theories addressing individuals proliferated inside social psychology and successfully competed for researcher attention, and (b) the lack of sufficient numbers of subjects makes group studies highly unattractive to potential investigators. During the same period, other disciplines increased their empirical research on small groups; this development accompanied the decline in social psychology, but did not contribute much to it.

THE STEINER QUESTIONS AND ANSWERS

Steiner's (1974) famous question, "Whatever happened to the group in social psychology?" has provoked much discussion. His own answer was predicated upon socio-historical forces; he posited that a group focus, after some temporal lag, was likely after periods of social conflict in the surrounding culture, and thus forecast a resurgence of research on groups during the late 1970s. Later Steiner (1983) qualified this hypothesis, using attributional notions, in order to explain why the predicted upsurge had not occurred. Still later (Steiner, 1986), he seemed pessimistic about any upturn in the near future, citing probable paradigm shifts in social psychology that favored a continued intraindividual emphasis. Likely to be permanent, he further implied that these changes fostered a concentration on individuals and immediate internal causes of behavior at the expense of external causes, multiple-person units, and sequences of behavior over time.

Obviously, our earlier analysis does not agree with Steiner's (1974, 1983, 1986) original and later proposals that the rise and fall of group research is closely tuned to larger societal concerns and phenomena that in turn stimulate social researchers. As a supporting counterexample of sorts, consider the deep distress among social observers of many kinds about possible changes in the United States judicial system during the late 1960s and 1970s—especially those focusing on the role and structure of the criminal jury. (During the same period, similar social and scientific issues stimulated considerable concern in Canada and the United Kingdom; see Muller, Blackman, & Chapman, 1984.) In particular, much research was stimulated by U.S. Supreme Court decisions about jury size and assigned decision rule (see discussions by J. H. Davis, 1980, 1989; J. H. Davis, Bray, & Holt, 1977; Vollrath & J. H. Davis, 1980), a very great deal of it focusing on studies of mock juries. However, the furor was about the jury as special social agency, not as small group, and once the excitement surrounding the political and ideological concerns of the period abated, the interest in group research declined as well. Most telling of all, research interest did not generalize beyond the jury to other collective behavior topics and environments.

The Steiner questions were recently very thoroughly addressed by Moreland, Hogg, and Hains (1994), who surveyed publication trends in several primary journals in social psychology. In light of our earlier discussion, as well as Levine and Moreland's (1990) earlier conclusions, it is regrettable that Moreland et al. did not also include communication and organizational research journals, among others. However, Moreland et al. did incorporate certain *social cognition* topics and the general area of *intergroup relations* ("European approaches") in the "group research" category, areas not ordinarily thought to be involved with the Steiner questions. Their results showed a recent upsurge in group research, but only if the two new areas were included; otherwise, the relative incidence of group studies remains fairly constant—and small. Finally, although the long-time group research topics indeed may not be studied at earlier rates, one can only applaud the Moreland et al. expansion of conceptual horizons—especially because there has been a related merging of research interests quietly taking place in at least one corner of the general area of group behavior and interpersonal interaction. An expansion of sorts, this new development is marked by the tendency of investigators to refer to "social decision making"—a broad category of interpersonal research that includes social dilemmas, bargaining and negotiation interactions, and experimental games, as well as consensual decision making. One could further make the case that a mature science of group and interpersonal behavior would eventually include as well such methodological topics as block models (Wasserman & Galaskiewicz, 1994) and cluster analysis (e.g., Arabie, Boorman, & Levitt, 1978), largely conceptual topics such as voting models (e.g., Grofman, 1981, 1987), social/public choice theory and research (e.g., Brams & Fishburn, 1983; Fishburn, 1973), and so on. However, only time will tell whether or not these and related areas, now often located in various disciplines outside of psychology, will emerge as part of a new synthesis.

In any event, it now seems that the time has come to put the Steiner questions to rest, especially the lamentations that have often surrounded their discussion. Just as the intellectual anguish associated with the "crisis in social psychology" (e.g., Baumgardner, 1976; Elms, 1975; Silverman, 1971) eventually became tiresome and finally dwindled (without any noticeable "resolution" of anything, including whatever it may have been that produced the sense of "crisis"), the time has come to talk less *about* the rise and fall of group-oriented research, and to act instead on the significant theoretical and methodological problems in the area.

THE QUESTION OF THEORY

Although there is not now an obvious solution to the subject-supply problem on the horizon, one can be much less pessimistic about the prospect of new theories and conceptual developments—a point to which we return later. There has always been a strong theoretical tradition in small-group research, but it has differed in significant ways from theory that has generally guided research in intraindividual social psychology.

First, group theory has tended to be relatively *formal*, often expressed as a mathematical or computer model. Second, group research in general has tended to be *problem oriented*, and of course, theoretical explanations have been similarly oriented. In contrast, as detailed earlier, intraindividual theory is quite *informal* in format (although there exist some striking exceptions—e.g., in attitude theory, Anderson, 1959, 1971; Hunter, Danes, & Cohen, 1984), and the related empirical intraindividual research is perhaps more likely to be *theory oriented* in the sense that studies are so often expressly motivated by the goal to demonstrate how the hypothesized theoretical process works in various contexts. Just after midcentury, cognitive dissonance theory (Festinger, 1957) appealed widely not only because it was (perhaps deceptively) simple and clear, but also because in principle it was virtually unbounded—thereby giving rise to the possibility of applications in a very wide variety of situations. Considerable effort was devoted to devising new situations to which the theory might potentially apply.

During the same period, group-level research, in contrast, tended to be organized around various (often unrelated) problems, and to be composed in mathematical or computer language. For example, consider the following problem-oriented, formal theories addressing questions associated with: (a) *group performance*, by Lorge and Solomon (1955, 1962), Thomas and Fink (1961), Smoke and Zajonc (1962), and Restle and J. H. Davis (1962) on group problem solving, and more recently, Gelfand and Solomon (1974, 1975, 1977), and Hastie, Penrod, and Pennington (1983) on jury decision making; and (b) *interpersonal processes/group structure* by Simon (1952), Harary, Norman, and Cartwright (1965), and Horvath (1965), and more recently, Stasser (1988) and Galam and Moscovici

(1991 in press-a, in press-b). Moreover, note that the foregoing discussion does not even include the equally problem-oriented and highly formal theoretical developments associated with research on social dilemmas, negotiation/bargaining, and voting models, to name only a few appealing possibilities.

Finally, the inclination to formal theory and the disposition to problem-oriented research will probably continue, and indeed is likely to be promoted further by the increasing involvement of such disciplines as organizational behavior, social choice, and economics. The applied nature of such disciplines is likely to foster a continued propensity for investigating particular problems, and given the academic training of researchers from those disciplines, the inclination to mathematical and computer models seems likely to continue.

CONCLUDING REMARKS

The preceding discussion aimed to identify general trends in recent past and present group research and theory, and to reflect upon possible influences that have helped shape those trends. Like all such summaries, it must be imperfect. Intraindividual research can of course be problem oriented (e.g., Hamilton, Sherman, & Ruvolo, 1990) and intraindividual theory can be formal in character (e.g., Anderson, 1971). Additionally, much of what has been said is more characteristic of North American social psychology, than elsewhere. For example, group-research problems of many kinds have been and continue to be the source of strong research themes in European and Japanese social psychology. General cultural differences may account for some of the relative differences in intra- and interindividual research focus, but other, less obvious, causes may also be involved. Such additional issues deserve further exploration.

A central aim here has been to argue against the imputation often associated with the Steiner (1974, 1983, 1986) questions that group-level research has declined because something went wrong, and by implication needs to be put aright. The thesis here is that the "original" group-level research topics have evolved into multidisciplinary problems of different kinds, have attracted investigators from a wide variety of areas outside social psychology, continue to stimulate theory phrased in languages not popular in most circles in social psychology, and, perhaps most of all, continue to require subjects in numbers that cannot easily be satisfied by the usual sources that feed most psychological research projects. The current relative incidence of group and intraindividual research is an evolutionary consequence of these factors. Nothing is wrong; change is inevitable. However, changes in relative emphases that would favor research on intact groups is currently unlikely due to the persistence of the influences discussed previously, especially subject shortages.

This volume offers a sample of current theory addressing group and interpersonal behavior, especially within that subtopic we might call "consensual action." These chapters also illustrate both the problem-oriented feature discussed earlier, and the inclination to mathematical and computer models. Although there are some interesting similarities in conceptual approaches among these chapters, there is also a challenging diversity in the theorizing herein, suggesting that the trends and influences discussed in this chapter indeed do not capture all that is going on in the field.

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PART

II

Social Aggregation and Combination Models

CHAPTER

2

A Probabilistic Model of Opinion Change Considering Distance Between Alternatives: An Application to Mock Jury Data

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Social decision-making research studies the mutual influences exerted by group members upon each other. To investigate this social decision schemes were postulated, which implicitly or explicitly transform the differing opinions of individuals into group decisions (Davis, 1973, 1982; Isenberg, 1986; Kaplan & Miller, 1983). For a brief review of the history of that research see also the contribution of Davis in this volume. The research on social decision schemes, if it considers the process of social judgment, includes process characteristics as a part of the scheme. The schemes, however, usually are not conceptualized to describe or to predict the process itself.

Of course, the question might arise whether the study of the process is useful per se. But, in our opinion, the study of the process of opinion change can contribute to the understanding of the principles underlying interpersonal communication, collective decision making, and problem solving. Hence, the theory of group behavior might benefit from the analysis of the process of change.

Several studies have been conducted to get insight into the nature of opinion change. To mention only a few studies, the works of Hastie, Penrod, and Pennington (1983), Kerr (1982), Stasser (1988), Stasser and Davis (1981), and Stasser, Kerr, and Davis (1980), for example, focused on the process of forming judgments and decisions in mock juries. Kaplan and Miller (1983) in their review suggested that models dealing with the process of collective judgment should be extended to situations involving more than two alternatives, including those in which the alternatives are ordered along a continuum (Kaplan & Miller, 1983;

see also Kerr, 1992). That implies that proximity or distance should be introduced into a model of social change.

INDIVIDUAL TRANSITION PROBABILITIES

The central objective of this chapter is to develop a generalized probabilistic model of the social group interaction process including a distance function. This model is derived in two steps. In the first step, individual transition probabilities are determined on the basis of theoretical assumptions. The set of individual transition probabilities consists of the probabilities for each individual to change from alternative i to any alternative j from time t to time t + 1. These transition probabilities need not be constant over time, because the probabilities might depend on the composition of the group to which the individual belongs.

In the second step, the transition probabilities for group constellations (distinguishable distributions of group members over alternatives) are derived. To calculate the probabilities of change from a group constellation k at time t to any other group constellation at time t + 1 requires the derivation of a combinatorial algorithm. As long as the individual conditional probabilities of change for any individual preferring a certain alternative in a given constellation are independent of time, these theoretical transition probabilities between group constellations are necessarily constant over time.

We first say something about the general concept of individual probabilities. To prevent misunderstanding, it should be stated that by individual probabilities we do not mean personal probabilities that are dependent on a person's characteristics, attitudes, and so forth. It is rather supposed that all persons have the same individual probabilities of change if they are exposed to the same influences relevant for the tendency to change. The framework of individual probabilities of change can be depicted by a general additive composition of sources of influence and their concatenation with a proximity or distance function. It should be noted that the notion of distance would have no meaning if the alternatives are not fixed by context or definition and any permutation of them is as reasonable as any other.

This general formula for the individual probabilities of change from alternative i to j, $(i \neq j)$ for m alternatives denotes as follows:

$$p_{ij} = (w_1 I_{1ij} + w_2 I_{2ij} \dots w_e I_{eij}) * f(d_{ij}), \quad (1)$$

with each w-weight ranging between 0 and 1 and the sum of w-weights being ≤ 1.00.

The probability to stay in the original position (p_{ii}) is then defined as

$$p_{ii} = 1 - \sum_{\substack{j=1 \\ i \neq j}}^{m} p_{ij}. \quad (2)$$

The terms of the expression in parentheses, I_{1ij}, I_{2ij}, and so on are different sources of influence exerted by alternative j on holders of alternative i. Such sources might be the instrumentality of an alternative, its social desirability, its truth value, its overt attractiveness, or the number of group members who plead for it.

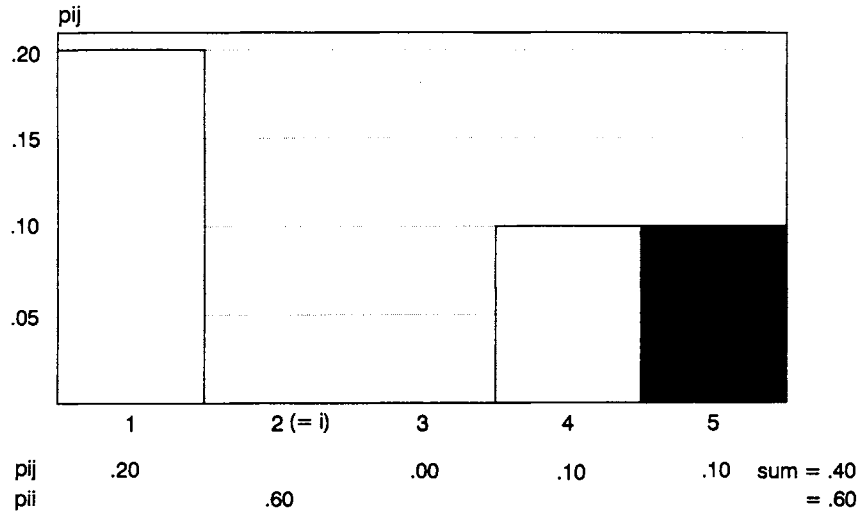
The w values are weights that are attached to the influence sources, but are not dependent on i. The sizes of the w weights also account for the fact that the readiness to change will depend on several task characteristics. For example, w weights will depend on the time interval between polls, because it seems plausible that changes of opinion are less likely to occur within shorter time intervals. Additionally, one might suppose that persons are less ready to change when the subject of discussion is an important issue.

The weighted sources of influence then have to be combined by a function of distances in one- or multidimensional cases. For example, if the alternatives can be arranged in a one-dimensional continuum, then persons with different points of view can approach each other step by step (Crott, Szilvas, & Zuber, 1991; Crott, Zuber, & Schermer, 1986; Zuber, Crott, & Werner, 1992). In this way, alternatives in between also may be chosen even if they have no attractiveness (informational or subgroup) in themselves. The sign * indicates that the combination of distance with the weighted influence sources is not just a multiplication but a special concatenation. We comment on this concatenation in more detail in the following section.

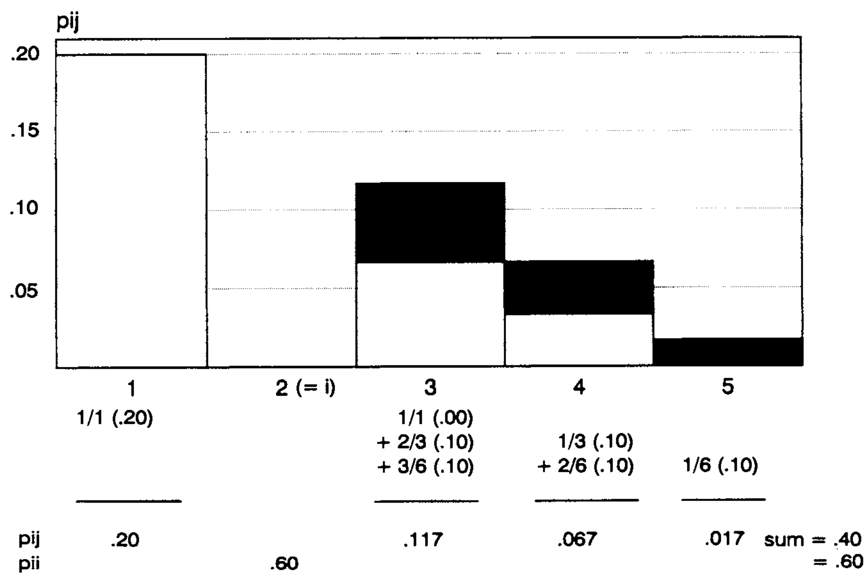
THE DISTANCE FUNCTION

The definition of the distance function can be illustrated by an object that is drawn along the continuum of alternatives by several forces, arranged one behind the other. The force of all sources pulls the object to the location of the first source. From that point, the force exerted by the first source lapses. The remaining sources draw the object to the location of the second source, then the third, and so on. Because the force of the sources decreases gradually with increasing distance from the object, the force has to be adjusted in each case by a distance factor. Such a kind of distance function is best illustrated by an example (see Fig. 2.1).

In the example in Fig. 2.1, assume that there are five alternatives, i is fixed as i = 2, and consider the group constellation is 21011. A group constellation 21011 indicates that two people at the moment prefer alternative 1, one person alternative 2, no persons alternative 3, one person alternative 4, and one person alternative 5. For reasons of simplicity, further assume for the moment that the influence potentials depend on one kind of force only, for example, the relative faction size r_j/r. Then the relative faction size of alternative 1 is 2/5, that of alternative 3 is 0/5, and that of alternatives 4 and 5 is 1/5 for each. The actual influence of the relative faction size on the subject at alternative 2 depends,



a) probabilities of change without distance



b) probabilities of change with distance

FIG. 2.1. Example for the modification of probabilities of change (p_{ij}) by the introduction of distance for an individual presently on alternative 2 (i) in constellation 21011.

among others, on the task characteristics and the time interval considered. Therefore, the relative faction sizes (r_j/r) have to be adjusted by a parameter w, which ranges from 0 to 1. Assume for example a w value of .50, for the purpose of calculating the probability p_{2j} of changing to any of the remaining alternatives 1, 3, 4 or 5. According to such a pure subgroup model without distance (see number under the continuum in Fig. 2.1), the person at alternative 2 cannot change to alternative 3. This possibility, however, will be created, as can be seen from the example in Fig. 2.1, by the concatenation of the influence potentials with the distance function. Observe how the influence potentials of the alternatives given by the numbers under the continuum in Fig. 2.1 are redistributed over the alternatives according to their distance to i. As seen from the example in Fig. 2.1, 100% of the influence potential of alternative 1 is effective for the change to alternative 1 ($p_{21} = 1.0 \times .50 \times 2/5$). The same is true for alternative 3. The influence potential of alternative 4 is distributed in inverse proportion to the absolute distance between alternatives 2 and 3 ($=|1|$) and the absolute distance between alternatives 2 and 4 ($=|2|$). That results in 2/3 of the influence potential of alternative 4 being effective on alternative 3 and 1/3 on alternative 4. Analogously, the influence potential of alternative 5 is distributed in inverse proportion to the absolute distances between alternatives 2 and 3 ($=|1|$) and alternatives 2 and 4 ($=|2|$) and alternatives 2 and 5 ($=|3|$) into 3/6, 2/6, and 1/6 of the influence potential of alternative 5 for alternatives 3, 4, and 5 respectively. The corresponding influence components in each line of the example in the bottom of Fig. 2.1 are summed to obtain the p_{2j} values. This procedure results in the probabilities of change p_{2j} given in the last row of Fig. 2.1. The total influence potential of any alternative remains preserved; it simply becomes redistributed over all alternatives. Thus the probability of maintaining a stable opinion (inertia) $p_{ii} = 1 - \Sigma\, p_{ij}$ will remain constant after application of the distance function. Note that by including the distance function, the *p*robabilistic model of opinion *c*hange including *d*istances (PCD) model allows a person at alternative i to change to any alternative j, even if the faction size of j is zero (alternative 3). This is a desirable property of the model, because such changes obviously occur in group discussions. It is further evident that taking distance into consideration drastically reduces the probabilities of changing to more remote alternatives in favor of the alternatives nearer to the current opinion. For example the probability of changing from alternative 2 to 5 reduces from .10 to .017, whereas the probability of changing from 2 to 3, which was zero, becomes .117 after the distance function is added.

APPROACHING GROUP PROCESSES

It should be noted that the individual probability of changing from alternative i to alternative j cannot remain constant over time in a model that incorporates the relative size of a subgroup. Because the size of a subgroup at alternative j can change from one point in time to another, the probability of switching from alternative i to alternative j also varies from one point in time to another. Actually, small-group research does not focus on the individual's probability of changing from alternative i to alternative j, but on the changes in group constellations. Previous research has used computer simulations to describe this process of change. Such simulations fix a unit of observation (e.g., a time interval); the factors of influence (e.g., informational value or faction size) are estimated from the nature of the experimental system, and the whole process is then simulated on the basis of path independence and stationarity of transition probabilities with random generators (Stasser & Davis, 1981). It appears worthwhile, however, to solve the matrix of group constellations in terms of probability theory. In order to determine the probability that a group will move from one constellation to another, the individual probability vectors have to be combined. This allows one to ascertain the probability with which any constellation (e.g., 20210) will change into any other constellation (e.g., 30200). By this procedure the process is expressed theoretically as a stationary Markov chain. The result is a cross table that contains for each state k the probability to remain stable or to change to any other state l from time t to time t + 1. Details of this method of combining the individual probability vectors are given in the Appendix.

DERIVATION OF A SPECIFIC MODEL (NORM-INFORMATION-DISTANCE MODEL)

The Norm-Information-Distance (NID) model yields a simple model for judgmental tasks that focuses on three components: the influence of the faction size on alternative j, the influence of the overt attractiveness of the alternative j, and the distance between alternatives i and j.

The social influence that is exerted by an alternative j on proponents of alternative i is supposed to be a function of the informational value that alternative j has for proponents of alternative i, the relative faction size within the group on alternative j, and the distance between i and j. More precisely, in Formula 3 that follows the τ_{ij} values (or respectively in the concatenation with the distance the τ_{ik} values) describe the informational attractiveness that any alternative j has on a representative of alternative i. The value $(r_j/r)^c$ describes the normative effect of a subgroup holding alternative j. With regard to the results of Godwin and Restle (1974) and Stasser and Davis (1981), the normative component is shown by a power function $(r_j/r)^c$. The parameter c takes the possibility into account that the influence of subgroups is an exponential function of their size. The term $(r_j/r)^c$ should be standardized to guarantee that the sum of all subgroup influences equals 1.00, so that the sum is not dependent on c. The w_1 and w_2 weights express the relative contribution of the informational and the normative components. Finally, the expression to the right of the parentheses of the formula summarizes the distance function as it was described in the section on the distance function.

$$p_{ij} = \sum_{k=j,1}^{m,j} \left[w_1 \tau_{ik} + w_2 \frac{\left(\frac{r_k}{r}\right)^c}{\sum_{l=1}^{m} \left(\frac{r_l}{r}\right)^c} \right] \frac{2(|k-j|+1)}{(|k-i|)(|k-i|+1)} \tag{3}$$

$i < j \leq k \leq m$, or $i > j \geq k \geq 1$ respectively
$0 \leq w_1, w_2$ and $w_1 + w_2 \leq 1$, $\Sigma\tau_{ij} = 1.00$

In the application given that follows, the individual transition probabilities are specified to depend on three components: faction size, informational value, and distance. It is apparent, however, that depending on the type of problem any additive combinations of an arbitrary number of components could be chosen to define the individual transition probabilities. Thus the general framework allows expression of various theories in terms of individual transition probabilities.

Several possibilities for applying the NID model to the data were developed: pure information models (including τ_{ij} or τ_j), pure subgroup models [including the (r_j/r) component only], and mixed models incorporating both informational and subgroup components (including both components). Regarding the informational component, it appears reasonable to test whether informational attractiveness of an alternative j depends on i, or not (τ_{ij} vs. τ_j). Following the idea of the bias sampling model of Stasser and Titus (1985, 1987), it makes sense to analyze whether the informational attractiveness of all m alternatives influences the process or only the informational attractiveness of those alternatives exerts influence on the process that are held by at least one group member at a certain point in time. Such models are called conditional models, because the effectiveness of the informational component depends on the existence of at least one proponent for that alternative within the group. Conditional models exist for pure information models and for mixed models; pure subgroup models are conditional per se.

Again depending on the choice of the c parameter—as, for example, 1, 2, or 3—different manifestations of the subgroup component can be tested, each of them with or without consideration of the distance function. Mixed models result from the combination of the informational and subgroup components.

We introduced a pure random model as a baseline model assuming that the individual probabilities of change from any alternative i to any alternative j are equal for any i and any j. The combination of the random model with the distance function would yield a pure distance model. It describes a situation in which the effects of equally attractive alternatives depend only on the distance of alternatives from each other.

The model fit analysis will determine those w weights that fit the empirical data best for any of the models. The estimation of the w values was done by an iterative maximum-likelihood function in steps of .01 from 0 up to a maximum of 1 with the restriction $w_1 + w_2 \leq 1$.

METHOD

This chapter does not focus on the presentation of experimental results. We do, however, use some results from two mock jury experiments, one of which has already been published (Crott & Werner, 1994), to demonstrate the possibilities of using Markov chain analyses to describe the process of group interaction. For the present purpose it appears sufficient to mention that subjects in the two mock jury experiments had to discuss in five-person groups for about 20 minutes in the role of mock juries. The task was to deliberate about the appropriate sentence. The sentences for each of the two cases are determined by German law to range between 1 and 5 years in prison. At the outset, subjects were asked to give their opinion about the appropriate sentence: 1, 2, 3, 4, or 5 years (it is a characteristic of the German judicial system that jury members determine the sentence). Additionally, subjects had to evaluate each sentence (alternatives 1 to 5) by distributing 100 points over the alternatives according to their attitude toward the respective sentences. Every 90 seconds an acoustic signal indicated that subjects had to mark their present opinion, that is, to indicate which sentence they preferred at that moment. Of the 47 five-person groups, 23 discussed a taxicab robbery case (an attempted robbery with physical injury resulting from negligence) and 24 discussed a traffic offense (a dispute about the right of way, followed by intentional physical injury).

RESULTS

Originally, the experiments were run under four conditions. However, experimental variables had no significant effects, either on the judgmental process or on the final discussion.[1] Therefore, in the following analyses we report the results for the joint data (see Crott & Werner, 1994).

We do not consider any of the results from this study except the process data in order to assess the NID model as a predictor of the observed changes

[1]In these two conditions, 47 groups of five persons each were involved. The complete experiment included two further control conditions—"no intermediate measurement and group decision" and "no intermediate measurement and no group decision"—to check whether the intermediate measurement influenced the group process. We do not discuss these conditions in the present text, because no effect could be found according to several criteria (Werner, 1992).

of verdicts. Thus, the sample of observed mock jury processes is compared with the theoretical predictions of the best fitting versions of the NID model and with the predictions of a random model as a baseline.

It is our intention to derive predictions on the distribution of group constellations over the 10 points in time. In addition, we strive to attain information about special features of the process itself by applying Markov chain statistics to a limited number of assessments. For example: How often do the groups change from one state into another before the end of the experiment? How many different states do groups enter before the end of the experiment? How long do groups stay on the average in a certain transient state before the end of the experiment?

As described earlier, many different versions of the NID model can be derived from the basic model. Whereas the measurement of the parameters (r_j/r), c, and the distance is obvious, there exists no obvious measure for the informational values τ_{ij} or τ_j. To estimate τ_{ij}, we took the mean number of points attributed by holders of alternative i to alternative j, and divided it by the total number of points, that is, 100. If informational attraction of the alternative j is considered independent of the first preference i of the judge, then τ_j can be defined by averaging the τ_{ij} values for the holders of the different alternatives i.

Altogether, we tested 40 different versions for both items. Considering the c parameter deviations were smallest for c = 1 for all 10 models containing the c parameters (with values 1.0, 2.0, and 3.0). It should also be stressed that all versions taking distance into account provided a better approximation to the data than models without distance (see Crott & Werner, 1994). To decide between the several models at disposure we used a multistage statistical evaluation process. In a first analysis, we determined the w weights that best fit the empirical data for any of the 40 models. The second analysis calculated the goodness of fit for each model. The third analysis consisted of a pairwise comparison among all those models that did not deviate significantly from the data (for details, see Crott & Werner, 1994). According to that multistage statistical evaluation process, a mixed conditional model with distance resulted for the taxi item (for the definition of this model, see Crott & Werner, 1994). The w-value for the faction size (r_j/r) was .07 and that for the informational effect (τ_j) was .01. For the traffic item, a pure subgroup model provided the best fit. The w value for the faction size effect (r_j/r) was .07 and the w value for the informational effect was accordingly .00.

The theory of Markov processes allows one, however, to derive several statistics that describe processes in more detail (see Kemeny & Snell, 1965). There are Markov processes that contain both transient states and absorbing states. The transient states have the property that one can switch with a certain probability to another state, whereas the absorbing states, once reached, can never be left. The two best fitting versions of the NID model, the mixed conditional model with distance for the taxi item and the pure subgroup model with distance for the traffic item, both imply the existence of an absorbing state. This is evident for the pure subgroup model with distance. For the mixed conditional model with distance, the absorbing character results from the conditional effect of the τ_j parameter. Alternatives that are not occupied have no informational attractiveness according to the conditional definition of the τ_j. The absorbing states then are the states of consensus. That is the case, because according to these two models, there exist no more forces that could cause a change to another alternative.

For groups of five persons and five alternatives there exist 126 distinguishable distributions. Therefore the matrix of transition probabilities consists of 126×126 cells. The size of that matrix makes it almost impossible to gain an overview. For that reason, we searched for meaningful criteria to aggregate the large number of states. Among all criteria considered (see Crott & Werner, 1994), the most informative one was the number of occupied alternatives. That is, all states with one alternative occupied fall into the first category, all states with two alternatives occupied fall into the second category, and so on up to the fifth category.

By doing this, we could reduce the 126×126 matrix of transition probabilities to a 5×5 matrix. In the following, we calculate all the Markov statistics on the basis of the original 126×126 matrix, and afterward combine them into the 5×5 matrix.

We conducted the following investigations separately for the taxi case and the traffic case and then combined them for both items. Because the direction and the strength of the effects are comparable for the two items, taxi and traffic, we report only the combined results. First, we investigated whether the process is a stationary (independent of time) Markov process, which is a prerequisite for the application of the PCD/NID model. This was achieved by comparing the matrix of transition probabilities for each single point in time with the matrix of transition probabilities averaged over all 10 points in time. The condition of stationarity was fulfilled with $\chi^2 = 28.2$, $df = 31$, $p > .60$. Next we checked how the transition probabilities predicted theoretically by the best fitting versions of the NID model compared with the observed transition probabilities (see Table 2.1). We found a sufficient correspondence for both items with $\chi^2 = 5.76$, $df = 4$, $p > .20$.

That is, the results in general met reasonable statistical criteria, so that we could analyze the dynamic processes using Markov chain analysis. First, we predict the development of group constellations over the 10 points in time by the transition probabilities provided by the best fitting versions of the NID model. Then we compare these predictions with the observed data. Finally, the random model serves as a baseline to compare the empirical data with data generated by a pure chance process. The random model implies that subjects jump with the same probability to any of the alternatives j ($i \neq j$). To illustrate the development of the process, we selected 4 points of measurement, namely, the starting point, and the 4th, 7th, and 10th points in time. Figure 2.2 combines the frequencies of both items. It becomes evident from Fig. 2.2 how the frequen-

TABLE 2.1
Observed and Expected Transition Probabilities (Expected in Parentheses) Averaged Over the 10 Points in Time

	1	*2*	*3*	*4*	*5*
1	1.000 (1.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
2	0.040 (0.018)	0.896 (0.924)	0.064 (0.059)	0.000 (0.001)	0.000 (0.000)
3	0.008 (0.000)	0.083 (0.064)	0.892 (0.894)	0.016 (0.042)	0.000 (0.000)
4	0.000 (0.000)	0.000 (0.004)	0.151 (0.150)	0.849 (0.833)	0.000 (0.012)
5	no entries (0.000)	no entries (0.000)	no entires (0.019)	no entries (0.268)	no entries (0.712)

cies (bars) with one to five occupied alternatives changed over the four chosen points in time. Obviously, the predictions of the best fitting versions of the NID model (solid line) corresponded to the observed changes quite well: $\chi^2 = 2.14$, $df = 6$, $p > .90$. In the course of time, the frequencies of group constellations with less occupied alternatives increased. These changes over time could not, however, be predicted by the random model (dashed line): $\chi^2 = 83.32$, $df = 6$, $p \leq .001$. The shape of the development that is visible in Fig. 2.2 was similar for both items, and the corresponding statistics provided equivalent results. The analyses so far, which were conducted with commonly used Markov statistics, indicated that the best fitting NID models were able to predict the deliberation process and its results well.

It is desirable to extract more detailed information about the process in order to generate new ideas for developing group process models further. With this objective in mind, we consider some more specific aspects of the process. From all possible Markov statistics, four appear to be especially instructive: (a) the number of groups that reach a majority (three or four persons on the same alternative) or a consensus (all five persons on the same alternative) at the end of the experiment, (b) the number of new transient states (i.e., states not entered by the groups before; including the states at the starting point) entered by the groups at the end of the experiment or before the absorbing state is reached, depending on the number of occupied alternatives at the beginning, (c) the number of times the groups change to transient states (from this number it is possible to derive further measures), and (d) the number of trials the groups remain in certain transient states until the end of the experiment or before the absorbing state is reached.