

INTRODUCTION TO A THEORY OF GROUP STRUCTURE
AND INFORMATION EXCHANGE*

Bernard P. Cohen and Steven D. Silver

Department of Sociology
Stanford University

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Abstract

This paper elaborates a theoretical framework for conceptualizing relationships between group structure and information exchange. The framework focuses on processes by which structure affects the flow of information in problem-solving attempts which lack well-developed solution paradigms. In our formulation, status orders based on member characteristics influence the amount, type, source, and target of message exchanges.

Our basic unit of analysis is the channel, a one-way link from a source to a target through which a specific type of content may be transmitted. We distinguish among channels for transmitting ideas, positive evaluations, negative evaluations, and data; we offer propositions describing variation in the use of channels as a function of expected costs and gains being a source or target of each type of channel. These costs and gains depend on status differentials between source and target as well as type of channel.

These propositions yield testable hypothesis on status orders and the transmission of ideas and negative evaluations under conditions of public and anonymous sources of messages.

Group structure has important consequences for the exchange of information in groups and organizations, consequences that increase in importance for tasks in which members are interdependent. Effects of structural factors on information exchange include (1) variations in the amount of information sent that are independent of the task-relevance or quality of the content, and (2) systematic biases in who transmits what content to whom. These structurally induced distortions in information exchange often lead to discernible performance decrements and may interfere with a group or organization achieving its task objectives.

While the recognition of disfunctional effects of group structure has led to practical techniques for enhancing the amount and quality of information exchange, such as the Delphi or Nominal Group Techniques (Dalkey and Helmer, 1964; Delbecq and Van de Ven, 1971, respectively) and, more recently, some proposals for computer-mediated information exchange (e.g., Hiltz, Johnson, Aronvith, and Turoff, 1980), these efforts have not generally been theory-driven. We believe that both our understanding of the consequences of group structure and our efforts to effectively manage information exchange in groups would benefit from a codification of the insights and empirical findings of the last four decades. Hence, we are engaged in the development of theoretical framework which draws on the work of Bales (e.g., 1951, 1970), Bavelas (e.g., 1950; also see Leavitt, 1951), and their associates, and the formulations and empirical research of the Expectation States Research Program. In this

paper, we will present an initial statement of our theory and a set of hypotheses drawn from this statement.

We begin by noting that social organization typically imposes restrictions or constraints on information exchange among its members. Such constraints are sometimes byproducts of role differentiation and specialization of function. In other cases, information exchange is constrained primarily as a means of control, i.e., to maintain leadership and influence.

Bureaucracies, for example, typically have well defined channels of communication which are limited or proscribed to members based on rank or position. Moreover, positive and negative sanctions frequently support the adherence to constraints on communication channels. Since the flow of information often serves multiple functions, it becomes important to understand the full range of outcomes of information constraints in social organizations. In doing this we immediately observe that information constraints in the service of one goal often have unintended but disfunctional consequences for other goals. For example, the same constraints on information exchange that serve coordination and control may seriously interfere with the flow of factual information and objective evaluations and the exchange of ideas. This may occur because when information provided by a subordinate unit, group, or individual is the basis for evaluation of their performance and/or the allocation of resources, it becomes in the interest of the source to restrict or bias its content.

While the foregoing discussion of information exchange is in the context of bureaucratic organization, we believe that such

contradictory outcomes of information exchange potentially occur in any hierarchical collective. Fundamental processes remain operative across differences in size and complexity. Research on small group problem solving, for example, has documented the effects of social differentiation on interaction among group members (Berger, 1958). It is clear that even informal groups tend to be hierarchically organized; actual or imagined differences in task relevant abilities and variation in other visible member characteristics typically result in a structuring of the members in a power and prestige order (Berger, Cohen, and Zelditch, 1972).

The development of a theoretical framework as undertaken in this paper will formulate mechanisms by which structure affects the flow of information in problem-solving activity. We initially focus on group problem-solving, but consider the framework to be applicable to other forms of activity, e.g., conflict resolution, and across social and organizational contexts.

The framework to be presented attempts to integrate existing knowledge from several different research traditions. The next section will outline a view of structure and process in information exchange within problem-solving groups. We will first distinguish several general classes of formal problems groups typically face and specify a focal problem class for the present inquiry. We will then briefly turn to cognitive processes in problem solving and their relationships to the interpersonal exchange of information. Finally, we will take up the operation and consequences of social structure in interactive

groups. These discussions will then become the basis for an initial statement of a formal theory of group structure and information exchange.

Conceptual Foundations for a Theory of Group Structure
and Information Exchange

In this section, we will outline conceptual foundations that support a formal theory of group structure and information exchange in problem solving. We begin with a consideration of problem typologies and their relationship to cognitive processes in group problem solving.

Classifying Problems in Terms of Their Structuredness.

Although experimental studies of group problem solving have typically generalized their findings across problem types, we believe there are important differences in problem dimensions that affect underlying cognitive processes, the type and amount of information exchanged, and the influence of group structure on solution quality. Accordingly, we begin our discussion by suggesting a typology for problem classes.

For the discussion that follows, we adopt MacCrimmon and Taylor's (1976) distinctions between well-structured, semi-structured, and ill-structured problems, and algorithmic, heuristic, and "creative" responses. We would characterize well-structured problems by the accessibility of all information needed to solve the problem. Since existant knowledge bases most often provide transferable solution paradigms and routinized

solution procedures, algorithmic responses are generally adequate for this problem class.

In the case of semi-structured problems, enough information is available to partially define the "nature" of the knowledge gap and some transfer of information on the connectedness of problem elements. However, limitations in the knowledge base preclude exclusively algorithmic responses. In such cases, problem-solvers can optimally employ "heuristics," procedures that rather than guaranteeing a satisfactory answer only increase the odds of converging on a satisfactory solution.

Finally, in ill-structured problems there is generally no more than background information on the knowledge gap and little or no transferable solution paradigms. Since clear-cut procedures for closing problem gaps do not exist, problem solvers must generate connections and solution forms through improvised or "creative" response procedures. Issues in the definition of such procedures have a long history (Kelley and Thibaut, 1969), but few controlled studies have evaluated their efficacy. There is also controversy as to the commonality and ordering of cognitive processes in the solving of ill-structured problem (Bell, 1982).

Thus, while ill-structured problems are often complex and of critical importance, operational procedures to generate solutions have been elusive and irregular in their results (Yetton and Bottger, 1982). It is clear that ill-structured problems are most typically taken up by groups of experts. This is in contrast to well-structured problems which are more typically assigned to individuals supported by machine technology.

Additionally, as differentiation and specialization in complex organizations increase, ill-structured problem solving increasingly involves small group interactions of individuals with diverse personal characteristics and expertise (Steiner, 1972).

While we believe that the theory to be presented has some applicability to all three types of problems, we primarily address the class of ill-structured problems. We choose this because we believe that the effects of social structure on both information exchange and solution quality will be most salient in this class of problems.

Cognitive Processes and Information Exchange in Ill-Structured Problem Solving.

Most conceptualizations of the cognitive processes underlying problem solving behavior suggest an interplay of convergent and divergent thinking that varies across both phases in solution generation and problem types. As used here, convergent thinking refers to operations that lead to singular "correct" solutions. This ability class is represented in intelligence and achievement measures. Divergent thinking refers to operations that are directed to generating a large number of disparate solutions that meet no singular criterion of "correctness." This latter class of operations has been discussed as a basis of creative thinking.

In such views, problem definition and idea evaluation depend for the most part on convergent thinking operations while idea generation typically entails divergent thinking. Considering

problem types, we would expect well-structured problems to emphasize convergent thinking operations in the matching of problem to known procedures and their implementations. Ill-structured problems, in contrast, would be expected to depend more on divergent thinking operations to generate solutions that meet no singular criterion of correctness.

In group problem solving, we would correspondingly expect different types of information to be exchanged during different cognitive operations. For example, we would expect the convergent thinking operations in problem definition and idea evaluation to be typified by the exchange of facts and evaluations, whereas the divergent thinking operations of solution generation should show relatively greater exchange of ideational information.

Social Organization in Interactive Groups

Along with formal problem solving operations, we expect other social processes to occur in interactive groups. Among the most important of these is the emergence and maintenance of a hierarchical structure or status order. As a consequence, information exchange in an interactive group serves several functions. The first of these relates to the problem solving task, while the second has importance to the definition and maintenance of social order; each affects the amount and type of information exchanged. To understand the flow of information in interactive groups, one must understand the components of these functions and their etiologies.

Having briefly considered information exchange in support of the cognitive operations of problem solving, we now turn to information exchange in support of the hierarchical social structure of the group. In the discussion to follow we will consider the organization and operation of group social structure and its effects on the amount and type of information exchanged in interaction.

Status Organizing Processes in Interactive Groups. From the early work of Bales to current work in the Expectation States research program, researchers have focussed on interpersonal evaluation as one of the key mechanisms linking social structure to group interaction. Evaluation processes play a significant part in accounting for the two major types of empirical findings in these research traditions; (1) the emergence of a status order in groups whose members are initially undifferentiated with respect to salient status characteristics such as race, sex, organizational position, and task competence; and (2) the capacity of a pre-existing status order that is external to the group to organize a status hierarchy in the group even when the basis of the external differentiation is totally unrelated to the group task. For Expectation States theorists, the concept of an expectation state--a relational construct incorporating an individual's beliefs about his own competence vis-'a-vis the others with whom he was interacting--accomplished the linkage; an individual deferred to others for whom he held higher expectations than he held for himself, and thus individuals in interaction are treated unequally because they are thought to

have unequal task-relevant abilities. Once high expectations are formed for a specific member, he or she is: (1) encouraged to talk more, (2) more likely to be perceived as having good ideas, (3) less likely to encounter disagreement, and (4) generally allowed more influence.

Evaluation processes, however, play an important role in determining an individual's self-other expectations. Individuals in interaction communicate both very specific and very generalized, diffuse evaluations; for example, A can tell B that she agrees with B's last suggestion or she can tell B that she likes B's style. Berger and Snell (1962), in a stochastic model of the action process by which a hierarchy emerges, limited themselves to very specific "unit evaluations"; each "performance output" by an actor leads to a unit evaluation of that performance. These unit evaluations build up expectation states which then influence later unit evaluations. In contrast, the process by which diffuse status characteristics affects group interaction and group structure involved generalized evaluations such as the global negative stereotypes associated with race (Berger et al., 1966, 1972).

That people differentially evaluate occupants of different status levels constitutes a principal underlying property of status hierarchies. Therefore, one should expect that interpersonal evaluations contribute to the emergence of a hierarchy and that hierarchies affect interpersonal evaluations. Furthermore, given the existence of a hierarchy, all evaluations of a specific action do not carry the same weight; evaluations from higher status evaluators undoubtedly have more impact than

those from lower status evaluators (Berger, Cohen, and Zelditch, 1972).

Expectation States research thus informs us about the formation, stability, and operation of power-prestige hierarchies and the general role of evaluation processes. In the discussion that follows, we will use the communication of evaluations as building blocks to look more closely at the interaction process as that process operates to solve the group problem and to construct and maintain the group structure. This use is roughly analogous to the use of "unit evaluation" concept as a building block in the formation of expectation states.

In our view, communications of evaluations represent critical aspects of information exchange in problem solving. On one hand, such communications contribute to the emergence and/or maintenance of the status order. On the other hand, evaluations can contribute to problem-solving functions by discriminating quality and direction in ideation. Furthermore, not only actual communication but anticipated communication impacts both sets of functions; concern for avoiding negative evaluations from superiors often prevents essential information exchange as the Challenger disaster well illustrates. We believe that actual and anticipated communication of evaluation link social structure to the problem solving process and to the outcome of that process. To explicate this view, in the next section we will briefly consider the connections between status organization and the cognitive and social processes underlying information exchange in group problem solving.

Structure and Process in Group Problem Solving

We have thus far presented a typology of problems, a brief discussion of cognitive operations and an examination of the relationship of status structures to interaction processes. We will now turn to the integration of these diverse content areas. We begin with the specific processes that link group structure to problem solving operations. We believe that these are affective processes that emerge in group interaction, reflect the status structure of the group, and influence cognitive processes addressed to solving the group problem.

Considering affective processes first, we note that along with studies of types of cognitive operations in problem solving, a concurrent body of research has dealt with affective correlates and facilitating and inhibiting performance conditions for different cognitive operations (cf., Amabile, 1983; Wallach and Kogan, 1965). Although the research represents a range of conceptual perspectives, it essentially suggests that while evaluative information may in some cases facilitate convergent thinking, such information most often has an inhibiting effect on divergent thinking. Partly in response to such findings, many heuristic procedures for ill-structured problem solving have the inhibition of explicit evaluation as a primary end.

However, since ill-structured problem solving seems to depend on the operation of both divergent and convergent thinking in ordered sequences, outcomes seem more likely to benefit from procedures that regulate the amount and timing of the exchange of

evaluative information. Such procedures require an understanding of sources of evaluative information.

Status Effects on Information Exchange. Consistent with previous discussion, we propose that the direction and amount of evaluative information exchanged in interacting groups are functions of status organizing and maintenance processes. The research and theory cited above allows strong inferences about the consequences of status differences for the flow of information in general and evaluative information in particular. For example, we would ordinarily expect negative evaluations to be disproportionately sent by high-status persons and directed toward low-status persons and their communications. Correspondingly, the content of low-status persons' communications should predominately be positive evaluations which are disproportionately directed toward high-status persons. As we have noted, these structural sources of the flow of evaluative information represent sender characteristics which are often independent of the substantive content of the information. The disfunctional effect of asymmetric communication is intensified if, as is often the case, characteristics such as age or rank rather than task-relevant abilities are the basis of status position in the social hierarchy.

Thus, we may expect that the status order of interactive groups will systematically shape their communication so that initially medium- and low-status individuals send proportionately more facts and positive evaluations and correspondingly fewer ideas and negative evaluations than high-status individuals. Our

discussion of cognitive operations in problem solving, leads us to expect that such distortions in the transfer of ideational information have particular importance for ill-structured problems.

In ill-structured problems, hypothesis generation assumes greater importance than in semi- or well-structured problems because the connectedness of problem elements is less well defined, and solution procedures, even if known, can not be as readily linked to poorly specified problems. Effectiveness in hypotheses generation clearly depends on unencumbered idea initiation and minimal but objective evaluation--exactly the processes that are most distorted in hierarchical groups.

We would further observe that since (1) there is typically little ability in the group to recognize initially which members are consistent sources of superior ideas, and (2) convergence on a single solution is not a major feature of the cognitive operations, social hierarchization can have significant costs to outcomes of hypothesis generation.

In contrast to hypothesis generation, we note that hypothesis evaluation typically is based on a greater exchange of facts and shared evaluations which are seen as less risky to members than the exchange of ideas. Thus, social hierarchy effects on information transfer may interfere less with the exchange of hypothesis evaluations and their contribution to the quality of final solutions. In cases where member positions in the hierarchy are based on ability relevant characteristics, hierarchical organization may in fact contribute to the outcome of hypothesis evaluation by weighting knowledgeable communications

most highly and reducing the time the group takes to converge on a single solution.

For ill-structured problems, then, the asymmetric communication of evaluation that occurs in hierarchies is likely to have both inhibitory and facilitating effects. In the idea-generation phase, actual or anticipated negative evaluation may constrict the flow of ideas. But in the idea-evaluation phase, communication of evaluation may promote the strengthening or discarding of weak ideas. In the final sections to follow, we will attempt to formalize and elaborate on the mechanisms that produce these effects with a set of theoretical propositions.

A Heuristic Theory of Structure-Mediated Evaluation and Information Exchange

While our framework is in an early stage of development and is a first approximation to representing the processes involved, we believe it is a useful way to structure systematically the relationships among influential variables in information exchange and problem-solving in interactive groups. Although we will present the theory in the form of a set of propositions, it is not yet sufficiently formalized to allow us to deduce consequences from these propositions in a rigorous manner. We are, however, able to extract testable hypotheses about processes of information exchange and their consequences for group problem-solving from the propositions in the present form.

Unit of Analysis and Objectives. The basic unit of the model is the "CHANNEL" which is defined as a one-way link from a particular source (S[i]) to a particular target (T[j]) through which a specific type of content may be transmitted. We should emphasize that in this view, a channel is not simply a neutral conduit like a telephone line (e.g., Bavelas, 1950), but depends on the type of content that flows through it as well as its address; a useful analogy may be a set of pipes, one restricted to transmitting water, one for oil and one for natural gas, each with specific destinations. Following this definition, there are $M(K)(K-1)$ potential channels where M = the number of information modes and K = the number of group members. For the present, we restrict channels to five types of information content" (1) Task data (D); (2) Solution proposals (I); (3) Positive Evaluations (P); (4) Negative Evaluations (N); (5) Source and Third Party data (E). While the first four are self-explanatory, E channels require some amplification. E channels transmit data about the Source or the Sources' evaluation of a particular target to group members other than the target. Thus, we use E channels to represent S[i]'s comment about T[j] as it is overheard by others.

As this definition indicates, a channel is an analytic construct that allows us to specify important elements of an actual information transfer. Channels may be available but not used and, in an actual group, many channels may be inextricably tied together so that use of one means use of all the others. In a face-to-face group, for example, source i transmitting a Negative Evaluation to Target j, $[N(S[i] \rightarrow T[j])]$, also involves transmitting third party information to all other targets, i.e.,

involves the use of E channels to all other targets. In particular cases, the medium of communication or the norms of the groups or what Kiesler (1984) calls the "etiquette" of group interaction may close some of these channels so that they are unavailable.

The principal aims of our model are: (1) to represent key factors that affect a given source's usage of a given channel; (2) to represent the consequences of usage of that channel to the source, the target, and the group, and (3) to represent the aggregate consequences of the use of all channels for the content of information exchange in the group. Although we recognize that group interaction has emergent properties beyond those that can be represented by the aggregation of dyadic relations, in this first formulation we treat the channels as having additive effects across individuals and types of information.

Basic Definitions. We begin the exposition by defining the basic terms we will use to state our propositions: Status Differential, Cost Differential, Expected Cost and Expected Gain.

Let the STATUS DIFFERENTIAL be the difference between the status in the group of the source and the status in the group of a given target. If $S[i]$ has higher status than $T[j]$ then the STATUS DIFFERENTIAL is positive.

The status differential can be the resultant of comparing $S[i]$ and $T[j]$ on a number of status dimensions including both task-relevant and nontask-relevant status characteristics. $S[i]$ can have more technical competence than $T[j]$ while $T[j]$ has more

seniority than $S[i]$; the status differential would then be a weighted combination of the competence difference and the seniority difference.

Let COST DIFFERENTIAL of using a given channel be defined as the EXPECTED COST of using that channel minus the EXPECTED GAIN from using it; (this ordering of Expected cost and Expected Gain in Cost Differential will allow subsequent propositions in Cost Differential to be more intuitive.)

where:

The EXPECTED COST of using a channel is the probability that the Source will become a Target for an N channel (negative evaluation) weighted by an estimate of the amount of loss of status or self-esteem to S resulting from receiving that negative evaluation.

and:

The EXPECTED GAIN of using a channel is the probability that the Source will become a Target for a P channel weighted by an estimate of the amount of gain in status or self-esteem to S resulting from receiving that positive evaluation.

We consider EXPECTED COSTS and EXPECTED GAINS to be separate dimensions that may vary independently. In other words, one is not the inverse of the other; a factor can affect a Source's EXPECTED COST and not effect that Source's EXPECTED GAIN. Even when a factor affects both, the effect may be asymmetric, e.g.,

when a factor produces a unit change in EXPECTED GAIN, it may produce much more than a unit change in EXPECTED COST. While we formulate these as "expected value" concepts, in this exposition we will only make use of ordinal comparisons as, for example, if S[i] uses an N channel to T[j] where the STATUS DIFFERENTIAL is negative the cost is higher than if N(S[i]--->T[k]) where the STATUS DIFFERENTIAL is positive.

We have chosen to focus on individual concerns with gains and losses of status and self-esteem and their consequences for the flow of evaluative information. Such a focus is consistent with our view of the importance of these processes to the amount and quality of ideation in interactive groups.

In this view, the flow of initial ideas, their amplification, clarification, transformation, and acceptance by the group is most closely related to the direction, amount, and sequence of positive and negative evaluation (i.e., the use of N and P channels).

With these definitions, we can now turn to the propositions of the model. The driving force of the model is an individual's concern over loss of self-esteem and status in the group's social hierarchy or other groups to which members belong. Thus, an individual is motivated to use a channel in order to prevent status and self-esteem losses due to the group's failure to solve its problem and/or to gain status and self-esteem. A person is constrained from using a channel because of possible negative evaluations from others which result in losses to self-esteem and status. In the present formulation, we assume that anticipated costs of group failure (and anticipated benefits of group

success) are constant for all members and exogeneously determined.

Propositions

We begin with three propositions that serve as background for subsequent propositions and derivative hypotheses.

1. BACKGROUND ASSUMPTIONS

P1.1 Ill-structured problem solving is facilitated when the process of generating ideas is separated from the process of evaluating ideas.

P1.2 Quality in problem solving is facilitated when the evaluation of an idea is separated from the evaluation of the person who is the source of the idea.

P1.3 Where solution paradigms do not exist (ill-structured problems), ideas that entail high potential cost to their Source are necessary for the group to have any chance of solving the problems.

Proposition 1.1 may be seen as an inherent consequence of the sensitivity of ideation to evaluation and negative affect. This proposition has its bases in formulations from diverse theoretical perspectives in social psychology (e.g., Amabile, 1985, Wallach and Kogan, 1965).

In our terminology, we will suggest that throughout the life of the group, all members perceive expected costs to exceed expected gains from using I channels. Separating the use of I channels from the use of N channels would therefore decrease the expected cost to members of using the former and increase the total number of ideas.

P2.1 has a rationale similar to that for P1.1; separating the individual from the idea again lowers the probability that being a source of I channel usage will result in being the target of an N channel.

In P1.3, we observe that by definition ill-structured problems require more uncommon ideas to span or link their problem elements than do well-structured problems. Such ideas are commonly perceived as increasing the probability of being the target of an N channel communication more than they increase the probability of being the target of a P channel communication.

2. CHANNEL CHOICE

P2.1 The probability that a Source will use a given channel increases as the Cost Differential of using that channel decreases.

P2.2 Given an option among channels, a source will choose the channel(s) with the least Cost Differential(s).

As we have defined the terms, when a Source expects more gains than costs, the Cost Differential will be negative and the

probability of a given channel's usage will increase since the Source expects greater gains. These propositions refer to choices of both targets and types of information in the set of available channels; when channels to different targets are tied together as in face-to-face groups, a source may choose subsets rather than individual channels.

3. COST DIFFERENTIAL

The Expected Cost and Expected Gain of being a TARGET and SOURCE of communication are both relevant to the individual's probability of using a channel. We assume that in considering whether to be a SOURCE each person takes the position of a TARGET of various types of information and calculates the costs and gains he may expect as a result of using a channel. Thus, we precede propositions on the SOURCE's expected costs and cost differential by a proposition on the TARGET's expected cost.

P3.1 For a person i , the EXPECTED COST of being the TARGET of an N channel from a Source $S[j]$ increases as the STATUS DIFFERENTIAL between i and j becomes increasingly negative (i.e., j becomes of increasingly higher status than i).

Proposition 3.1 formulates the target's perception that negative evaluations are more costly from higher status Sources. Even if the probability of using an N channel did not vary with the status of the Source, the negative consequences of being a target of an N channel are greater from higher status sources.

For example, in the case of formally organized groups, it is obvious that a negative evaluation from one's superior is much more serious than one from a peer. Even in informal groups a negative evaluation from one believed to be higher in competence can be more damaging to the target's self-esteem.

P3.2 and P.3.3 use P3.1 to state the SOURCE's perspective on Expected Cost.

P3.2 The EXPECTED COST to person i of being a SOURCE ($S[i]$ ----> $T[j]$) in any type of channel increases as the STATUS DIFFERENTIAL between $S[i]$ and $T[j]$) becomes increasingly negative.

P3.3 The COST DIFFERENTIAL to person i of being a SOURCE ($S[i]$ ----> $T[j]$) in any type of channel increases as the STATUS DIFFERENTIAL between $S[i]$ and $T[j]$ becomes increasingly negative.

In propositions 3.2 and 3.3 person i is applying the results of his calculations of his potential as a target to his future role as a Source. Maintaining the assumption of a constant probability that usage of a given channel will result in the target's negative response, the cost of that negative response will increase with increases in the relative status of the target.

We note that these propositions posit beliefs of the Source which may or may not have any relation to the actual situation.

Sometimes the person's perceptions will be an adequate basis for expectations, but at other times social processes will distort the perceptions and the expectations based on them. This point is important because, as we have previously noted and will subsequently argue, status organizing processes are often based on individual characteristics that are minimally related to problem requirements or task-relevant abilities. We should also re-emphasize that these expectations are relative, not absolute---to S[i], a high status Source, there may be very little expected cost with either (S[i]---->T[j]) or (S[i]---->T[k]), but if the status differential between i and j is more negative (or less positive since STATUS DIFFERENTIALS are symmetric) than the differential between i and k, then the EXPECTED COST of the former channel would be greater than the EXPECTED COST of the latter.

The effects of positive evaluations from high status sources are more beneficial than positive evaluations from equal or low status sources, but propositions about positive evaluations and status gains are not mirror images of 3.1 and 3.2. Since we focus on negative evaluations and costs, we omit propositions about positive evaluations to avoid additional complexity.

P3.4 For a given T, an N channel is more likely than an I channel to have a negative COST DIFFERENTIAL and an I channel is more likely than a D channel to have a negative COST DIFFERENTIAL.

P3.5 For a given T, in the absence of social constraints, the COST DIFFERENTIAL of an I channel is more likely to be negative than positive.

where:

SOCIAL CONSTRAINTS are mechanisms that separate evaluations of products from evaluations of Persons producing those products or limit COST DIFFERENTIALS to a given Source from a set of Targets.

Proposition 3.4 formalizes the previous discussion. Since individuals seek to maintain or increase status and self-esteem, N channels with themselves as TARGETS are likely to have the most negative COST DIFFERENTIALS. Being the SOURCE of N channel usage is most likely to result in being a subsequent TARGET of an N channel. Since facts and data are generally neutral, being the SOURCE of a D channel usage is least likely to result in being the TARGET of an N channel in a subsequent period.

We further believe that use of I channels in interactive groups where the source is known can be more costly (i.e., have more negative cost differentials) than is sometimes recognized. This is because, in the absence of formally adopted, dominant criteria for judgments, groups tend to resist initial, new, uncommon, "radical" solution proposals when they are first offered. Such a behavioral assumption is supported by informal observations and related research findings (e.g., Moscovici and

Nemeth, 1974). Thus, being the SOURCE of an I channel communication is more likely to have the short-run consequence of becoming the TARGET of an N channel than of a P channel communication.

Simply put, since groups tend to resist initial proposals, the most likely reaction to a proposal is either an explicit or an implicit negative evaluation (the latter is most often expressed by silence or totally ignoring the proposal). The longer run consequences of being an I channel source are likely to be more complex and depend on such factors as the quality of the communication, the status of the SOURCE, the groups's interaction "history" in terms of previous N and P channel usage of the Source and the willingness to further use N channels (with their Expected Costs) in support of the communication.

In proposition 3.5, we introduced a claim about the sign of the cost differential for the SOURCE of an I channel communication. Proposition 3.6 asserts the interdependence between usage of N and I channels. In proposition 3.7, we generalize influences from dyad unit in previous propositions to the group unit.

P3.6 For all Ss, as the frequency of usage of N channels increases the EXPECTED COST of I channels increases.

In general, social etiquette or concerns about retaliation limit the expression of explicit negative evaluations. In much group interaction, ignoring a message is the way of expressing negative evaluation. Being implicit, it is somewhat ambiguous

and thus has less cost for its expression. Once, however, Ss recognize that inhibitions against explicit negative evaluations are not operative, they increase their estimates of the probability that one of their proposals will receive an explicit negative evaluation.

P3.7 The COST DIFFERENTIAL of using a given channel is the sum of the COST DIFFERENTIALS of that channel and all other channels that are tied to it.

This proposition refers to two kinds of situations, those in which targets cannot be segregated and those in which E channels are intertwined with D, I, P, and N channels. If a Source must communicate to several targets simultaneously, that Source must anticipate possible reactions from all targets, not only the target for whom the message was intended.

Relative to using a channel to a single target, a source can expect both more gains and more costs from a multiple channel communication, but we again consider the effects of the increase in costs to be more significant.

Similarly, using E channels--transmitting information about self or third parties--may result in both gains and costs, but the same argument implies that costs are more influential. Using an N channel to one target is very different from using that channel while also transmitting the fact of $S[i]$ negatively evaluating $T[j]$ through E channels. Public negative evaluations are more damaging than private ones and hence may invite costly retaliation.

4. OUTCOMES

Having offered our propositions on channel choice, Expected Cost, and Cost Differential, we now turn to propositions on Outcomes.

P4.1 In groups dealing with ill-structured problems, the probability of a successful solution is an asymptotic increasing function of the usage of I channels.

P4.2 In groups dealing with ill-structured problems, the probability of a successful solution is a U-shaped function of the total usage of N channels.

P4.3 In groups dealing with ill-structured problems, the probability of a successful solution is increased when N channel usage is a monotone increasing function of time spent in interaction, and I channel usage is a monotone decreasing function of interaction time.

Here we restate more formally ideas that we presented earlier. We suggested that the solution of ill-structured problems depends on both the generation of many ideas and the operation of negative evaluations to eliminate unsatisfactory or less than optimal proposals. Thus, negative evaluations are a two-edged sword--necessary to the selection of better proposals but inhibiting the generation of these proposals.

P4.1 to P4.3 result from observations of the sequencing of cognitive operations in ill-structured problem solving. Since ideation precedes evaluation and N channel usage inhibits I channel usage, we would anticipate solution quality to be increased when N channel usage is kept at low levels in early phases of interaction but allowed to increase slowly as interaction proceeds and remain at its highest level throughout the final phases of evaluation and consensus.

Although the above propositions are preliminary, they do codify ideas about the relation of status to the transmission of solution proposals and negative evaluations and allow us to generate some initial hypotheses on interaction and outcomes in status-differentiated and status homogeneous groups.

Hypotheses. These hypotheses will consider information exchange in status differentiated and status undifferentiated groups. While we recognize that even relatively undifferentiated groups have status hierarchies, we will for expository purposes consider a class of status-homogeneous groups in which there is not a status hierarchy of consequence.

1. Status Factors and the Transmission of Ideas and Solution Proposals

H1.1 Frequency of usage of I channels will be greater in status-homogeneous groups than in groups that are status differentiated.

H1.2 In status-differentiated groups, the frequency of I channels usage will be directly related to the status levels of individual members.

H1.3 In status-differentiated groups, frequency of I channels will be inversely related to the frequency of usage of N channels.

H1.4 The difference between the frequency of usage of I channels in status homogeneous and status differentiated groups will decrease as the possibility of segregating channels increases.

H1.5 The difference between the frequency of usage of I channels in status homogeneous and status differentiated groups will be minimal when sources can use I channels anonymously.

Hypothesis 1.1 maintains that equalizing the expected costs of using an I channel across group members will not only equalize the frequency of member usage of this channel, but will also increase total group usage of the I channel. This is because the expected cost of being the target of an N channel in response to being the source of an I channel decreases as status differences between members decrease.

Hypothesis 1.2 applies the frequent findings of expectation states research that individual participation varies with individual status to the generation and exchange of ideas. In

the case of I channel usage, higher status individuals face less expected costs for being the target of an N channel.

A general climate effect of the transmission of negative evaluations on the flow of ideas is represented in H1.3. Simply stated, increases in the frequency of N channel usage as observed by individual group members increase the probability term of Expected Cost (i.e., the probability of being an N channel target as a consequence of being an I channel source).

H1.4 and H1.5 introduce the technology of constrained information or limited interaction to information exchange in interactive groups. Restricting information and distinctions between public and private dyadic communication have important implication for efficiency in attaining the goals of interacting group. Technology in the forms of electronic communication (such as computer conferences and mail drop procedures) allow channel usage to be flexibly limited and expanded.

In H1.4 we recognize that when an uncommon idea can be communicated to an individual rather than the entire group, the expected cost in terms of status loss from becoming the target of a negative evaluation and having it observed by other group members is decreased. The expected cost of public evaluation to low status members is highest in status differentiated groups. Segregating an N channel communication from members other than the dyad involved would be likely to reduce this cost and consequently increase the use of I channels to a level close to that of a status homogeneous group.

H1.5 points out that in the limiting case where I channel communications are not publically matched to their source, the probability of becoming the target of N channel communicaiton becomes unrelated to the generation of ideas. Thus there would little or no differences in expected costs from I channel usage in status differentiated and status homogeneous groups.

2. Status Factors and the Transmission of Negative Evaluations.

H2.1 Frequency of usage of N channels will be greaer in status differentiated groups than in groups that are status homogeneous.

H2.2 In status-differentiated groups, the frequency of N channels usage will be directly related to the status level of individual members.

H2.3 In status differentiated groups, higher status members will most often be the source and lower status members will most often be the targets of N channel communications.

H2.4 The difference between frequency of usage of N channels in status homogeneous and status differentiated groups will decrease as the possibility of segregating channels increases.

H2.5 The difference between the average frequency of usage of N channels in status homogeneous and status differentiated groups will be minimal when sources can use I channels anonymously.

Hypotheses 2.1 and 2.2 parallel H1.1 and 1.2 and claim that the transmission of negative evaluations is similar in operation to the transmission of ideas and solution proposals.

In H2.3 we recognize that the cost differential of N channel usage will always be more negative for low status members than for high status members. This implies that in an exchange of N channel communications, a lower status member will face a greater loss of status and/or self-esteem. Therefore, lower status members will avoid being the source of communications that result in their being the target of an N channel.

Hypotheses 2.4 and 2.5 offer conjectures on the consequences of constraining information transfers to less than full member exchanges and removing source labels. (Such computer-aided modifications of interaction have important implications for the source, amount, and type of information exchanged).

In H2.4 we anticipate that reducing or eliminating E-channels in status differentiated groups will reduce the cost differential of N channel usage and increase its frequency. Similarly, in H2.5 we anticipate that removing source labels from I-channel usage will reduce the cost differential of using this channel in status differentiated groups and increase its usage to approximate levels observed in status homogeneous groups.

In our final set of hypotheses, we turn directly to effects of communication structure on information exchange. We focus on the transfer of negative evaluations because of their influence on group interaction and ideation.

3. Communication Structure and the Transmission of Negative Evaluations.

H3.1 Frequency of usage of N channels in interactive groups will be greater when the communication structure allows private dyadic (single channel) exchange rather than public (multiple channel) exchange.

H3.2 Frequency of N channel usage will be greater when the source can be anonymous than when the source's identity is known.

H3.3 The use of an N channel will have less impact in single channel media than in multiple channel media.

Arguments that multiple channels involve greater EXPECTED COSTS than single channels, and that anonymous Sources have minimal EXPECTED COST for using a channel also provide the basis for H3.1 and 3.2. Hypothesis 3.3, however depends on a slightly more complex argument. The reasoning about lower EXPECTED COSTS implies less fear of retaliation on the part of a potential Source. If all Sources have less fear of "retaliation," i.e.,

being the target of a negative evaluation, then the behavior of all sources is less constrained. A given level of usage of N channels will constrain the usage of other channels to a much greater extent in public (multiple channel) communication structures than in private (single channel) communication.

Hypotheses 3.1 to 3.3 suggest the use of communication technology to create and modify communication structure as one potential means of realizing advantages of status differentiation for problem solving while mitigating its disadvantages. For example, when information exchange is restricted to dyadic communication, the expected cost of initiating an A channel communication in terms of subsequently becoming a public target of an N channel communication should decrease.

Imposing structure on member communication offers similar potential benefits to idea generation in groups with even minimal status differentiation. If I channels are used anonymously, the expected cost of initiating an N communication should decrease.

The foregoing hypotheses exemplify testable implications of the propositions we have presented. These hypotheses together with the propositions on which they are based on seek to provide additional insight into the influence of structure on information exchange and problem solving in interactive groups. In the next and final section, we will briefly summarize the efforts of this work and suggest directions for subsequent theory and research.

Scope of the Theory. We posit four conditions under which the theory is applicable and which must be taken into account in constructing tests of the model. These are:

1. The group must be engaged in a group task.
2. There are no norms in the situation that proscribe or mitigate negative evaluations.
3. Members cannot leave the group until the group achieves its goals or disbands.
4. The only relevant external evaluations of the group or its members are those for group success or failure in accomplishing the group task.

By group task we mean a task that requires resources (information, knowledge, materials, and skills) that no single individual possesses so that no single individual can solve the problem or achieve the task objectives without at least some input from other group members. This definition requires that the task imposes some degree of interdependence in the group.

The second condition addresses cultural norms that emphasize courtesy and politeness to such a degree that negative evaluations directed to an individual are taboo. Politeness norms operate in a wide variety of task situations; indeed, some techniques for enhancing group problem solving deliberately invoke norms against direct disagreement with, or disparagement of, another's contribution. While such norms may be conducive to group success, their operation interferes with the processes underlying the present theory. Hence, we rule out such

situations as testing grounds. While there are probably very few natural situations with no normative constraints on the communication of negative evaluation, in constructing experiments to test this theory we want to minimize as much as possible the operation of such norms.

The group has less power over individuals who can freely choose to leave than over members who are constrained to remain in the group. The possibility of leaving the group mitigates the impact of negative evaluations from others; furthermore, the threat that a member might quit operates to inhibit directing negative evaluations to that member, particularly where interdependence among members is high. Thus additional complex processes arise when members have the option to resign from the group. The purpose of our third condition, then, is to simplify situations in which to test the theory by reducing the effects of additional processes. To be sure, even when physically leaving the group is not an option, it is often possible for an individual to withdraw psychologically and the frequently observed lack of participation of low status group members may reflect, in part, such psychological withdrawal. While it may not be feasible to eliminate the possibility of psychological withdrawal entirely, we need to design research that makes such withdrawal very costly and therefore highly unlikely.

Restricting external evaluations to those directed at group success or failure also serves to simplify situations in which to investigate the theory. If a member's actions in this group will lead to positive or negative evaluations from some other group, then the individual's actions are affected differentially by

concerns for other groups and the weight of the attachments to the competing groups. The intention of this scope restriction is to exclude effects of social comparison processes and reference group conflicts on the problem solving activities of the group (cf., Berger, Fisek, Norman, and Zelditch, 1977).

Undoubtedly, these scope constraints are too restrictive in their present form. As we develop the theory we hope to relax and perhaps eliminate one or more of them entirely.

Summary and Conclusions

We have presented the initial formulation of a theory of information exchange mediated by group structure. We believe that the theory provides a framework within which to consider the effects of structure on interaction and outcomes of group problem solving.

The basic unit of the theory is the "channel" and channels are differentiated according to source, target, and content mode of a communication. We distinguish five modes: Ideas, data, positive evaluations, negative evaluations, and what we term "source and/or third party data." Source or third party data channels typically refer to communications where person k observes that Source $[i]$ negatively evaluates Target $[j]$. The propositions of the theory link channel usage and channel choice to the status structure of the group through propositions about the cost of receiving negative evaluations from various sources who differ in status. For ill-structured problems, the theory relates successful solution to the frequency of usage of Idea and Negative evaluation channels and also to the time patterns of

this usage.

In the theory, usage (or anticipated usage) of N channels is the principal mechanism that drives the process, and differences in member status determine the amount and targets of such usage. While other writers have noted the importance of negative evaluations in group process (e.g., Bales, 1951, 1953), the present theory systematically explicates key antecedents and major consequences of variation in the communication of negative evaluations in problem solving groups.

Receiving negative evaluations from others can reduce an individual's status in the group or diminish his self-esteem. Failure to accomplish group objectives can have similar consequences. Hence, avoiding such costs involves an individual in delicately balancing when to communicate and when not to, what to communicate and what to avoid communicating, to whom to initiate and to whom to respond, whether to communicate publicly or privately, whether to identify oneself or to be anonymous, etc. In terms of the theory, an individual deals with these choices by choosing a channel, and the probability of choosing each type of channel depends in part on the status structure of the group and the individual's position in that structure.

We posit that the probability of choosing a channel varies inversely with "cost differential" (the difference between expected loss and gain in, e.g., status). We also assert that negative evaluations and ideas are more likely to have negative cost differentials than data or positive evaluations. Moreover, we claim that the cost differential for transmission of ideas increases as member status differences increase, for all but the

highest status group member. As a consequence of this analysis, the transmission of ideas in a group is likely to decrease as status differences increase.

The last section presented three sets of hypotheses. Although we do not rigorously derive these hypotheses, they are generally consistent with the lines of reasoning we have explicated. The first two sets relate status factors to the communication of ideas and negative evaluations, while the third set deals with the effects of the communication structure on the communication of negative evaluations. Where the communication structure allows the segregation of channels and/or the anonymity of sources, the theory assumes that it is possible to reduce the negative costs of channel usage. Thus we hypothesize that use of negative channels will increase when private and/or anonymous channels are available, and that the impact of negative evaluations will be reduced in such structures. If these hypotheses are supported, then such structures could mitigate some of the effects of status differentiation (Kiesler, 198?).

The heuristic framework we have presented clearly requires elaboration, clarification, and integration. Further development of the theory, however, would benefit from a set of empirical studies that would indicate which ideas of the theory are adequate, which need modification, and which should be abandoned. With the advent of computer-mediated interaction (Hiltz et al, 19??, Kiesler, 1984, Cohen, forthcoming), we now have the technology to create experiments where we can focus specifically on the use of negative channels, for example, and the effects of such usage. We are in the process of developing an experimental

paradigm that will allow us to compare face-to-face with various degree of restricted interaction.

If the basic ideas of the theory are supported empirically, then there are scientific and practical implications that need to be explored. This framework should enable us to reconsider the problem of the sequencing of problem solving operations and information exchange; we intend to reconstruct our propositions to deal with developments in time over the life of the group. In addition, the theory can be elaborated to provide guidelines for enhancing group performance in dealing with ill-structured problem solving. For example, one appropriate objective for developing our framework would be to answer the question, "How can groups retain the benefits but minimize the negative consequences of status structures on information exchange?" Further consideration of these possibilities as well as additional background for our theory are presented in Silver, Cohen, and Rainwater (1988). We believe the importance of information exchange at all levels of social organization underscores the potential value of this line of inquiry.

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