SUBSTRUCTURAL RATES OF CHANGE, AND ADOPTION AND KNOWLEDGE GAPS IN THE DIFFUSION OF INNOVATIONS

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JOHN J. GALLOWAY
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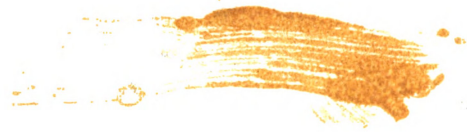

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ABSTRACT

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By

John J. Galloway

The study explored certain inequalities between "more-advantaged" and "less-advantaged" segments of a social system--inequalities in adoption and knowledge of innovations which were thought to have possible social change implications. Within the context of a planned diffusion of innovations program in a developing community, the study sought to examine different intra-system adoption rates and to detect causal links between adoption at one point in time and later structural changes. Structural changes within the system did not necessarily constitute social change, defined in terms of significant alterations to the structural form of the system. Under certain conditions, it was suggested that a change program may serve either to reinforce social inequalities pre-existing in a system, or reduce them.

A central part of the conception involved what were termed "substructural criterion gaps" and whether they tend to widen or narrow over time. Structure referred to the arrangement of statuses and roles in a social system, and substructure referred to specified parts of that arrangement. Recent communication research suggests that substructures defined in terms of "high" versus "low" respondent education tend to have different rates of knowledge gain, such that

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"knowledge gaps" widen over time rather than close. The present study examined substructures defined by numerous variables such as agricultural production, land area cultivated, social participation, opinion leadership, and prestige, as well as education; and gaps were examined for adoption criteria as well as knowledge. Substructural criterion gaps referred to observed differences at one point in time between specified substructures in the knowledge and adoption criterion variables.

In the absence of previous and directly related research, one quite general working hypothesis was advanced: that gaps in adoption and knowledge would tend to widen initially because of intrapersonal selective processes, and then tend to narrow via interpersonal and cross-substructural channels spreading information and influence on the new ideas.

Re-analysis was carried out for a set of three-time panel data among 192 Indian villagers. Each respondent had been interviewed once before and twice after media forums had been conducted in the villages, with a three-year period separating the first and last surveys.

Configurational analysis with a total of thirty-five predictor variables was used to define sets of substructures which then became the units of analysis. "High" and "low" subgroups were formed on the basis of various characteristics, such that each pair of subgroups represented close to maximal partitions in the variance of indices of adoption and knowledge at "earlier" points in time. Since there were numerous agricultural and health innovations, it became possible to identify four samples of gaps: adoption gaps for agricultural innovations (total=90), health adoption gaps (15), agricultural knowledge

gaps (180).
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gaps (130), and health knowledge gaps (25). A separate analysis involved the study population as a whole; a cross-lagged panel correlation technique was used to determine whether adoption consequences included later structural changes.

Adoption gaps for both agricultural and health innovations showed no clear trends toward either narrowing or widening, and there were no differences for "earlier" and "later" time periods. The hypothesis was not supported. Gaps for specific innovations or specific substructures did vary to an extent, but mostly they cancelled each other with respect to the overall tendencies.

Adoption consequences for a number of innovations did involve structural changes. However, since the rates of adoption for "more-advantaged" and "less-advantaged" segments were approximately the same, it could not be concluded that the change program tended either to reinforce or alter pre-existing social inequalities within the time period of the study.

Knowledge gaps about innovations did show clear trends--nearly all decreased rather than increased ($p<.001$). This pattern was observed almost regardless of particular time periods, substructures, or innovations. However, the strongest narrowing tendencies were observed for innovations which had encountered "ceiling effects". Relative to the "less-advantaged" segments, the "more-advantaged" segments had less "room" to maintain higher rates of knowledge gain. It was suggested that where discrete sets of innovation-messages are input to a system, ceiling effects--and therefore decreasing knowledge gaps--are likely to occur to some degree and at some eventual stage. On the other hand, where there are "on-going" change programs with new ideas more or less continuously introduced, knowledge gaps may not show such strong narrowing tendencies.

SUBSTRUCTURAL RATES OF CHANGE, AND ADOPTION AND KNOWLEDGE GAPS IN THE DIFFUSION OF INNOVATIONS

By

John J. Galloway

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Wendy, my wife, has been an enormous help over the past few months especially and throughout our stay in the U.S. She has given me much needed support and one of the funniest little guys imaginable, Scott, aged nineteen months. I dedicate this dissertation to them and my mother.

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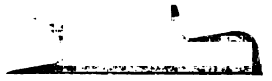

CHAPTER I

INTRODUCTION

The Concept of Change

Social change has become a popular term in connection with contemporary problems and issues at the societal level and other system levels such as communities and organizations. Some writers seek to speed up social change while others prefer to slow it down.* Either way, people want to control it. Lay observer and social scientist alike intuitively know that social change phenomena are important; and the scientist has also learned that these are exceedingly complex phenomena to subject to systematic study. Relatively "grand" theorists of social science have been attacked for their alleged failure to properly account for social change (e.g. Martindale, 1961:21-30). Yet, somewhat less pretentious "middle-range" theorists have also been criticized, for being too circumspect in their views to be able to account for social change processes (e.g. Moore, 1963: 85-88).

The present study utilizes one of the middle-range theories, the "classical" diffusion of innovations model. From beginnings in the

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*For example, Alvin Toffler in Future Shock.

study of agricultural innovations in rural sociology, the model has since been developed and generalized to other innovations and other fields by several writers, principally Rogers (1962; Rogers with Shoemaker, 1971).

A planned diffusion of innovations program and certain adoption patterns and consequences will be examined in the present study. Consequences are the changes that occur within a social system as a result of the adoption or rejection of innovations (Rogers with Shoemaker, 1971:7). To the extent that certain consequences of the planned change program have been observed, it will be suggested that one type of social change as defined by grand theorists has been effected.

Before proceeding further it is necessary to outline the sorts of processes and changes to which I am referring. The diffusion process is the process by which innovations (new ideas, practices, or objects) are spread to the members of a social system. It is primarily a social communication and influence process extending across time among the members of a social system. Implementation of certain aspects of the "classical" diffusion model that describes this process may lead to the more rapid acceptance of new ideas in a given situation. However, the model is not primarily prescriptive; it is more descriptive with respect to a particular process. It does include certain "control" or "guidance" features about the management of change processes, and of course explanation and prediction usually go hand in hand. However, the present study underscores that researchers in the area of planned social change should be careful to avoid possible implied equations

between diffusion and change processes and diffusion criteria and social change.

Parsons (1961) and Moore (1967) have both defined social change in terms of "significant" alterations in social structure.* Nisbett (1972) attempts to clarify the meaning of "significant" alterations. He borrows and extends an argument earlier put forward by Radcliffe-Brown for distinguishing between two types of change: (1) changes within structure that do not affect the overall structural form, and (2) changes of structure that do affect the overall structural form. Nisbett does not fully define "alterations in structural form", but states that this can be said to have occurred when a social system "passes from one type of structure to another."

Nisbett argues that the distinction can and "must" be made for "any valid theory of social change". The conceptual level distinction becomes clearer when Nisbett argues the point by analogy with Kuhn's (1962) insightful analysis and use of the concept of paradigm. Two types of change occur in science according to Kuhn: cumulative changes in on-going science, and those more strongly restructuring changes that follow a paradigm such as Newtonian theory.

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*By social structure is meant patterns or arrangements of statuses and roles in a social system.

Status refers to the rights and obligations that accompany occupancy of a position in a social system.

Role refers to reciprocally held expectations about performance that accompany occupancy of a position.

Thus, when reasoned by analogy the distinction seems reasonable. Yet the most basic questions remain: "When is a paradigm a paradigm?" and "What guidelines about the distinction are there for the researcher at the operational level?"

Although Nisbett favors paradigmitic changes as the proper criteria for social change, it seems that the distinction is mainly one of degree. The changes are of the same generic order; whether they are of Nisbett's first or second type, the dependent variables for which measures can actually be gathered are social structural. Thus, the present study will simply refer to structural changes, defined as across-time variations in status or role. Nisbett's distinction will be kept in mind, however; for it will be suggested that under certain conditions the observed patterns of structural changes may tend either to reinforce the overall structural form, or significantly alter it. The emphasis on "tend" derives from a consideration of the time periods involved. Field studies are necessarily limited in duration, while social change processes may extend over many years. To be able to conclude that a structural form has, or has not, significantly altered is probably beyond the scope of most diffusion researchers.

Structural changes are assumed to be consequences of systemic or personal factors, including the adoption of some innovations. Rogers and Shoemaker (1971:30, 340-341) have pointed out that certain innovations are probably more "restructuring" in type than others. Examples suggested are land reform, an overhaul of the taxation system, and establishment of a research and development unit in an industrial firm.

These innovations do not involve optional decisions about adoption by individuals, our present concern; instead, they involve what are termed collective or authority innovation-decisions. However, quite independent of the type of innovation-decision, a much neglected aspect of diffusion research has been the attempt to systematically examine relationships between adoption of innovations and structural changes as consequences of adoption.

Given field experimental evidence of increases in adoption in a social system following a planned change program, and given evidence of adoption of those innovations leading to structural changes, then it would appear that the change program influenced the occurrence of structural changes within the system. In Nisbett's terms, changes within structure were affected.

A further question of interest concerns whether the pattern in the across-time structural changes tends toward an altered structural form (in the long-term), or reinforcement of the "before" structural form. In the most general terms, "Do the rich get richer relative to the poor?"

Assumptions of the present study are as follows with respect to the antecedent conditions tending toward reinforcement or an altered structural form. Given:

(1) the field experimental evidence noted above,

(2) evidence that adoption of innovations advocated in the change program leads over time to structural changes, and

(3) evidence that the "more-advantaged" segments of the social system adopt at different rates than the "less-advantaged" segments, so that the "gap" in adoption between these segments tends to increase rather than decrease,

then it is assumed that the overall structural form tends more toward reinforcement rather than alteration (within the time period of the study). On the other hand, it is assumed that the structural form tends more toward alteration than reinforcement under the same conditions as those above, except for number 3 which reads:

...so that the "gap" in adoption between these segments tends to decrease rather than increase.

It is further assumed that either tendency concerning the structural form is, in part, attributable to the planned change program.

Study Objectives and Significance

In the present study, an exploratory attempt will be made to assess the social change implications that may accompany different intra-system rates of adoption. However, the intra-system differences in adoption (or knowledge) over time are considered to be important issues in their own right, with or without inferences about an altered structural form.

Thus, one present objective is to examine social change tendencies which follow the conduct of a planned change program; but this, in turn, rests upon a set of assumptions which include another and more basic

objective--the study of "substructural rates of change" and "criterion gaps."

A substructure is some specified part of a social system which is defined by reference to certain statuses or roles. Substructures in a rural community, for example, might be defined as follows: farmers or non-farmers; owners of more than fifty acres, or owners of fifty acres or less; college-educated or non-college-educated, etc. The structure of a social system refers to the arrangement of statuses and roles in the whole system, whereas a substructure refers to specified parts of that arrangement. Tichenor, Donohue, and Olien (1970) defined substructures on the basis of education in order to study differential patterns of information-acquisition over time from the mass media. For public-affairs information it appears that "knowledge gaps" widen between substructures defined by respondent education. Such patterns have not been described within the context of planned change programs, and not for adoption criteria. The present study aims to investigate the occurrence of such "gaps" defined on the basis of numerous criteria, and to examine the tendencies for these differences to increase or decrease over time following a planned diffusion of innovations program. In other words, do "gaps" widen or close, for knowledge or adoption, for which innovations and which substructures, and at what points in time in relation to the change program?

Substructural criterion gaps are simply observed differences at one point in time between specified substructures in criterion variables of interest, for example, knowledge or adoption of innovations.

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It is assumed that criterion gaps may increase or decrease over time, such that with two or more points in time the study of gaps becomes the study of substructural rates of change in the change program criteria.

The units of analysis are substructures. These might be expected to vary in size themselves through structural changes influenced by adoption, depending upon time periods involved and the defining criteria. For example, farm size might not be expected to vary much within a two or three years period; but, as a consequence of substantially higher rates of adoption of agricultural innovations among large-size farmers rather than small-size farmers, there may be comparatively more changes in prestige ratings, income levels, membership in associations, life-style ratings, etc. That is, the structural and functional consequences of adoption within different parts of the system may differ,* as well as the rates of adoption in different parts of the system.

Before introducing further aspects of the study, it is important to more closely examine what is meant by substructural rates of change. Two points will be mentioned. First, cumulative changes in a system in a diffusion criterion variable can be plotted over time. Over a sufficient period of time this procedure generally yields an S-shaped curve (Rogers with Shoemaker, 1971). Second, the S shape of a curve

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and its relative steepness are assumed under the "classical" model to be influenced primarily by patterns of social interaction in the system. Rogers (1962:154) states: "individuals in a social system who have adopted an innovation influence those who have not yet adopted. Adoption of a new idea is a product of human interaction."*

Social structures are of course patterns of action and interaction. To the extent that substructures or categories in an overall social structure are sociologically "meaningful", there should be discontinuities in the patterns of action and interaction. Furthermore, social interaction is assumed to be the primary influence on the S shape of the curve and its relative steepness.

These considerations suggest that substructural rates of change in diffusion criteria are likely to differ within the same system over given periods of time. (We shall review the research findings that relate to this question in the next chapter). What is being

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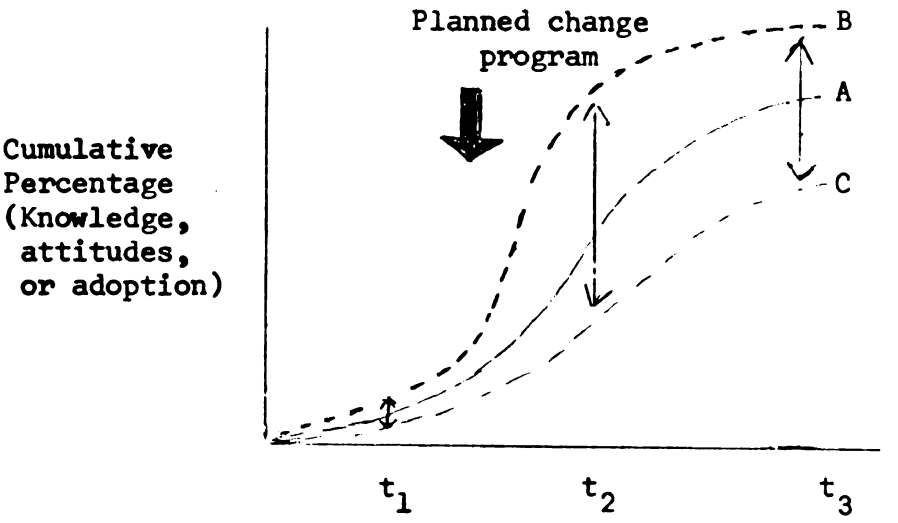
This conclusion is based on a survey of empirical findings. Carlson (1965) makes much the same point logically. He argues that if adoption of innovations were an individual process, the number of adoptors in any time period would remain a fixed percentage of those not yet adopted. Non-interpersonal factors such as the mass media might have an influence, but most often their function is not strongly affective on innovation-decisions. Thus, potential adoptors would be influenced at a fairly constant rate.

suggested here can perhaps best be represented graphically.



A = Rate of change in social system

B = Rate of change in substructure S_1

C = Rate of change in substructure S_2

↕ = Response gaps

Figure 1 Illustration of Substructural Rates of Change and Criterion Gaps.

Figure 1 depicts hypothetical rates of change in an overall system (A), and in two substructures (B & C). The substructures might be defined by different levels of education, farm size, etc., although not necessarily restricted to two levels. Criterion gaps are shown at t1, t2, and t3.

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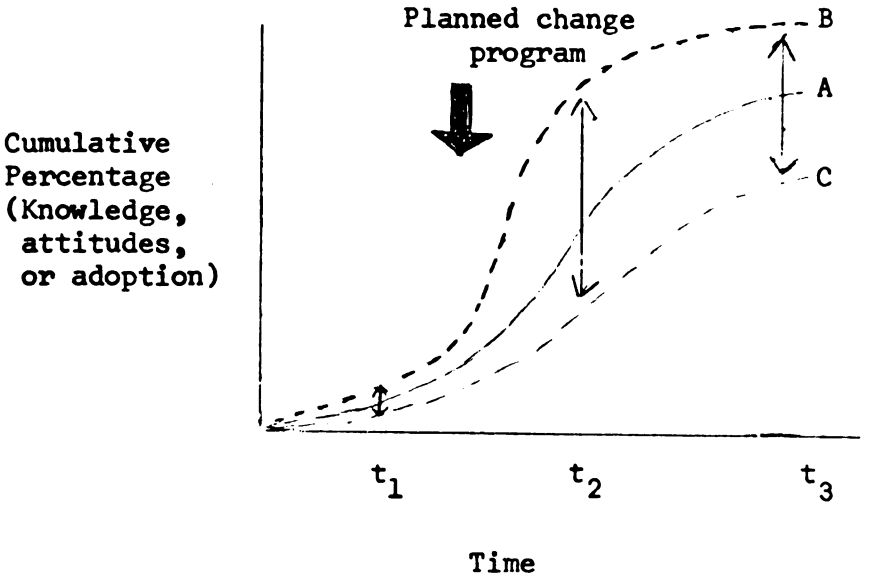

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In the situation where gaps are observed to widen over time,

the discontinuities in information and influence flows are probably rather sharp. The patterns of communication would be almost exclusively homophilous, rather than heterophilous.* Where gaps are observed to narrow over time, however, there should be relatively more heterophilous communication than when the gaps are observed to further widen.

Since communication patterns most often do tend to be homophilous, a structural prerequisite for the diffusion of innovations is the existence of some heterophilous relationships (Rogers and Bhowmik, 1971). Liu and Duff (1972) support this proposition in a study which points to the importance of "strategic" interpersonal links across subgroup boundaries. It would appear to be through such links that new ideas are passed on between substructures to decrease gaps over time. Thus, diffusion programs that are relatively more successful than others should have: (a) more "strategic" links, or activation of them, and (b) gaps which decrease over time through the interpersonal communication of information and influence to different parts of the system. A fundamental assumption in diffusion theory is that interpersonal channels have different but potentially complementary roles to play in spreading new ideas (Rogers with Shoemaker, 1971). New ideas entering a system via the mass media or external contact may be

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*Homophily is the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, values, education, social status and the like. Heterophily is the degree to which pairs of individuals who interact are different in certain attributes (Rogers with Shoemaker, 1971:210).

initially accepted in certain segments only; but over time information and influence interpersonally transmitted may lead to wider acceptance in other segments.

An examination of networks of interpersonal relationships in a social system should enable the identification of communication role occupants who appear to serve strategic linking functions between substructures. The persent study does not attempt to identify such "strategic linkers", since sociometric nominations among the respondents were not available. This particular implication of differences in substructural rates of change is an important one, however, and a subject we shall raise again under the heading of "liaisonness" in the final chapter.

For there to be social change implications of different substructural rates of adoption, it was earlier assumed that adoption would need to be evidenced as leading to structural changes. Thus, different parts of the analysis will employ structural variables as dependent or independent variables. They will obviously be independent variables in defining different types of substructures; they will be dependent variables in a causal analysis of adoption of innovations leading over time to structural changes.

So essentially, the principal objectives of the study are to explore the following interrelated concerns within the context of a diffusion of innovations program:

(1) substructural rates of adoption and knowledge of innovations, particularly whether criterion gaps decrease or increase.

(2) structural changes as consequences of adoption.

(3) social change implications of substructural rates of adoption.

The third objective involves a consideration of findings analyzed in connection with both the first and second objectives.

Reanalysis of panel data will be carried out. Respondents were 192 Indian villagers; each was interviewed once before and twice after a diffusion of innovations program.

Some qualifications in the way structure will be operationally defined should be noted. Historically, communication researchers have tended to neglect structural variables and their relationships and interdependencies with other variables in the communication process. This is perhaps a reflection of the so-called "psychological bias" in much communication research, where the units of analysis have tended to be individuals rather than relationships between them or groups of individuals (Rogers, 1973a). However, a growing number of studies in recent years has emphasized relationships in terms of "who talks to whom"; that is, they have described the communication structure in which communication relationships are the units of analysis. The correlates of communication structure are often found not to be only the conventional social structural indicators, such as power, wealth, education, etc., they are also found to be numerous and rather less conventional "structural" variables.* People talk mainly with

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*Less conventional variables in the present study include: average size of plots owned and farmed, functional literacy and amount of contact with change agents.

people like themselves; these homophilous relationships and the individual "social" positions are often best defined by less conventional, as well as more conventional, social structural criteria. For these communication-related reasons, social position and social structure are interpreted broadly in the present study. Variables used at the operational level as potential definers of individual positions include those which are likely to be meaninfgul discriminators of homophilous and heterophilous patterns of relationships. Sociodemographic indicators and several less conventional "structural" variables are included at the operational level under the heading of structural variables. They do appear to be variables for which discontinuities in information and influence flow may be observed; therefore, they do function as potential discriminators of the communication-related social positions in which we are primarily interested in the present study.

The discussion so far has served to define key terms and point the study in certain directions. We shall want to make refinements to this introductory analysis in the next chapter after reviewing relevant research and theory. Before doing so, however, it is as well to outline some background thoughts and biases the investigator brings to the exploratory analysis. These concern the question of observed social inequalities, particularly with respect to the role of planned change in developing communities.

Social Inequalities

A social system is a collectivity of units functionally differentiated but sharing more or less a common core of values. The question of the necessity for this functional differentiation has been actively debated by social scientists.

The well-known Davis and Moore (in Bendix and Lipset, 1966) argument holds that inequalities in wealth and various correlates such as education, prestige, appearance, responsibility, power and so on, serve an essential function in society. If all social positions were equally important and required equal abilities, it would make little difference which persons filled a position. This is clearly not the case, so rewards and incentives need to be differentially "built into" positions. "Social inequality is thus an unconsciously evolved device by which societies insure that the most important positions are conscientiously filled by the more qualified persons."

Critics of social inequality rarely argue for complete equality.* Rather, they often argue against the necessity for maintaining extremes of inequality. Tumin (in Bandix and Lipset, 1966) notes that a basic feature maintaining inequalities is that privilege is inherited, regardless of ability. Homans (1967) argues that power is maintained through the artificially preserved scarcity of resources. Thus, privilege is inherited or artificially created and maitained, and so social importance is entirely relative.

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*Including Marx.

There has been an increasing number of criticisms against the Davis and Moore thesis that we shall not detail here.** The point is that there seems to be less basis in any functional necessity for social inequalities, quite apart from a string of moral questions that relate to the issues.

Our concern is not with moral issues, but with the role of social and behavioral sciences with respect to the question of growing inequalities--particularly in terms of possible redistributions of income, agricultural production, education, knowledge and so on, within the development context.

Until recently, most change programs in developing countries were designed to improve overall levels of development in a target social system. A major objective was to increase average levels of income, agricultural production, education, etc., for members of the system as a whole. This is the so-called "first dimension of development".*

In the last few years there has been a belated recognition that such development activities rarely benefited those for whom the assistance was most needed, the members of relatively "less-advantaged" segments. Statistics computed across all members of a social system

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**See, for example, a review by Anderson (1971).

*An excellent discussion of first and second dimensions of development can be found in Rogers and Danziger (1974). The authors also strongly point to the significance which studies such as the present one should have within the context of the "second dimension".

may be misleading, in that an unintended outcome of raising average levels of various development criteria may be to exacerbate the existing differences that separate "more-advantaged" and "less-advantaged" segments. These types of questions have forced a growing concern with what has come to be termed the "second dimension of development". This involves change programs being designed to play a redistributive role in the target system with respect to income, agricultural production, education, knowledge, and so on. This second dimension obviously calls for researchers to focus increased attention upon what we have termed substructures as the units of analysis, and to investigate in much greater detail the conditions under which various substructural criterion gaps tend to widen further or narrow.

The key concept in the present study is communication, the communication of new ideas and their acceptance as part of a planned change program. But we know that communication is non-random; it tends to be fairly regularly patterned among the members of a social system. It seems important, therefore, for communication scientists to study whether well-intentioned programs to introduce new ideas might not also serve to further differentiate, maintain, or lessen pre-existing social inequalities.

CHAPTER II

RELATED RESEARCH AND CONCEPTUAL FRAMEWORK

From an overview of the intended directions to be taken in this study we now move to brief reviews in each of several areas of research. Each area bears a relationship to the study objectives; yet, in several cases it is only the underlying assumptions or approaches that are of concern to us here rather than the substantive findings. Empirical results in the two or three areas that bear most directly on the sorts of questions to be investigated will be examined: for example, the "knowledge gap" research, and diffusion research on substructural rates of change. Finally, an attempt will be made to integrate diverse theory and research within a conceptual framework to guide the later analysis.

Planned Change

Since our context is planned change and our model is the classical diffusion of innovations model, it is important to assess the relationship of model to context; in particular, how does the specific type of diffusion program to be examined in the present study relate to other conceptions of planned change?

According to Bennis (1969:65), "The process of planned change involves a change agent, a client system, and the collaborative attempt to apply valid knowledge to the client's problems." The degree

of "collaboration" and the degree to which "validity" is defined exogenously by a change agency, would seem to be matters of the amount of "directedness" in planned change programs.

Esman (1972) has presented the following classification of change processes (see Figure 2). His definition of guidance change (No. 5) closely approximates Bennis'

Change Process	Directed (D) or Non-Directed (ND)	Environment Permissive (P) or Manipulated (M)
1. Evolutionary	ND	P
2. Revolutionary	D or ND	M
3. Dialectical	ND	P
4. Coercive	D	M
5. Guidance	D	P

Figure 2. Esman's classification of types of change.

definition of planned change, although Esman further specifies the type of guidance change he is concerned with in an institution-building model of planned change.

Guidance change and Bennis' planned change take place within a "permissive environment." Esman's permissive environment" appears to closely parallel the type of environment implied in the diffusion model's "optional" type of innovation-decisions for individuals. Thus, as far as Esman's classification scheme is concerned, further distinctions between Esman's and Rogers' conceptions in relation to planned change would seem to be associated with the dimension of directedness."

Zaltman, Pinson, and Anglemar (1973: Chapter 8) have made a useful contribution in this regard. They have developed the concept of "control" in terms of planned change, in part, as follows:

> The sense in which we intend to use "control" here has been best expressed by Skinner: "When we discover an independent variable which can be controlled, we discover a means for controlling the behavior which is a function of it." Note that Skinner uses the concept of control twice: once in reference to the independent variable and once in reference to the dependent variable. Essential to this use of control is the idea of an intervention in the environment--that is, the creation of change (p. 174).

Zaltman and his colleagues elaborate their analysis in a "metatheory of control" in relation to marketing practices. The implications of interest to us here are, firstly, that approaches toward planned change involve at least two steps: (1) strategies are selected that are more or less well capable of being controlled, and (2) those strategies in turn may be more or less controlling of the dependent variables of interest in the change program. A second implication is simply that planned change programs can be thought as varying in type according to whether they are relatively controlling or uncontrolling, or intervening or nonintervening.

Certainly planned change models do seem to vary in this regard. The change management model of Kaufman (1972) assumes the change processes can be controlled at each of the following steps: analyzing, planning, administering, implementing, auditing and evaluating. Kotler and Zaltman's (1971) "social marketing" model has slightly less emphasis on control because the "core idea in marketing lies in the

exchange process"; active rather than passive receivers seek needs fulfillment.*

In these and a number of other planned change models what one can control is more than the independent variables usually associated with communication and diffusion processes. Kotler and Zaltman put it this way: "social marketing is a much larger idea than social advertising or even social communication."

Rogers' (1973b) innovation-process model makes the same point perhaps even more clearly, although the model itself resembles Havelock's (1969) R, D & D model** rather than the models of Kaufman or Kotler and Zaltman. The innovation process is conceived as a series of stages. A need for information or problem solution exists; invention takes place; it is developed into more readily usable forms; now called an "innovation", it is diffused to the social system members who adopt or reject it; various direct or indirect effects or consequences follow.

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*Social marketing employs the principles of marketing to further social causes and issues. It "is the design, implementation, and control of programs calculated to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research." (Kotler and Zaltman, 1971).

**Research, Development, and Dissemination.

The fundamental importance of the communication-diffusion process is still recognized by the above writers. However, the more encompassing models take a longer-term view of change processes; and, in terms of our earlier discussion, they postulate additional control factors that may ultimately influence the S-shape and relative steepness of the diffusion curve.

An example of this point is the use of segmentation techniques. Kaufman's model, for one, makes use of "target segmentation": the development and pursuit of different change programs by the change agency for essentially the same objectives but for different components of the target system. Clearly this is a recognition of different substructural rates of change in such diffusion program criteria as knowledge or adoption. Therefore, a change program which has employed relatively <u>few</u> controlling features, particularly of this type, lends itself extremely well to an analysis of those more purely "naturalistic" social influence processes which are at work. Esman (1972) speaks of "autonomous diffusion." This is, of course, a contradiction in terms if diffusion is regarded as a <u>social</u> influence process. But it points up that diffusion in planned change can be controlled to greater or lesser extents.

Control features in the classical diffusion of innovations model include: use of the mass media to create awareness, change agent contact with opinion leaders to obtain legitimation, timing of various change agent activities, combined mass media and interpersonal channels by way of media forums, etc. It is the last point only, the use of

media forums, which was the principal control feature of the change program in the present study.

Media forums are organized small groups of individuals who meet regularly to receive a mass media program and discuss its contents. The forums are designed to act as radiating points for the diffusion of information and influence to other members of the system, and to minimize the use of scarce change-agent resources in achieving the spread of innovations. The control features on the change process are minimal.

This has important implications; for what occurs in the way of widening or closing gaps in such "minimal" and "naturalistic" situations can perhaps be controlled for in the Skinnerian sense of the term in future planned change programs.

The Social Origins of Information Needs and Uses

Change programs that incorporate marketing concepts often employ a segmentation strategy. An assumption underlying the strategy is that potential adopters in a social system differ either in their own characteristics or in the nature of their environment in such a way that the probability of their adopting also varies. Different segments are likely to have different needs and uses, and to have different rates of adoption for the same innovations (cf. Engel, Fiorillo, and Cayley, 1972).

The several primary groups with which a potential adopter interacts serve to shape his values, sanction his behavior, define his roles, and generally "mediate" the likelihood of the types of messages he receives and sends (Riley and Riley, 1972). What information is perceived by the individual to be needed and useful to adapt in an environment is largely a function of the person and his environment. These notions are reflected in many writings; particularly, for example, in the Lewinian concepts of life space and social field (1963).

The topic of social origins of needs and uses for information could lead us far afield: for example, social perception, value systems, stratification principles, the sociology of knowledge, categorization processes, etc. Instead, we shall very briefly examine two research areas.

Uses and Gratifications. In mass communication research, there has been a resurgence of interest in questions of why people seek information from the mass media--what uses do they have and what needs are fulfilled? The research shows that "almost any type of content may serve practically any type of function" (Rosengren and Windhall, 1972). Although this is hardly surprising, there do seem to be definite clustering effects of needs and attempts to fulfill them on the basis of situational and sociological differentiating criteria (Blumler, Brown, and McQuail, 1970).

Selective Exposure. Again in mass communication research, informational needs and uses seem to be influenced by situational and demographic factors, as well as individual factors. The selective exposure

proposition has been widely debated and researched, that people seek and prefer information which supports their views and avoid information contrary to their views. A review of laboratory research on the proposition reports no convincing evidence of a psychological basis to account for the repeated field-study observations of selectivity. Instead, Sears and Freedman (1967) suggest that informational needs and uses are largely a function of situational and socio-demographic factors--especially education and social class. These act as informational environment parameters, so that an individual exposed to supportive information is acting in accordance with common interests and uniformities and what information is available in his locale, rather than from a strong desire only for information that supports his views. On the other hand, Atkin (1970) has reanalyzed data to show that Sears and Freedman themselves were selective in their interpretation of the findings; the original proposition should not be discarded.

Lewin probably would comment, and Atkin (1974) recently has, that it is likely that both personal and social factors are important with respect to what information is deemed to be needed and useful. A recent review by Schramm (1973) concludes that much more needs to be found out about selective processes in general, including selective perception and recall, as well as exposure.

Rogers and Shoemaker (1971:106) point out that it is difficult to be sure whether a need (say, to seek solutions to a problem) precedes an innovation-message, or whether an innovation-message creates

the need. Either way, it is assumed in the present study that: individual differences and dispositions are still likely to show considerable variation within structural constraints, but such constraints (reflected in sociodemographic variables) can be conceived as parameters making for certain degrees of homogeneity of informational needs and uses.

The Knowledge Gap Research

A principal consequence of mass media coverage of public-affairs and science information appears to be an increasing "knowledge gap" between social strata. This hypothesis aroused considerable attention among mass communication researchers when first proposed by Tichenor, Donohue and Olien (1970). It stated:

> As the infusion of mass media information into a social system increases, segments of the population with high socioeconomic status tend to acquire this information at a faster rate than the lower status segments, so that the gap in knowledge between the segments tends to increase rather than decrease.

The authors of the hypothesis offered several independent pieces of evidence in support. In each case, what we have termed substructures were defined solely by level of education. First, national opinion poll data showed gaps over twenty years between high and low education categories on three topics that had been increasingly covered in the mass media. The findings on one of these topics are shown in Figure 3; the other topics were the identification of earth satellites, and the association between cigarette smoking and lung cancer.

Second, findings from two field studies were examined. High- and low-education respondents in a community with a newspaper strike were more similar in knowledge levels than their counterparts in a non-strike community; and, there were greater differences between high and low subgroups in a social system for topics which had been given relatively more publicity.

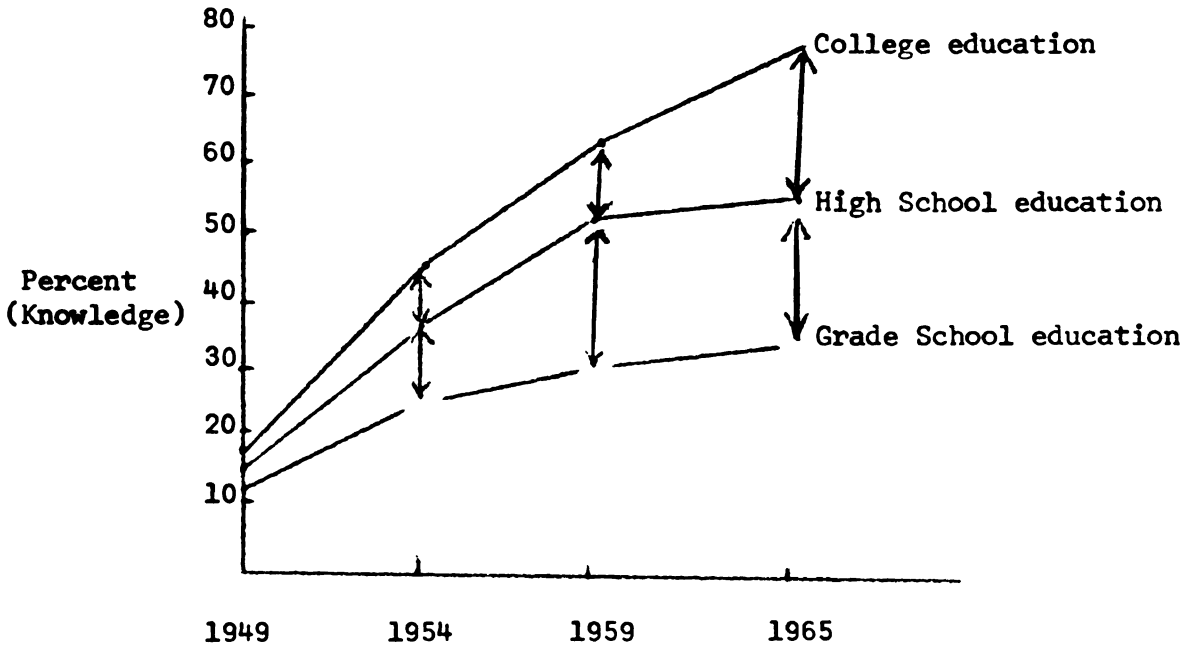


Figure 3. Percent of Respondents in National Surveys Stating Belief that Man will Reach Moon, by Education and Year.
(Source: Tichenor et al., 1970)

Tichenor and his colleagues point out certain limitations: the findings might only apply to print media, and to public-affairs and science topics. We might add that none of the supporting evidence represents a definitive test. However, other studies report findings

for different media and for substructures defined by different criteria. Each lends support to the hypothesis, although the specific propositions tested vary to some extent.

McNelly and Molina (1972) report knowledge gaps in Lima, Peru, for "international affairs" information associated with media usage patterns for most mass media, but particularly print media. The differences were observed between two levels of socioeconomic status indexed by occupational prestige, area of dwelling, income, and education. An Indian study by Sinha and Mehta (1972) found that those high on need-achievement and "change proneness" gained more information about televised agricultural programs than low scorers on the same variables. Bogantz and Ball (1971) and Springle (1972) examined learning patterns from television's Sesame Street, and Williams and Evans (1969) investigated the effectiveness of Head Start education programs. Both Sesame Street and Head Start were designed to benefit comparatively less-advanced children, but in both cases middle-class children gained more information over time.

The studies support a trend of widening gaps, in some cases from cross-sectional data gathered at one point in time with inferences about earlier levels of knowledge. Perhaps more important in our diffusion of innovations context is that the mass media/interpersonal interface is neglected at conceptual and empirical levels.

It is interesting to note, however, that the original authors of the hypothesis recently have: (1) given implicit recognition to the importance of interpersonal communication processes, and (2) reported

findings on knowledge gaps that tend to narrow rather than widen.

In a paper subtitled "An Hypothesis Reconsidered", Donohue, Tichenor and Olien (1974) analyze survey data from fifteen Minnesota communities to provide support for a modified knowledge gap hypothesis. Their major intervening variable becomes the level of conflict among the members of a social system about particular issues. An issue which generates more conflict increases salience, and more individuals in low-education segments are aroused to acquire information about the issue; thus, gaps tend to be reduced. Where an issue generates little conflict gaps are less likely to be reduced over time.

The authors do note that interpersonal communication processes intervene, but the major interpretation given the findings is via the variable, level of conflict. In any event, the diffusion theoretic perspective of wider patterns of interpersonal communication leading to reduce gaps is quite compatible with the arguments of the revised hypothesis.

Indeed, the compatibility is even greater if it is agreed that diffusion research has most often been conducted in relatively less pluralistic and more homogenous social systems (e.g. among farmers, medical practitioners, etc.). Donohue, Tichenor and Olien (1974) suggest the following:

> In a more homogeneous community, such as the small, traditional rural service center, there are fewer specialized media of communication and more dependency upon common, informal communication patterns. There is, consequently a greater likelihood that in such a community, the "whole town will talk" about a topic of basic concern. Such universal discussion

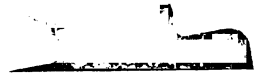
> would, theoretically, tend to equalize information flow across status lines and narrow the knowledge gap.

Diffusion Research on Substructural Rates of Change

The remarks in the above quotation seem quite logical, yet even in communities which we might regard as fairly homogeneous there are likely to be substructural criterion gaps for knowledge and adoption.

Kivlin and Fliegel (1968), for example, found important differences in rates of adoption within rural communities. Subsamples of dairy farmers in Pennsylvania were contrasted according to farm size. Small farmers (those with less than sixteen milk cows) were slower to adopt agricultural innovations than were the larger farmers (sixteen to forty-nine cows). Individual perceptions of the attributes of the innovations were quite different; they accounted for sixty-nine percent of the variance in rates of adoption for the small farmers, and fifty-one percent for the larger farmers. The small farmers were quicker to adopt those innovations they perceived as decreasing discomfort, whereas the larger farmers had faster rates of adoption for innovations perceived as economically profitable.

Graham (1956) categorized a sample of New Haven, Connecticut, families into six social classes based on occupation. He found substantial differences in the rates of adoption between classes for canasta and television. The game of canasta was accepted by seventy-two percent of the upper class but only twelve percent of the lower



class; television was accepted by seventy-two percent of the lower class but only twenty-four percent of the upper class. Different recreational values and the compatibility of the innovations with those values were found to explain the different patterns of adoption.

In the above two studies substructures were defined in terms of status criteria--farm size, and social class. As noted earlier, structural positions can also be differentiated in terms of function or role criteria. On this basis, numerous substructural criterion gaps in adoption have been documented in the diffusion literature, particularly with respect to opinion leadership.

An investigation of the diffusion of a new drug among medical practitioners by Coleman, Katz and Menzel (1966) is one of the most detailed studies available on sociometric opinion leadership. Figure 4 indicates that observed adoption gaps between those high and low on

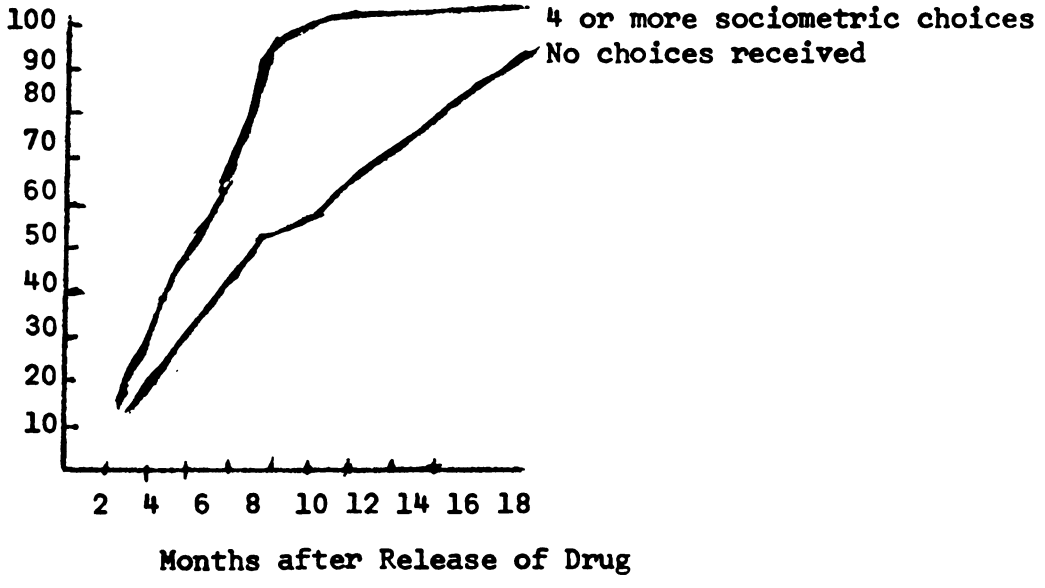


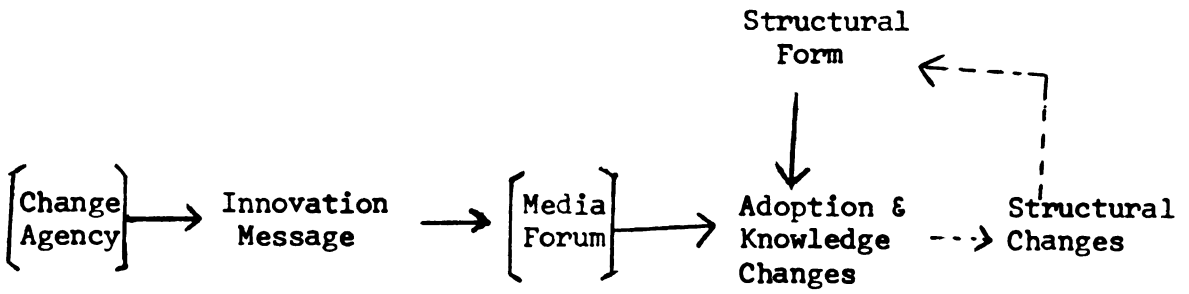
Figure 4 Percent Adopters of Drug by Opinion Leadership and Time
(Source: Coleman, Katz, and Menzel, 1966:84)

opinion leadership appear to widen at first and then later close.

The status-related differences in adoption in the Kivlin and Fleigel, and Graham studies do not tell us whether gaps observed at one point in time tend to widen or close. The differences reported at one point in time are of interest in our present context. But of greater interest would be some indication of the across-time patterns in the observed within-time differences.

Conceptual Framework

The principal change processes, and the interdependencies between diffusion criteria and structure, in which we are interested can be represented as follows:



The main variables are:

1. The nature of the innovation messages. Particularly the extent to which they engage the needs and concerns of system members. These are assumed to be independent variables in the larger process.
2. The structural form of the system; particularly its

differentiation with respect to substructures and, thus, the relationships among the members as relatively homophilous or heterophilous on specific variables. The structural form is assumed to be (a) an intervening variable in the larger process, (b) an independent variable where innovation messages are taken as "given", and (c) a possible dependent variable, which is assumed to be relatively stable but which may alter in the long-term.

3. Changes in adoption and knowledge of innovations are dependent variables. Adoption may also be an independent variable for certain innovations and lead over time to structural changes.
4. Structural changes are dependent variables in the process, for certain innovations. However, they may in turn lead toward an alteration in the structural form of the system.

The knowledge gap hypothesis originally held that one effect of mass communication is to further widen existing gaps in knowledge between categories of receivers high and low in education. The present conceptual scheme assumes that: (1) adoption of new ideas as well as knowledge, is a legitimate and important variable for which substructural rates of change may be observed; (2) numerous sociodemographic variables may serve to define a number of substructures, as well as only those specifically related to education; and

(3) interpersonal information and influence channels carry messages about new ideas, as well as mass media channels.

The last mentioned point has been partially taken into account in a recently modified version of the knowledge gap hypothesis. This brings the hypothesis a step closer to diffusion theory. Both Tichenor and the knowledge gap researchers, and Rogers and other diffusion researchers, hold that selective processes have important initial effects upon the distribution of new ideas introduced into a social system. In underscoring the importance of interpersonal channels, diffusion researchers have also implied that criterion gaps are likely to be reduced over time as information and influence are more widely diffused--largely via opinion leaders, or "strategic" linkers (Liu and Duff, 1972). The modified gap hypothesis still gives emphasis to widening gaps, but also now suggests that they may narrow over time as more conflict is generated and levels of interpersonal communication increase.

Thus, the across-time pattern depicted in Figure 5 is assumed to be a reasonable working hypothesis for our exploratory analysis. Substructural criterion gaps are hypothesized initially to widen because of selective processes, and to later show closing tendencies as more people learn about and are influenced by others to adopt the innovation.

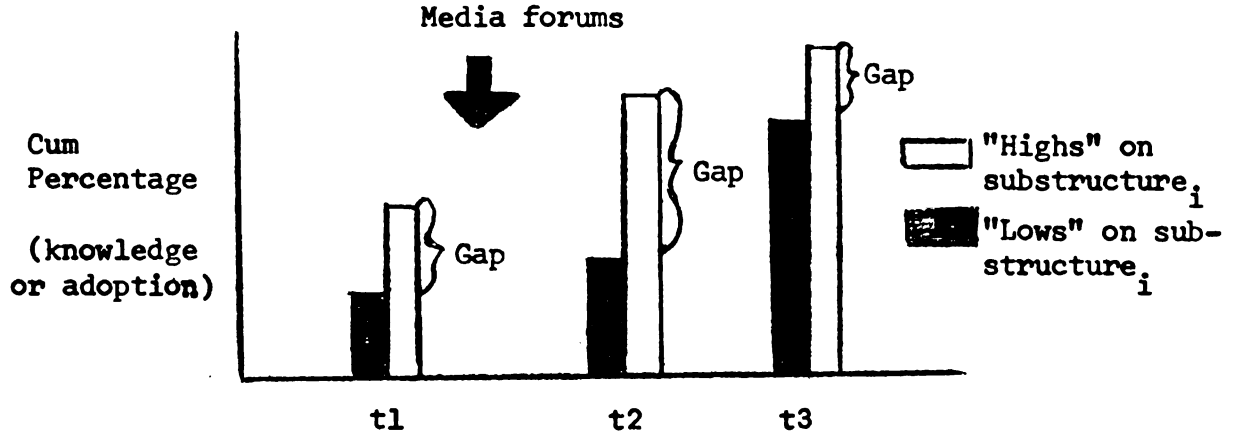


Figure 5. Representation of Across-Time Changes Expected in Substructural Criterion Gaps.

Two points should be noted. First, little is known about what constitutes a "sufficient" period of time for narrowing tendencies to be observed. Presumably this depends upon numerous factors such as the innovation, the system, etc. Secondly, cross-sectional findings often show low or only moderate correlations for knowledge and adoption (Rogers and Shoemaker, 1971:108). Nonetheless, we have little to go by in the way of relevant theory or research to suggest that the two types of substructural criterion gaps should behave differently. They may well do so, but in the absence of arguments otherwise we shall not further specify the above general hypothesis.

Finally, structural changes are likely to be found more for certain sorts of variables than others. For example, adoption of certain innovations may lead to increased social participation or agricultural productivity, but changes in farm size seem a less

likely consequence within the period of a few years. Apart from such common-sense expectations, the analysis of structural changes will also be exploratory in nature.

CHAPTER III

METHODOLOGY

Source of Data

The data to be used in the present study were obtained in connection with communication field experiments conducted in eight villages near Lucknow, India, beginning in 1964. The research project was initiated by UNESCO and carried out by the National Institute of Community Development, Hyderabad, in conjunction with the Department of Communication at Michigan State University.

A benchmark survey was taken in mid 1964. Communication treatments were applied between October, 1964, and March, 1965. Two resurveys were then conducted in May and June, 1966, and in October, 1967.

The objectives were to assess the impact of three communication treatments: two types of media forums via radio broadcasts and literary classes, and an "animation" treatment (a form of leadership training). The topics introduced for discussion by forum participants centered on various agricultural and health practices. It was expected that this information might then be diffused to non-participants and thereby influence overall rates of knowledge gain and adoption.

Of the eight villages, two were "radio forum" villages, two were "literary reading forum" villages, two were "animation" villages,

and two were "control" villages in which there were no treatments.

Because there were negligible differences in adoption figures between the 1964 benchmark and the 1966 resurvey in the animation villages these were dropped from the sample in 1967. The 1967 resurvey comprised the maximum number of heads-of-household cultivators in the remaining six villages who were interviewed in both 1964 and 1966. The resulting sample was 279 respondents, all males who cultivated some land in 1966.

Details on the background to the UNESCO-NICD project, selection of villages, treatment specifics, etc., are reported in Roy, Waisenan and Rogers (1969), and in Kivlin, Roy, Fleigel and Sen (1968).

The project as a whole was designed for comparative assessment of the different types of treatments. Roy and others analyzed the findings for adoption and knowledge gains between 1964 and 1966; Kivlin and others carried out a similar analysis, but included the 1967 data and the reduced sample which did not include the animation treatment. Kivlin and his coleagues conclude as follows:

> We found that one of the communication treatments, radio farm forums, was considerably more effective than the other treatment, adult literacy classes. Both sets of communication treatment villages tended to show more change than the control villages, in which only the usual community development programs were undertaken (p. 48; italics added).

Roy and others also had concluded that the radio forums were superior to the literacy reading forums, but that both were superior to the control conditions.

The Study Population

Numbers of respondents in each village who were interviewed at all three points in time were as follows:

Village	Treatment	N
Bhuhar	Radio forum	41
Atrauli	Radio forum	38
Barawan Khurd	Literacy reading forum	83
Sikandarpur Khurd	Literacy reading forum	30
		192
Bahadurpur	Control	49
Karimabad	Control	38
		87

Total N = 279

Since our present concern is with the intra-system effects of change programs, rather than the comparative analysis of different treatments, our study population N is the 192 respondents who had been members of a treatment village.

An interest is still retained in the 87 control village respondents, although they are not included in the main study population for the following reason. If field experimental results already demonstrate higher rates of adoption for treatment versus control systems, and if it is shown that adoption does lead to structural changes, then it is reasonable to suggest that observations of structural changes within the treatment system are effects at least partially attributable to the change program. The next chapter will briefly present findings for differences in adoption and knowledge between the 192 treatment villagers and the 87 control villagers.

However, for details on the comparative findings the reader is referred to Roy and others (1969), and Kivlin and others (1968).

Selection of Variables

A major concern in selecting variables was the aspect of achieving comparability across time. Variables which suited the conceptual framework were preferred when they had been measured at all three time periods. In some instances this was less important; for example, caste membership and caste rankings change little over time in India. In other cases certain variables were not included that probably would have otherwise been so. For example, more details were obtained and additional measures taken in 1966 than in other time periods on media-related behavior and sources of information decisions. At certain time periods particular innovations were singled out for more intensive investigation, or indices similar in nearly all respects included an additional item or had a particular item deleted. In some cases, responses to the same questions were coded into more or less extensive categories. To achieve comparability, this meant recoding according to the least extensive category set for responses across all three time periods.

Such are the difficulties encountered in secondary analysis (Hyman, 1972). The data had been collected primarily for another purpose, to assess the impact of different communication treatments.

There are three main classes of variables in the present study: (1) knowledge and adoption of innovations, (2) structural variables, and (3) type of innovation.

Knowledge is confined here to mean simple awareness that an innovation exists. It does not refer to "how to" or "principles" knowledge of innovations (Rogers with Shoemaker, 1971: chapter 3). Adoption is the decision to make full use of a new idea.

Structural variables are those for which individual statuses or roles may be defined relative to other members of the social system. As already indicated, certain variables in the present study may be more socio-demographic in type than the classical definitions of structure might allow, for example, level of political knowledge. In any case, structural variables in the present study are ones on which persons can be meaningfully differentiated and categorized. Relationships among persons within such categories--substructures--are, by definition, homophilous on the variable(s) which define the category.

Selection of Innovations

Agricultural and health-related practices had been selected in 1964 on the basis of four major criteria: (1) applicability in all of the sample villages, (2) salience to both villagers and agencies of change, (3) suitability to be included in the communication treatments, and (4) existing adoption levels such that there was a potential for sizable increases by the end of the experiment. A final number of ten agricultural and seven health-related innovations were included in indices of adoption and knowledge, after they had survived Gutman scaling and internal consistency correlational analysis.

All innovations from 1964 were included again in the follow-up studies, with the exception of two items. Smokeless chula (stove) was dropped from the health list because of near zero adoption levels. And

family planning was treated in different ways across the time periods.

In 1964, family planning was one of the health innovations and therefore an item in the health adoption and health knowledge indices. In 1966 and 1967 family planning was singled out for closer investigation. Questions about knowledge and adoption were asked with respect to ten specified methods of family planning, in addition to the more general treatment in 1964 of knowledge about the concept and adoption of any method. Separate knowledge and adoption indices for the ten specific methods were computed in 1966 and 1967 only. Because of the lack of comparability and also low adoption rates for the specified-methods in indices,* family planning in the present study was treated as it had been in the 1964 benchmark survey--as a health innovation. Innovations included in the study are listed below.

Agriculture

Japanese method of paddy cultivation
Line-sowing of wheat
Improved potato seed
Green manure
Ammonium sulphate
Insecticides
Modern plough
Tine cultivator
Animal disease innoculation
Superphosphate

Health

PRAI latrine (Planned Research and Action Institute)
Bed-bug killer
Modern child-birth practices
Typhoid and cholera innoculation
Family planning

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*Zero percent in 1966, and 7 percent in 1967.

Most of the practices are self-evident. The Japanese method of paddy cultivation is actually a package of practices including improved seed, seed treatment, land preparation, etc. Green manure means the growing of a leafy crop to plough back into the soil to improve soil health. The PRAI latrine is a locally constructed water-seal latrine with an underground septic tank. Modern child-birth practices refer to attendance at birth either at home or in hospital by a trained midwife or doctor. And, as stated, family planning refers to any method of birth control, including indigenous methods such as withdrawal.

Operationalization of the Variables

Knowledge and Adoption Variables

Measures on all knowledge and adoption variables were obtained for all three points in time.

Knowledge of each innovation was scored dichotomously; the respondent reported that he had either heard of the innovation or not.

Adoption of each innovation was treated in a similar manner. Each respondent was asked, "Do you use it (the innovation) now?" It was thus possible for a respondent to have previously adopted but later decided to discontinue use of an innovation.

Agricultural adoption is an index comprised of the simple sum of 0-1 scores of adoption of each of the ten agricultural innovations. Its range is 0-10.

Agricultural knowledge is an index computed in a similar way to

agricultural adoption. Knowledge score for each of the ten agriculture innovations were summed to give an index range of 0-10.

Health adoption and health knowledge indices were computed in an identical manner to the above two indices, except that they referred to the five health innovations. Scores could range from 0-5.

Structural Variables

As already stated, variables were preferred in the selection process for which there were comparable measures across all three points in time. Of the 35 structural variables in the analysis, the following 10 had measures at each of the three time points.

Education, age, size of family, and joint family are fairly self-evident variables. Education was coded 0 through 12 years of schooling.

Social participation was an index based on six items. Respondents were asked whether they or any persons in their household were members or office-holders in the following: cooperative society, panchayat, youth club, night school, women's club, and defense force. Membership in each was coded as a 1 and office-holding as a 2. Non-membership and no answers were coded as zero. The index was summed to range from 0 to 12.

Change agent knowledge indexed the extent of familiarity with ten change agents, such as the village level worker, midwife, agricultural change agent, and teacher. Responses were scored 2 for ability to name each change agent, 1 for knowing the agent but not his name, and zero for not knowing the agent or no answer. The ten items were

summed to give an index range of 0-20.

Change agent contact was a similar index for the same change agents measuring frequency of communication contact. A response that indicated the respondent had not spoken with an agent in the past year was coded as zero; talking occasionally (1-10 times) was coded as 1, and frequently (more than 10) coded as 2. The ten items gave an index range of 0-20.

Political knowledge. Five questions (coded 0,1) comprised the index about national and local political office-holders.

Mass media exposure. Three comparable questions over the three time periods dealt with self reports on exposure to radio, newspapers and films. Never listen, read or view were zero codes. For radio, 1's were don't know/no answers, and 2's were positive responses that they did listen. Newspaper reading less than once per week was coded as a 1, and more frequently as a 2. One film seen in the past year was coded as a 1, and two or more as a 2. The three items were summed to give a 0-6 range.

Scores on functional literacy ranged from 0-7 for the number of words correctly read in a simple test.

The following 21 variables were measured only in 1964 and 1966. It seems convenient to classify them under the following headings.

Farm-Size and Productivity

Land area cultivated, Land area owned, amount of Irrigation, and Average size plots owned were all measured in bighas or tenths of

bighas. Number of plots was simply counted.

Value of Agricultural production in the past year was computed by assigning current values per maund to the products actually produced by the respondent, and summing to obtain a total value in rupees.

Farm specialization was the percentage degree of specialization in any one crop with the highest value, relative to all other crops produced by the respondent.

Livestock owned was an index reflecting number of livestock owned with appropriate weights for type of livestock.

Employer status was a simple dichotomous measure of whether the respondent employed any laborers.

Supplementary Income and Debt Status

Off-farm work (respondent), and Off-farm work (other family members) were measured by respondent reports on the number of days in the past year he or other family members had spent in outside work.

Type of off-farm work, and Place of off-farm work were asked with respect to the respondent's activities. The first variable was graded by occupational status from "agricultural labor" (code 1) to "professions" (code 7). Place of off-farm work ranged from "own village", to "other village", "Lucknow", and "other city".

Off-farm income (respondent), and Off-farm income (family) were measured in rupees over the past year for the respondent and the total family.

Total debt was the respondent's report of his debt situation in rupees.

Sociometric Variables*

Three variables were measured sociometrically by the following questions:

Opinion leadership--"If some pests attacked your wheat plants and you were uncertain what to do, which cultivator in your village would you talk with to help solve this problem?"

Prestige--"If there is a quarrel over crops being grazed by cattle in your village, whom would people in the village ask to settle this dispute?"

Functional leadership--"Suppose the village was asked to send three men to get a sanction from the ADO for constructing a tube well, whom would you nominate?"

Two other variables with measures in 1964 and 1966 only were Level of Living and Cosmopoliteness. Level of Living was a 0-12 index of possession on numbers of twelve items, such as a torch, bicycle, chair, water-well, woolen goods, etc. Also the interviewer's rating of the respondent's status (coded 0-1) was an item.

Cosmopoliteness, or urban contact, was indexed by five items in 1964 and three in 1966. Only two of these items were comparable: (a) the number of times in the past year the respondent had travelled to Lucknow, and (b) the distance of the furthest place travelled in the past year. Each item had 0-9 codes which were summed to construct the index.

Finally, the following caste membership rankings were obtained in 1966. The assignment of castes to ranks was carried out by local

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*Sociometric scores only for each respondent on these variables were available for the present study, not the actual nominations.

persons known to the Project officers to be especially knowledgeable about castes.

Inter-village caste ritual ranking had 25 ranks and was applicable to all 192 respondents.

Intra-village caste ritual ranking, caste economic ranking, and caste power ranking each had variable numbers of codes depending upon the distribution of castes in each village. Median splits were then made on each of the variables in order for them to be suitable for population-wide usage.

Missing data for some variables had already been coded in certain ways. In general, there were relatively few missing values, but when encountered the procedure was adopted of recoding them to the mean or median response depending upon the type of variable.

Data Analysis

There are three broad stages in the analysis. Each stage with its principal analytic technique is as follows:

(1) investigating across-time relationships between adoption and structural changes--Cross-lagged panel correlation

(2) defining relevant substructures--Configurational analysis

(3) examining changes over time in substructural criterion gaps--Descriptive statistics

In addition, multiple correlation techniques will be used, although not as an essential part of the analysis at any of the three stages.

Multiple Correlation

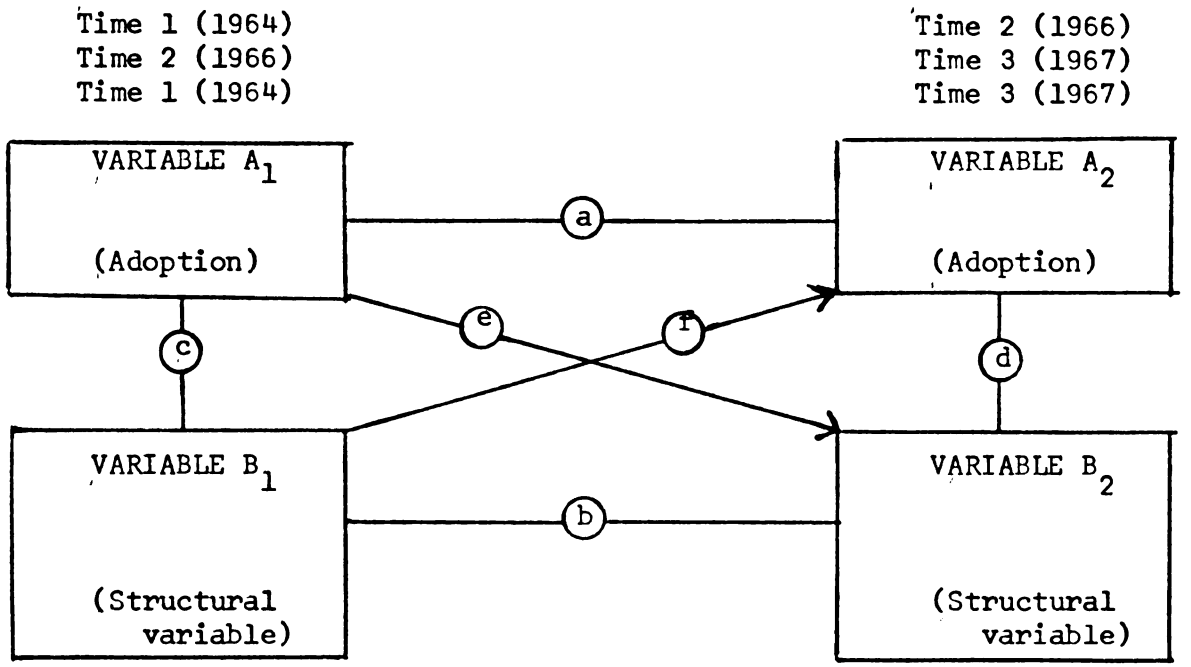
Least-squares delete multiple correlation analysis will be performed on the 1964 and 1966 data. All 35 structural variables will be examined as "within-time" predictors of variance in the four main indices, i.e. agricultural adoption and knowledge, health adoption and knowledge.

The objective is twofold. In the investigation of adoption leading across time to structural changes, the use of multiple correlation and the partial correlations will help to provide a sounder basis for any causal inferences we might wish to make. One variable may precede another in time, but they need to be functionally related. The use of a baseline which takes this into account will be described shortly, but multiple correlation gives a degree of additional surity about the associations. Secondly, least-squares delete multiple correlation is a procedure for selecting the "best" set of "within-time" predictor variables for a particular dependent variable. Having some idea of the best set of predictors will be helpful when we come to define substructures via configurational analysis.

Cross-Lagged Panel Correlation

The causal analysis about adoption leading to structural changes will be carried out using a recent technique pioneered by Rozelle and Campbell (1969). The general design for a two-variable and two-time panel study is illustrated below. The combinations of time periods that will be examined in the present study (where possible

according to the availability of measures on variables) are shown. The two correlations between variable A and B across time are of key



importance. To determine causality, the cross-lagged correlations (e and f) must be compared to a "no cause" baseline statistic that takes into account both the cross-sectional (c and d) and test-retest (a and b) associations that may spuriously produce sizable diagonal relationships. Conceptually, the bivariate correlations across time are compared to an average static correlation that is adjusted for unreliability due to temporal instability. This is the computational for the baseline statistic:

$$\text{Baseline} = \frac{c + d}{2} \times \sqrt{\frac{a}{r_A} \times \frac{b}{r_B}}$$

where r_A, r_B = geometric means (both time periods) of internal consistency component of reliability coefficient.

Causal influence from variable A to variable B can be tested by examining the extent to which the diagonal statistic e exceeds the baseline. Similarly, the reverse diagonal statistic f may be assessed against this base figure. When the diagonal correlation is greater than the baseline, the relationship meets the basic criteria for causality: association, functionality, and time-order. The relative contribution of each variable to the relationship can be inferred from the relative strength of the two diagonal correlations.

Configurational Analysis

From adoption as a predictor variable of structural changes we now move to adoption as a dependent variable. To define the substructures, we also need to move from across-time to within-time analysis. The dependent variables are the indices at t1 and at t2 of agricultural adoption and knowledge, and health adoption and knowledge. The independent variables are the 35 structural variables at t1 and at t2, whether they had or had not survived the least-squares delete procedures. Since a question of major interest is the tendency for gaps to widen or narrow, the t1 and t2 data only are subjected to configurational analysis in order to define the substructures.

For the intended type of analysis, there are certain advantages in configurational analysis over multiple correlation. The latter gives an indication of the best set of predictors for the entire sample, and therefore ones which are likely to show up in defining relatively homogeneous subgroups on a particular dependent variable.

Interactions are not taken into account directly in multiple correlation, however, whereas configurational analysis is primarily designed to detect interaction effects (Sonquist and Morgan, 1964). Furthermore, configurational analysis does not require assumptions about linearity, additivity or properly scaled variables.

From a set of independent variables, one is selected which maximally divides the variance in the sample according to a partition point in the codes of the independent variable which is optimal for the division. Each subsequent interaction then examines subgroups already defined, and does so in terms of all the independent variables (whether previously selected or not) in order to maximally partition the variance to form new subgroups. Each division occurs at the optimal split point in the codes of the independent variable selected at each stage.

In terms of the present study, these procedures would seem to provide the necessary empirical definitions of the set of substructures which relate to each of the four main criterion indices. This conclusion would be correct were it not for: (a) the relatively small N of 192, and (b) the fact that the criteria defining a substructure at t1, say, might be such that structural changes by t2 or t3 have reduced the substructure N considerably. Furthermore, not all the independent variables used to define the substructures were measured at t3.

The following guidelines were established to meet these problems:

(1) If a substructure is defined by a variable(s) which

does not have t3 measures on the variable(s), it is assumed to be defined on the same set of respondents as at t2. For example, land area cultivated might define substructures with a split point equal to and above 2.5 bighas vs. less than 2.5 bighas. The respondents who fall into these groups at t2 are assumed still to be members at t3.

(2) Substructures must have 30 or more members across all three time points.

(3) Where "best" splits are quite asymmetrical in numbers of respondents, either (a) the next best partition point in the codes of the same variable are chosen, or (b) another variable which is close to being the best one for that particular division is selected instead.

With these additional guidelines, configurational analysis is well suited to the task of defining substructures.

Descriptive Statistics

Means, percentages, frequencies, and percentage points in across-time changes, will be used to describe the findings concerning tendencies for gaps to widen or narrow.

The analysis could be carried out either in terms of gaps based on the adoption and knowledge indices, or a much larger number of gaps in adoption and knowledge based on specific innovations. Both

approaches will be used, and "findings" for each reported. Only the findings based on the specific innovations are taken to be valid. This point will be discussed in more detail later. However, it appears that across-time changes in the magnitude of gaps based on the indices become extremely difficult to interpret or meaningless; for, each index is constructed on within-time scores referencing several innovations each of which may have widening or closing gaps. The net effect using indices is to cancel the tendencies that show up when tendencies for specific - innovation gaps are studied. This methodological note is mentioned in advance, since the spurious results on gap tendencies are included in the chapter on the "findings" purely for methodological reasons. The results are contrasted between the approaches.

Thus, gaps which may widen or narrow are described in terms of specific innovations and specific substructures. The number of relevant innovations by the number of relevant substructures gives a sample of gaps--for adoption or knowledge, or agricultural or health. Thus, each of four sample of gaps is analyzed separately to describe the widening or closing tendencies.

The present study is an exploratory one. Statistical tests of significance are used mainly to give an indication of the magnitude of observed differences, rather than as strict tests of an hypothesis. Furthermore, generalizability is not claimed in that this is essentially a case study of intra-system effects of planned change. To the extent, however, that the study villages are similar to a population

of other peasant villages, and the change program is similar to other change programs, the findings may have limited applicability to those situations.

CHAPTER IV

FINDINGS

One hundred and ninety two Indian villagers were the panel study respondents. Benchmark measures were taken in 1964 (t1); media forums were conducted in 1965 with topics which included ten agricultural and five health-related innovations; post measures were then gathered in 1966 (t2) and 1967 (t3).

The present chapter summarizes findings specifically dealing with: (1) levels of adoption and knowledge among the 192 members of the study population at each of the three points in time; (2) multiple correlation predictors of adoption and knowledge; (3) causal relationships between adoption and structural changes; (4) the determination of substructures; and (5) substructural rates of change in adoption and knowledge in terms of widening or closing "gaps". In the final chapter, certain of the above mentioned specific findings will be drawn together in an attempt to assess whether the structural form tended toward reinforcement or social change.

Before summarizing levels of adoption and knowledge among the 192 treatment villagers, the main effects of the treatment versus control village conditions are briefly outlined. The 87 control villagers and 192 treatment villagers were reasonably comparable on

most characteristics. For example, the averages on age were 41 (control) and 44 (treatment), and the averages on size of family were 5.5 (control) and 5.8 (treatment). Other characteristics for the groups are reported in Kivlin and others (1968), and far more extensive details than those below on the comparative effects of the forums on adoption and knowledge of innovations.

The media forums increased both adoption and knowledge more among the treatment villagers than the control villagers (Table 1). The greatest impact was found for gains in adoption rather than knowledge, and for knowledge of health innovations more than knowledge of agricultural innovations. Although later discontinuance occurred for some health practices that had been previously adopted, the media forums appear to have had an impact on both agricultural and health adoption beyond chance expectations.

Levels of Adoption and Knowledge

In the study population (N=192), there were differences between the agricultural and health innovations as far as adoption levels within and across time are concerned (Table 2). Agricultural innovations were more widely adopted than helath innovations. Agricultural innovations also were increasingly adopted over the three time periods, whereas there was relatively less increase and more discontinuance of the health innovations, especially a year or two after the forums (between t2 and t3). Of the health innovations, the practice of having typhoid and cholera innoculations was twice as widely accepted

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Table 1. Differences between Media Forum and Control Village Respondents in Agricultural Adoption & Knowledge & Health Adoption & Knowledge

Dependent Variable	Means and p Values*					
	Benchmark t1(1964)		1st Restudy t2(1966)		2nd Restudy t3(1967)	
Agric. adoption						
--media forum villagers	2.47		3.30		4.42	
--control villagers	2.51		2.76		3.41	
	-.04	(p=.89)	.54	(p=.08)	1.01	(p=003)
Agric. knowledge						
--media forum villagers	6.15		8.52		8.91	
--control villagers	6.33		8.51		8.60	
	-.18	(p=.57)	.01	(p=.95)	.31	(p=.14)
Health adoption						
--media forum villagers	.68		1.01		.92	
--control villagers	.70		.63		.62	
	-.02	(p=.78)	.38	(p=.001)	.30	(p=.007)
Health Knowledge						
--media forum villagers	1.76		3.27		3.95	
--control villagers	1.52		2.67		3.61	
	.24	(p=.10)	.60	(p=.001)	.34	(p=.04)

N = 192, media forum village respondents

N = 87, control village respondents

* t-tests (two-tailed)

Table 2. Percent Adopters of Specific Innovations.

Innovation	Percent Adopters t1(1964)	t2(1966)	t3(1967)
Agricultural			
Japanese meth. paddy cult.	14%	12%	31%
Line sowing	21	51	60
Improved potato seed	13	34	33
Green manure	18	25	25
Ammonium sulphate	64	43	60
Insecticide	34	41	53
Modern plough	44	72	82
Tine cultivator	3	3	5
Animal disease innoc.	23	27	38
Superphosphate	13	23	55
$\bar{X}$ =	24.7	33.1	44.2
Health			
PRAI Latrines	1%	3%	3%
Bed-bug killer	13	30	16
Mod. child-birth practices	2	5	13
Typhoid & cholera innoc.	48	55	55
Family planning	4	8	6
$\bar{X}$ =	13.6	20.2	18.6

N = 192

Table 3. Percent Knowers of Specific Innovations

Innovation	Percent Knowers		
	t1(1964)	t2(1966)	t3(1967)
Agricultural			
Japanese meth. paddy cult.	57%	83%	82%
Line sowing	82	96	97
Improved potato seed	17	89	69
Green manure	71	89	92
Ammonium sulphate	93	84	97
Insecticide	79	90	96
Modern plough	88	99	100
Tine cultivator	12	73	76
Animal disease innoc.	17	82	89
Superphosphate	46	67	94
$\bar{X}$ =	56.2	85.2	89.2
Health			
PRAI Latrines	24%	51%	71%
Bed-bug killer	25	53	64
Mod. child-birth practices	13	45	72
Typhoid & cholera innoc.	71	88	94
Family planning	43	91	94
$\bar{X}$ =	35.2	65.6	79.0

N = 192

as any other innovation at all points in time. There was considerable variation between the health innovations in adoption patterns. Of the agricultural innovations, most had been adopted by 40 percent or more of the respondents by t3, except for the tine cultivator which was poorly adopted (5 percent by t3).

Average levels of adoption of innovations before the forums were quite high (25 percent for agricultural innovations and 14 percent for health innovations). Thus, the practices, were not entirely "new" to many respondents, and thereby not innovations (for those respondents) as previously defined.

This particular point is still more evident when knowledge levels are considered. Table 3 shows an average level of knowledge across the ten agricultural innovations of 56 percent at t1 (35 percent for the five health innovations). Both agricultural and health innovations became more widely known over time. This was mainly over the period of the forums in the case of agricultural innovations; in the case of health innovations, the number of knowers continued to increase over the t2 to t3 period.

"Ceiling effects" on knowledge are apparent by t2 for a number of innovations, and by t3 for even more innovations (Table 3). Over eighty-five percent of respondents were aware of half the ten agricultural innovations and two of the five health innovations by t2. These "ceiling effects" have been noted in the previously cited research reports.* They would appear to have possible implications

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*See Roy and others (1969) especially.

for our later analysis on widening and closing gaps, particularly knowledge gaps; for it is with knowledge rather than adoption that they are most apparent. If there was progressively less margin for increase among substructures with faster rates of gain, and the counterpart substructures showed some increase, then any narrowing gaps may be partly a function of the ceiling effects.

The distributions for the number of innovations known about, show the ceiling effects even more clearly (Table 4). Well over half the respondents (65 percent) knew of at least nine agricultural innovations by t2. The comparable figure at t3 had only increased a few percentage points (to 71 percent). Before the forums, at t1, 11 percent knew of nine or more innovations; there was therefore more "room" for increases across the t1 to t2 period. The distributions for knowledge of health innovations show quite similar patterns.

On the other hand, Table 4 also indicates that ceiling effects were not a major problem with respect to adoption, that is, of either agricultural or health innovations. By t2, only 10 percent of respondents had adopted at least six of the ten agricultural innovations; by t3, 24 percent had adopted at least six agricultural innovations. The patterns were similar for the adoption of health innovations.

In general, then, ceiling effects were encountered for knowledge but not adoption. At the post-treatment stages (t2 and t3), there were mostly more innovations that individuals could adopt if they decided to, but not many additional innovations that remained unknown to most respondents.

Table 4. Distributions of Adoption and Knowledge of Ten Agricultural and Five Health Innovations

Class of Innovation	Number of Innovations	Percent Adoption t1(1964)	t2(1966)	t3(1967)	Percent Knowledge t1(1964)	t2(1966)	t3(1967)
Agricultural							
	0	20%	15%	4%	6%	1%	0%
	1	21	13	12	1	0	0
	2	14	14	11	1	0	0
	3	14	15	12	6	1	0
	4	13	10	17	6	5	2
	5	7	11	11	11	4	2
	6	4	13	9	14	4	3
	7	5	4	9	27	8	8
	8	1	4	6	18	12	14
	9	0	2	7	9	18	25
	10	0	0	2	2	47	46
		100%	100%	100%	100%	100%	100%
Health							
	0	43%	37%	40%	14%	0%	1%
	1	47	30	37	32	6	2
	2	9	28	17	29	21	13
	3	1	4	5	15	32	11
	4	0	1	2	8	21	30
	5	0	0	0	2	19	43
		100%	100%	100%	100%	100%	100%
	N =	192	192	192	192	192	192

Table 5. Part-Whole Index Correlations for Agricultural Adoption and Knowledge, and Health Adoption and Knowledge

Item	Corr. with Adoption Index			Corr. with Knowledge Index		
	t1(1964)	t2(1966)	t3(1967)	t1(1964)	t2(1966)	t3(1967)
Agricultural items:						
Modern plough	.71	.64	.49	.66	.43	.15
Ammonium sulphate	.61	.59	.54	.68	.65	.33
Superphosphate	.59	.60	.62	.55	.58	.48
Green manure	.59	.54	.61	.71	.61	.48
Insecticide	.55	.54	.68	.61	.73	.38
Japanese method of paddy cultivation	.54	.48	.62	.63	.66	.61
Line sowing	.53	.62	.57	.74	.49	.33
Animal disease innoculation	.43	.55	.70	.52	.54	.59
Improved potato seed	.38	.64	.62	.35	.58	.63
Tine cultivator	.37	.33	.28	.35	.73	.56
Health items:						
Typhoid and cholera innoculation	.75	.78	.75	.48	.41	.44
Bed-bug killer	.46	.73	.63	.62	.60	.62
Family planning	.42	.40	.61	.71	.29	.51
Modern child-birth practices	.39	.34	.51	.41	.67	.78
PRAI Latrines	.13	.17	.19	.56	.64	.72
N = 192						

Note: All correlations are significantly different from zero at the 5 percent level.

The distributions in Table 4 also represent distributions for the four main indices: agricultural adoption and knowledge, and health adoption and knowledge. The adoption indices are more positively skewed for the earlier time periods; and, as already discussed in terms of ceiling effects, the knowledge indices become more negatively skewed for the later time periods. Even so, all the indices appear to have underlying normal distributions, with the degree of skewness in each index shifting over the time periods. Such skewness might be a reason for not using the indices in correlational analysis. However, a study by Norton (cited in Lindquist, 1953) found that sampling distributions are relatively unaffected by lack of symmetry, provided the samples do not vary in size. Our concern is with a panel of the same 192 respondents. The index distributions are therefore assumed to be satisfactory for present purposes.

In Table 5 are reported the part-whole simple correlations for the main indices of agricultural adoption and knowledge, and health adoption and knowledge. Despite the considerable variability found among the specific innovations for both adoption and knowledge, all the items are statistically significant in their index associations (5 percent level). Even the most poorly adopted innovations--tine cultivators and PRAI latrines--contribute significantly to the two adoption indices. Thus, all innovation-items were retained in each of the four indices.

To summarize the findings so far, the media forums did influence greater levels of adoption and knowledge in the treatment villages

than the control villages. The impact was greatest on adoption. Among the 192 media-forum villagers, a number of innovations were fairly widely known and/or adopted before the forums began in late 1964. Some discontinuance of adoption occurred mainly in health innovations, otherwise most adoption and knowledge levels continued to increase over time. Ceiling effects on knowledge only, for both classes of innovations, were quite marked in the post-treatment periods. The four indices of agricultural and health, adoption and knowledge, comprised innovation-items showing considerable variability; however, none of the item to index associations warranted changes in construction of the indices.

Before presenting further findings it is as well to briefly summarize the various analytic techniques and their main purposes. Although there are assumed to be independencies between adoption and knowledge, and structure, for purposes of different types of analysis the 35 structural variables and the adoption variables are given varying status as predictor or criterion variables. As well, some analytic techniques apply to "within-time" and some to "across-time" forms of analysis. It is probably helpful to re-state these techniques briefly before moving to the findings.

	Technique and Purpose	Variable Relationships
1.	Multiple correlation --to obtain "best" sets of predictor variables to provide guides and additional checks in later analyses.	Adoption and knowledge indices as dependent variables; structural variables as "within-time" predictors.

2. Cross-lagged panel correlation --to examine the number of structural changes as a consequence of adoption (primary emphasis on adoption-to-structural changes, rather than attention to reverse causality).	Adoption indices and adoption of specific innovations as "across-time" predictors; structural variables as dependent variables.
3. Configurational analysis --to define sets of sub-structures by procedures which optimally partition the variance among subgroups and detect interaction effects	Adoption and knowledge indices as dependent variables; structural variables as "within-time" predictors.
4. Descriptive statistics on "across-time" changes in samples of gaps --to examine whether gaps tend to widen or narrow, and which ones.	Adoption and knowledge levels for specific innovations and for specific and contrasting substructures previously defined.

Predictors of Adoption and Knowledge

This section makes use of a multiple correlation technique to determine "best" sets of predictor variables on the four main indices.

The intentions are as follows: (1) to give an indication of which structural variables might figure prominently later in defining substructures through a modified form of configurational analysis, and (2) to determine which variables have significant partial correlations with the indices in final equations, so as to provide an additional criterion in the later examination of cross-lagged relationships between adoption and structural changes. The multiple correlational results, therefore, merely assist as supplementary guides or checks to later parts of the analysis. No findings in this section bear directly on the main study objectives.

Step-wise least-squares delete analysis* was performed using the 1964 (t1) and 1966 (t2) sets of data only. The same 35 structural variables acted as predictors on each of the four main indices, agricultural adoption and knowledge, and health adoption and knowledge. The results are shown in Tables 6 through 9. Only those of the 35 structural variables which survived the deletion procedures are shown in the Tables. Each variable that had been deleted, neither added significantly to the overall variance explained nor had a partial correlational significantly different from zero at the 5 percent level. At each stage of the deletion procedures, the partial correlations control for other independent variables which survived deletion up to that particular point.

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*The computer program is described in STAT Series Description No. 8, Agricultural Experiment Station, Michigan State University, (1967).

Leading predictors of agricultural adoption were of two main types (Table 6). As might be expected, the "farm-size and productivity" variables figured prominently, such as agricultural production, land area owned, and irrigation. A second broad class of variables that were well represented reflect general social activity or competence: for example, social participation, change agent knowledge, and opinion leadership. Notably absent were the demographics of education and age, and only one of the "supplementary income" variables had not been deleted.

The best predictors of agricultural knowledge comprised a set of variables that largely overlapped the predictors of agricultural adoption (Table 7). An additional variable, and one we would expect to be closely related with knowledge, was mass media exposure.

Among the predictors of health adoption, the "supplementary income" group of variables were well represented; that is, those relating to work outside the respondent's own farm (Table 8). The leading predictors of health knowledge were relatively mixed as far as variable types are concerned, with no one type particularly well represented.

Thus, the types of predictors for each index are fairly much those which might be expected. Of more concern is the direction of some particular relationships. For certain variables we might except a negative relationship (e.g., off-farm work and agricultural adoption), while others surprise in this regard. Especially noticeable is cosmopoliteness. Possible reasons include the following:

Table 6. Multiple Correlation Predictors of Agricultural Adoption at t1 (1964) and at t2 (1966)

Independent Variable	Correlations with Agric. Adoption	
	Zero-order Corr.	Partial Corr.
Time 1 (1964)		
*Agricultural production	.47	.30
Social participation	.44	.25
*Change agent knowledge	.49	.23
Opinion leadership	.32	.23
*Functional leadership	.21	-.19
*Political knowledge	.37	.18
Cosmopoliteness	-.01	-.18
Intra-village caste power ranking	.09	.17
Average size plots owned	.23	.16
Multiple correlation R =	.68, R^2 = .47	
Time 2 (1966)		
Off-farm work (resp.)	-.29	-.30
Land area owned	.20	-.29
*Functional leadership	.26	.28
Prestige	.15	.28
Level of living	.42	.28
Irrigation	.44	.28
*Agricultural production	.36	.21
Functional literacy	.23	-.17
*Change agent knowledge	.36	.17
*Political knowledge	.35	.17
Multiple correlation R =	.67, R^2 = .45	

N = 192 for both time periods

*Variable in final equations of both time periods.

Note: The same 35 independent variables at each time period were subjected to a stepwise least-squares delete analysis. Partial correlations control for other independent variables remaining in final equations; all partials are significantly different from zero at the 5 percent level.

Table 7. Multiple Correlation Predictors of Agricultural Knowledge at t1 (1964) and at t2 (1966)

Independent Variable	Correlations with Agric. Knowledge	
	Zero-order Corr.	Partial Corr.
Time 1 (1964)		
Cosmopoliteness	-.11	-.32
Change agent knowledge	.47	.28
*Political knowledge	.40	.24
Social participation	.36	.23
Intra-village caste power ranking	.17	.22
Level of living	.48	.20
Functional leadership	.13	-.19
Multiple correlation R = .65, R^2 = .42		
Time 2 (1966)		
Off-farm work (resp.)	-.25	-.31
Irrigation	.32	.23
Mass media exposure	.30	.20
Number of plots owned	.06	-.19
Prestige	.02	-.19
*Political knowledge	.28	.18
Land area owned	.15	.17
Size of family	-.07	-.16
Average size plots owned	.07	-.16
Multiple correlation R = .53, R^2 = .28		
N = 192 for both time periods		

*Variable in final equations of both time periods.

Note: The same 35 independent variables at each time period were subjected to a stepwise least-squares delete analysis. Partial correlations control for other independent variables remaining in final equations; all partials are significantly different from zero at the 5 percent level.

Table 8. Multiple Correlation Predictors of Health Adoption at t1 (1964) and at t2 (1966)

Independent Variable	Correlations with Health Adoption: Zero-order Corr.	Partial Corr.
Time 1 (1964)		
Level of living	.34	.31
*Off-farm work (resp.)	.19	.28
*Change agent contact	.37	.28
Cosmopoliteness	.02	-.19
Off-farm work (other fam. mem's)	.17	.19
Prestige	.31	.18
Inter-village caste ritual making	.07	-.17
*Off-farm income (family)	.19	-.15
Intro-village caste economic ranking	.11	.15
Multiple correlation R = .58, R^2 = .33		
Time 2 (1966)		
Change agent knowledge	.34	.33
*Off-farm work (resp.)	-.15	-.23
Education	.28	.22
*Change agent contact	.13	-.19
Mass media exposure	.05	-.18
*Off-farm income (family)	.13	.17
Functional leadership	.24	.16
Off-farm income (resp.)	-.03	.14
Multiple correlation R = .52, R^2 = .27		

N = 192 for both time periods

*Variable in final equations of both time periods.

Note: The same 35 independent variables at each time period were subjected to a stepwise least-squares delete analysis. Partial correlations control for other independent variables remaining in final equations; all partials are significantly different from zero at the 5 percent level.

Table 9. Multiple Correlation Predictors of Health Knowledge at t1 (1964) and at t2 (1966)

Independent Variable	Correlations with Health Knowledge	
	Zero-order Corr.	Partial Corr.
Time 1 (1964)		
Level of living	.48	.32
*Change agent knowledge	.42	.28
Off-farm income (resp.)	.25	.26
Land area cultivated	.26	-.22
Off-farm income (family)	.17	-.20
Number of plots owned	.22	.18
Education	.44	.15
Intra-village caste economic ranking	.22	.15
Multiple correlation R = .63, R^2 = .40		
Time 2 (1966)		
*Change agent knowledge	.39	.34
Functional literacy	.30	.23
Mass media exposure	.11	-.17
Agricultural production	.25	.17
Multiple correlation R = .48, R^2 = .23		

N = 192 for both time periods

*Variable in final equations of both time periods

Note: The same 35 independent variables at each time period were subjected to a stepwise least-squares delete analysis. Partial correlations control for other independent variables remaining in final equations; all partials are significantly different from zero at the 5 percent level.

(1) in order to achieve comparability of measures only a two-item index was used: (2) both items may have been somewhat unreliable in that they rested heavily upon respondent recall about distances travelled or frequency of visits to Lucknow over the previous year; and (3) the relatively traditional norms of the social systems in the present study may have acted as partial modifiers on the expected relationships (cf. Rogers with Shoemaker, 1971: Chapter 3). Furthermore, a number of studies have not found positive relationships between cosmopoliteness and adoption.*

Mass media exposure and functional leadership are two other variables for which some relationships are contrary to expectations. The above remarks about system norms might apply here as well, although the main reasons may be found in problems of unreliability and non-linearity. Mass media exposure had been indexed by three simple items. In order to achieve comparability, the items had been recoded to the least comprehensive codes in the three sets of data. The resulting index was a more gross measure of this variable than would have been preferred. Functional leadership, along with the two other sociometric indices (opinion leadership and prestige), had not been standardized. Individual scores ranged to 56 (t1) and 62 (t2) nominations received. Furthermore, non-linearity was noticed

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*Of 132 studies referred to in Rogers with Shoemaker (1971:369) dealing with this question, 42 do not report a positive relationship.

for this variable in configurational analysis; for some indices the variance distributions associated with the codes of the variable showed this quite clearly.

As mentioned in the last chapter, configurational analysis does not assume linearity, additivity, or properly scaled variables, whereas multiple correlation does. Furthermore, the differences between zero-order and partial correlations for a number of variables indicate the complex nature of many of the relationships, with predictor variables often highly inter-correlated. Configurational analysis is much better suited to detect these interactions. In fact, we shall attempt to capitalize upon interactions in defining substructures.

Finally, more variance could be accounted for in the agricultural indices than in the health indices. This is to be expected, since the agricultural indices had 0-10 ranges as against 0-5 ranges in the health indices. Configurational analyses confirm the same pattern later; the index variances were consistently partitioned in more symmetrical ways for agricultural indices than health indices.

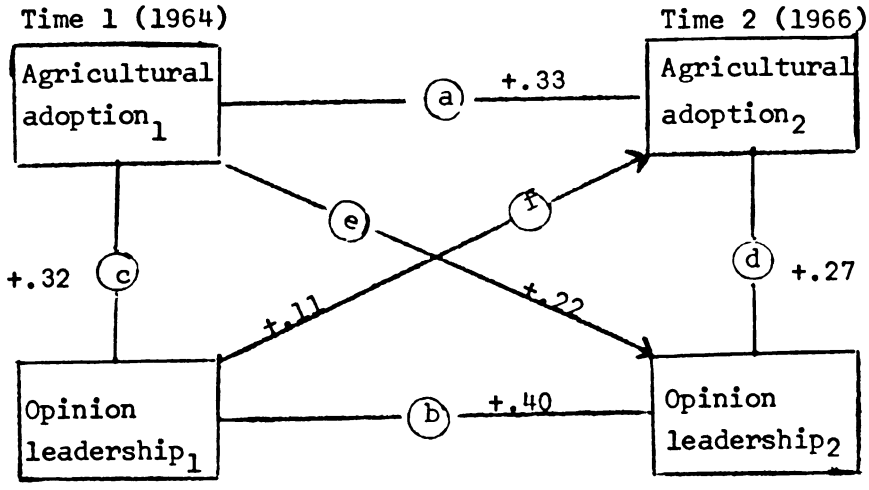
In summary, the leading predictors of agricultural adoption and knowledge are variables which broadly reflect size of operations and productivity, and general social activity and competence. The situation is less clear-cut for health adoption and knowledge, although variables indicating the amount of off-farm work or remuneration do seem to figure in predictions of health adoption.

Structural Changes

This section summarizes findings which bear directly on one of the main study objectives: the extent to which adoption of innovations leads over time to structural changes (that is, changes within the structure, rather than a necessarily altered overall structural form).

The use of cross-lagged panel correlations is a technique suited to the analysis of across-time causal relationships (Rozelle and Campbell, 1969). The general design for a two-variable and two-time set of relationships was outlined earlier (page 50).

The design is repeated in this section, before the presentation of findings, in order to provide concrete illustration to help clarify the interpretation of the findings. By way of example, the first relationships in the first Table (Table 10) are between agricultural adoption and opinion leadership (a variable measured at t1 and t2 only). The full set of associations for this pair of variables is diagramed on the next page. The main diagonal, e (+22), does exceed the "no cause" baseline statistic (+.15), and does so by a "reasonable" margin. Since they are positively signed relationships, it is concluded that agricultural adoption in 1964 led to later increases in opinion leadership. The summarized findings in Table 10 also show a mean static correlation (c = +.32 & d = +.27) of +.30. The mean static correlation is not essential within the Rozelle-Campbell design for the determination of causality; rather, it merely serves to provide



Baseline = +.15

the reader with additional summary information on "within-time" strengths of the relationships between the variables.

Since the baseline statistic can be regarded as representing an average static correlation corrected for temporal attenuations, then the relevant partial correlations have already, in effect, been taken into account. As an additional criterion, however, structural variables only are included in the following analyses which survived the least-squares delete procedures and which had significant partial correlations with an adoption index. (That is, only those structural variables are included which were reported in Tables 6 and 8 of the last section dealing with multiple correlation).

Although no formal hypotheses have been stated, it should be emphasized that our main theoretical interest in this section is whether adoption does or does not lead to later structural changes (main diagonal, e); that is, rather than focusing on the reverse causal

direction (reverse diagonal, f) which would suggest that structural changes lead to later adoption. The assumed interdependencies between adoption and structure have been noted, and indeed are of major importance within the broader conceptual framework. Given the earlier assumptions about social change implications of planned change programs, however, and disproportional rates of adoption for innovations which do have structural consequences, our immediate objective is to focus upon general patterns of consequences of adoption rather than the presence or absence of reverse causality. As discussed in earlier chapters, research shows that structural variables often predict adoption, but there has been very little in the way of research on the consequences of adoption in terms of later structural changes.

A number of structural variables were measured only twice (t1 and t2), and others at all three points in time. Since the cross-lagged technique was originally designed with reference to two-time panel studies, "multiple" two-time associations are available for those structural variables with measures at all three points in time. (That is: t1-t2, t2-t3, t1-t3). It is conceivable that the multiple time intervals could be treated in separate ways. However, in the absence of theoretical or logical grounds for doing so, multiple two-time associations will be treated as replications of the relationships between the same variables. The main criterion will be adoption as a consistent predictor of these across-time structural changes.

Findings on the adoption indices of agriculture and health are summarized first, and then findings on the adoption of specific innovations.

Adoption Indices

Agricultural adoption appears to be a fairly strong predictor of later structural changes. Table 10 shows cross-lagged correlations for agricultural adoption with structural variables where either diagonal had exceeded the baseline. Agricultural adoption in most cases is a better predictor over time of the structural variables, than they are over time of adoption. Treating the relationships with variables which have multiple two-time associations* as replications, gives sets of twelve relationships between the adoption index and the structural variables (Table 10). Agricultural adoption is evidenced in eight out of the twelve cases as leading over time to structural changes. In four cases, either the reverse explanation is to be preferred or the "replications" are not consistent.

Thus, it appears that agricultural adoption leads to over time increases in the following:

-opinion leadership
-functional leadership
-average size of plots owned
-agricultural production
-irrigation
-level of living
-political knowledge
-change agent knowledge

Furthermore, there appear to be no quite unfeasible structural changes amongst these; all have a degree of face validity in addition

*Functional literacy, political knowledge, social participation, and change agent knowledge.

Table 10. Cross-Lagged and Mean Static Correlations between Agricultural Adoption and Structural Variables

Structural Variable	Diag. r (e)	Reverse r (f)	Baseline	Static r (mean c&d)
Opinion leadership (t1-t2)	.22	.11	.15	.30
Functional leadership (t1-t2)	.25	.17	.17	.24
Av. size plots owned (t1-t2)	.22	.01	.08	.14
Agric. production (t1-t2)	.38	.17	.21	.42
Off-farm work (resp.) (t1-t2)	-.07	-.22	-.15	-.23
Cosmopoliteness (t1-t2)	-.03	-.09	-.02	-.03
Level of living (t1-t2)	.39	.26	.29	.42
Irrigation (t1-t2)	.49	.22	.21	.38
Functional literacy (t1-t2)	.32	.23	.19	.29
Functional literacy (t2-t3)	.23	.29	.26	.31
Functional literacy (t1-t3)	.28	.28	.24	.37
Political knowledge (t1-t2)	.26	.14	.17	.36
Political knowledge (t2-t3)	.30	.23	.23	.39
Political knowledge (t1-t3	.22	.18	.14	.33
Social participation (t1-t2)	.35	.36	.24	.39
Social participation (t2-t3)	.34	.25	.26	.48
Social participation (t1-t3)	.27	.38	.30	.53
Change agent knowledge (t1-t2)	.27	.18	.24	.43
Change agent knowledge (t2-t3)	.37	.23	.25	.44
Change agent knowledge (t1-t3)	.32	.24	.26	.51

N = 192

Note: Only variables are included: (a) where partial correlation with agricultural adoption at t1 or t2 remained significantly different from zero at the 5 percent level after least-squares delete analysis and controlling for the remaining variables, and (b) where either cross-lagged correlation exceeded the baseline.

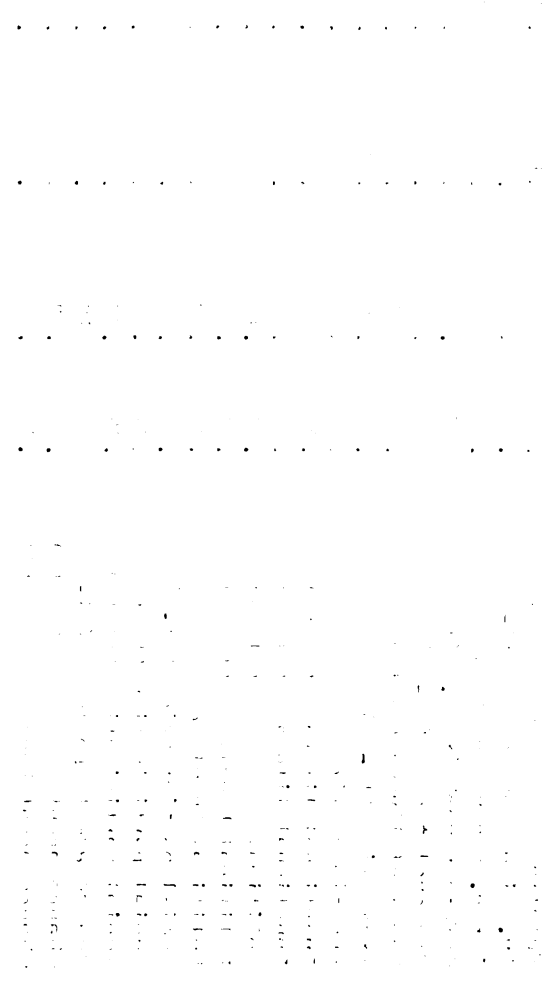


Table 11. Cross-Lagged and Mean Static Correlations between Health Adoption and Structural Variables

Structural Variable	Diag. r (e)	Reverse r (f)	Baseline	Static r (mean c&d)
Off-farm income (family)(t1-t2)	.18	-.05	.05	.16
Prestige (t1-t2)	.31	.13	.11	.23
Functional leadership (t1-t2)	.42	.19	.12	.25
Off-farm income (resp.)(t1-t2)	.15	-.05	.04	.09
Off-farm work (resp.)(t1-t2)	.10	-.12	.02	.04
Off-farm work (oth. f.mems)(t1-t2)	.19	-.05	.04	.14
Cosmopoliteness (t1-t2)	-.06	.05	.03	.07
Level of living (t1-t2)	.24	.21	.14	.30
Mass media exposure (t1-t2)	.15	.18	.07	.19
Mass media exposure (t2-t3)	.08	.29	.07	.24
Mass media exposure (t1-t3)	.10	.26	.17	.37
Change agent knowledge (t1-t2)	.20	.11	.14	.37
Change agent knowledge (t2-t3)	.22	.17	.11	.46
Change agent knowledge (t1-t3)	.27	.21	.19	.49
Change agent contact (t1-t2)	.25	.22	.09	.25
Change agent contact (t2-t3)	.18	.24	.09	.34
Change agent contact (t1-t3)	.28	.22	.19	.46
Education (t1-t2)	.30	.24	.15	.32
Education (t2-t3)	.28	.29	.11	.29
Education (t1-t3)	.29	.32	.18	.33

N = 192

Note: Only variables are included: (a) where the partial correlation with health adoption at t1 or t2 remained significantly different from zero at the 5 percent level after least-squares delete analysis and controlling for the remaining variables, and (b) where either cross-lagged correlation exceeded the baseline.

to the several statistical criteria having been met for causality.

Health adoption also appears to be causally related over time to structural changes. Table 11 shows relationships with twelve structural variables, four of which have "replications." Here we find that health adoption is evidenced as leading to structural changes in ten out of the twelve cases. Mass media exposure could be added to the list of variables affected by adoption, but a main diagonal for one period (t2-t3) only barely exceeds the baseline. Mass media exposure and cosmopoliteness are concluded not to have been influenced over time by adoption.

Two variables are shown to have rather strong mutual causal relationships with health adoption. Health adoption leads to increases in change agent contact and in education, just as each of these in turn leads to further increases in health adoption.

Thus, health adoption over time appears to lead to increases in the following variables:

-off-farm income (family)
-off-farm income (respondent)
-off-farm work (other family members)
-off-farm work (respondent)
-prestige
-functional leadership
-level of living
-change agent knowledge
-change agent contact
-education

Again, some face-validity seems reasonable for the relationships with each variable, although exact reasons are difficult to specify from these data. Adoption of health practices may either enable more

outside work to be undertaken because of improved health, or the work may be undertaken to pay for the practices adopted. Adoption leading to increased status over time seems straight-forward and reasonable; and more familiarity and contacts with change agents seem likely to be fostered following the adoption of health practices.

In summary, agricultural adoption appears to have its greatest effects on farm income and productivity indicators, and also status levels and knowledgeability. The consequences of health adoption include more outside work and remuneration, and also increases in status, change agent familiarity and education.

Adoption of Specific Innovations

Since adoption does appear to have structural consequences for the individual, it may be that the adoption of certain innovations rather than others have greater effects.

Moving from the use of only two adoption predictors to fifteen, a substantial increase occurs in the number of cross-lagged correlations to be compared with the baseline. The greater number involved seems to warrant an additional criterion for the influence of chance factors, even though the lagged correlations might exceed the baseline. For this reason, this part of the analysis carries the additional stipulation that either diagonal correlation should exceed the baseline by approximately seventeen or more correlation points.* Table 12

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*"Approximately", since to perform calculations on r's it is necessary to first convert them to Fisher z's, make the computations and test differences, and reconvert to r's. Two-tailed t tests were used for which $t=1.64$, $p<.10$.

shows the relationships which meet these criteria for the adoption of specific agricultural innovations; Table 13 shows similar relationships for the adoption of specific health innovations.

Agricultural innovations show considerable variation in their consequences for structural changes. The adoption of two innovations, green manure and superphosphate, led to over time increases in four structural variables. However, three innovations--line sowing, modern plough, and insecticides--have no clear-cut consequences in terms of structural changes. Line sowing adoption relationships met none of the stated criteria (it is not included in Table 12 for this reason). The modern plough and insecticides adopted at earlier points in time did appear to produce later increases in structural variables. However, the particular variables had measures at three points in time and the "replications" did not meet the stated criteria ("replications" are not necessarily shown in Table 12 for this reason). Similar associations not "replicated" were those of green manure, for example, with functional literacy, political knowledge, and social participation. While it is conceivable that the adoption of green manure might lead to increased political knowledge or social participation, it is difficult to envision a causal relationship for the adoption of green manure with functional literacy. The adoption relationships shown below do have a degree of face-validity, however. Adoption of these agricultural innovations at one point in time appears to have led to later increases in the variables indicated.

- Japanese meth. paddy cult.:	irrigation
- improved potato seed:	irrigation
- ammonium sulphate:	av. size plots owned
	agric. production
	irrigation
- green manure:	opinion leadership
	agric. production
	irrigation
	level of living
- tine cultivator:	agric. production
	irrigation
	level of living
	agric. production
	irrigation
	level of living
- superphosphate:	functional leadership
	agric. production
	irrigation
	level of living
- animal disease innoc.:	av. size plots owned

These structural-change consequences are consistent with those found when the agricultural adoption index was used. Farm-operations and productivity variables are again prominent.

What accounts for the specific causal findings? Some of the specific findings are more easily interpreted than others. For example, the Japanese method of paddy cultivation is actually a package of practices according to Kivlin and others (1968:13). The component practices may either be taken up together or singly, although the interdependence is not such that all individual practices need to be adopted in order to obtain some benefits. Among the component practices of the Japanese method are: improved seed, seed treatment, and "adequate irrigation and drainage." It seems that other specific causal relationships that have been identified here, might be amenable to similar logical interpretations given considerable detail about the nature of the innovations. Local agricultural experts,

Table 12. Cross-Lagged and Mean Static Correlations between Adoption of Specific Agricultural Innovations and Structural Variables

Innovation and Structural Variable	Diag. r (e)	Reverse r (f)	Baseline	Static r (mean c&d)
Japanese method of paddy cult.				
Irrigation (t1-t2)	.29	.02	.07	.17
Social participation (t1-t2)	.10	.24	.07	.16
Social participation (t2-t3)	.27	.10	.08	.26
Improved potato seed				
Off-farm work (resp.) (t1-t2)	-.06	-.31	-.11	-.21
Cosmopoliteness (t1-t2)	-.06	-.21	-.03	-.05
Irrigation (t1-t2)	.33	.31	.14	.31
Functional literacy (t1-t3)	.21	.29	.11	.32
Social participation (t1-t2)	.12	.31	.13	.26
Change agent knowledge (t1-t2)	.14	.27	.10	.23
Ammonium sulphate				
Av. size plots owned (t1-t2)	.20	-.07	.02	.04
Agric. production (t1-t2)	.23	-.06	.07	.17
Irrigation (t1-t2)	.34	.06	.10	.24
Political knowledge (t1-t3)	.10	.19	.02	.16
Social participation (t2-t3)	.25	.12	.06	.22

Table continued...)

Note: Relationships shown in this Table and the next one are only those where either cross-lagged correlation exceeded the baseline by approximately 17 correlation points (after converting r's to z's), for which $t=1.645$, $p<.10$ (two-tailed). Furthermore, only variables were examined for which significant partial correlations with the adoption index were observed after least-squares delete analysis.

Table 12 (Contd)

Innovation and Structural Variables	Diag. r (e)	Reverse r (f)	Baseline	Static r (mean c&d)
Green manure				
Opinion leadership (t1-t2)	.25	.00	.08	.23
Agric. production (t1-t2)	.31	.13	.11	.32
Level of living (t1-t2)	.33	.18	.15	.31
Irrigation (t1-t2)	.30	.08	.07	.20
Functional literacy (t1-t2)	.30	.26	.13	.30
Political knowledge (t1-t2)	.31	.15	.10	.33
Social participation (t1-t2)	.33	.14	.12	.29
Tine cultivator				
Agric. production (t1-t2)	.28	.09	.09	.26
Level of living (t1-t2)	.25	.15	.09	.18
Irrigation (t1-t2)	.30	.17	.08	.20
Social participation (t1-t2)	.26	.20	.09	.22
Social participation (t2-t3)	.10	.27	.05	.22
Social participation (t1-t3)	.29	.31	.11	.23
Insecticide				
Change agent knowledge (t2-t3)	.23	.09	.06	.22
Modern plough				
Functional literacy (t1-t3)	.32	.07	.14	.25
Political knowledge (t1-t3)	.25	.06	.08	.22
Change agent knowledge (t1-t3)	.30	.18	.14	.32
Superphosphate				
Functional leadership (t1-t2)	.22	.06	.05	.13
Agric. production (t1-t2)	.32	-.02	.04	.15
Level of living (t1-t2)	.26	.04	.07	.22
Irrigation (t1-t2)	.29	.02	.06	.22
Functional literacy (t1-t2)	.23	.06	.03	.10
Social participation (t1-t2)	.30	.28	.05	.18
Social participation (t2-t3)	.30	.09	.12	.28
Social participation (t1-t3)	.05	.26	.06	.30

Table 12 (Contd)

Innovation	Diag. r (e)	Reverse r (f)	Baseline	Static (mean c&d)
Animal disease innoculation				
Av. size plots owned (t1-t2)	.23	.07	.04	.13
Functional literacy (t2-t3)	.11	.31	.15	.26
Functional literacy (t1-t3)	.18	.30	.12	.27
Political knowledge (t1-t2)	.03	.25	.06	.26
Social participation (t2-t3)	.05	.31	.15	.37
Social participation (t1-t3)	.09	.35	.12	.31
Change agent knowledge (t1-t3)	.23	.34	.12	.34
N = 192				

Table 13. Cross-Lagged and Mean Static Correlations between Adopted of Specific Health Innovations and Structural Variables

Innovation and Structural Variable	Diag. r (e)	Reverse r (f)	Baseline	Static r (mean c&d)
Family planning				
Prestige (t1-t2)	.31	.04	.08	.13
Functional leadership (t1-t2)	.39	.06	.08	.13
Change agent knowledge (t1-t3)	.31	.07	.11	.29
Change agent contact (t1-t2)	.28	.22	.11	.25
Change agent contact (t1-t3)	.31	.06	.12	.30
Modern child-birth practices				
Cosmopoliteness (t1-t2)	.01	.22	.05	.09
Mass media exposure (t1-t3)	.18	.23	.06	.25
Change agent knowledge (t2-t3)	.27	.22	.11	.28
Change agent knowledge (t1-t3)	.20	.29	.07	.33
Change agent contact (t1-t3)	.21	.26	.08	.33
Education (t2-t3)	.28	.34	.18	.31
Education (t1-t3)	.30	.32	.11	.35
Bed-bug killer				
Off-farm work (resp.)(t1-t2)	.18	-.13	.01	.04
Off-farm work (oth. f.mems)(t1-t2)	.19	-.12	.01	.05
Change agent contact (t1-t3)	.19	.14	.02	.21

N = 192

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for example, may be in a position to clarify some of the specific findings. An additional observation that can be made, however, is that adoption of the three fertilizers (ammonium sulphate, superphosphate, and green manure)* seem to have produced fairly similar types of changes. All three produced later increases in agricultural production, irrigation, and one of the various indicators of status.

Of the five health innovations, two did not have adoption relationships over time with structural variables. These were typhoid and cholera innoculations, and PRAI latrines, the most and least widely adopted health innovations, respectively. Table 13 shows the relationships for the other three health innovations. Applying the same criteria as before indicates the following: adoption of these innovations at one point in time led to later increases in the variables indicated.

- family planning:	prestige functional leadership
- modern child-birth practices:	change agent knowledge
- bed-bug killer:	off-farm work (respondent) off-farm work (other family members)

The family planning relationships are of particular interest, and may have a degree of face validity. However, these findings should be treated cautiously. There were very few adopters of family planning or modern child-birth practices,* and high rates of

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*Green manure is actually a fertilizer practice, rather than a fertilizer.

*Family planning--4, 8, and 6 percent over the three time periods; and modern child-birth practices--2, 5, and 13 percent.

discontinuance for the bed-bug killer (Table 2). Agricultural innovations had generally higher levels of adoption, and for this reason the findings are probably more reliable.

To summarize this section, the adoption of agricultural innovations was shown to be causally related to numerous structural changes. The changes were increases in mainly farm-related operations and productivity, as well as status and familiarity with change agents. Seven of the ten agricultural innovations led to structural changes; green manure and superphosphate were the most widely influential innovations. Health adoption also led to certain structural changes, notably increases in off-farm work and income, and also status and familiarity with change agents. However, it was difficult to trace these influences to specific health innovations. Furthermore, the health findings on adoption consequences are suspect since there were very few adopters.

The Determination of Substructures

To empirically define sets of substructures, configurational analysis* was carried out on each of the four adoption and knowledge indices with all 35 structural variables as predictors. Only t1 and t2 data sets were submitted to configurational analysis, because of our theoretical interest in whether criterion gaps between them widen or narrow at later points in time. For this same reason, where substructures were defined on identical variables in both t1 and t2 data

*The computer program is described in Sonquist and Morgan (1964).

sets, the split criteria (codes in the variables) from t1 were preferred.

Figure 6 illustrates the pattern of relationships following configurational analysis on t1 data for predictors of agricultural adoption. The mean on the (0-10) index for all 192 respondents was 2.47. Agricultural production was then selected as the variable which explained most variance in all 192 scores. Two subgroups were then formed, according to the best partition point in the codes of agricultural production. Group 2, with a mean of 1.78 and N of 130, comprised villagers who earned 300 rupees or less in value of agricultural products in the past year. By contrast, group 3 (mean of 3.90, and N of 62) comprised villagers who earned more than 300 rupees in the past year. These subgroups then became candidates as possible substructures under the label "agricultural production."

At this stage they were only candidate substructures, because the size of subgroups defined by these criteria might be reduced to less than 30 by either t2 or t3. In this example, however, there was not undue shrinkage. Table 14, substructure number 2, shows these subgroups at t1 and subsequent periods with their means and N's.*

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*Agricultural production was measured at t1 and t2 only; hence, the number of members varies only once (See "guidelines", p. 52).

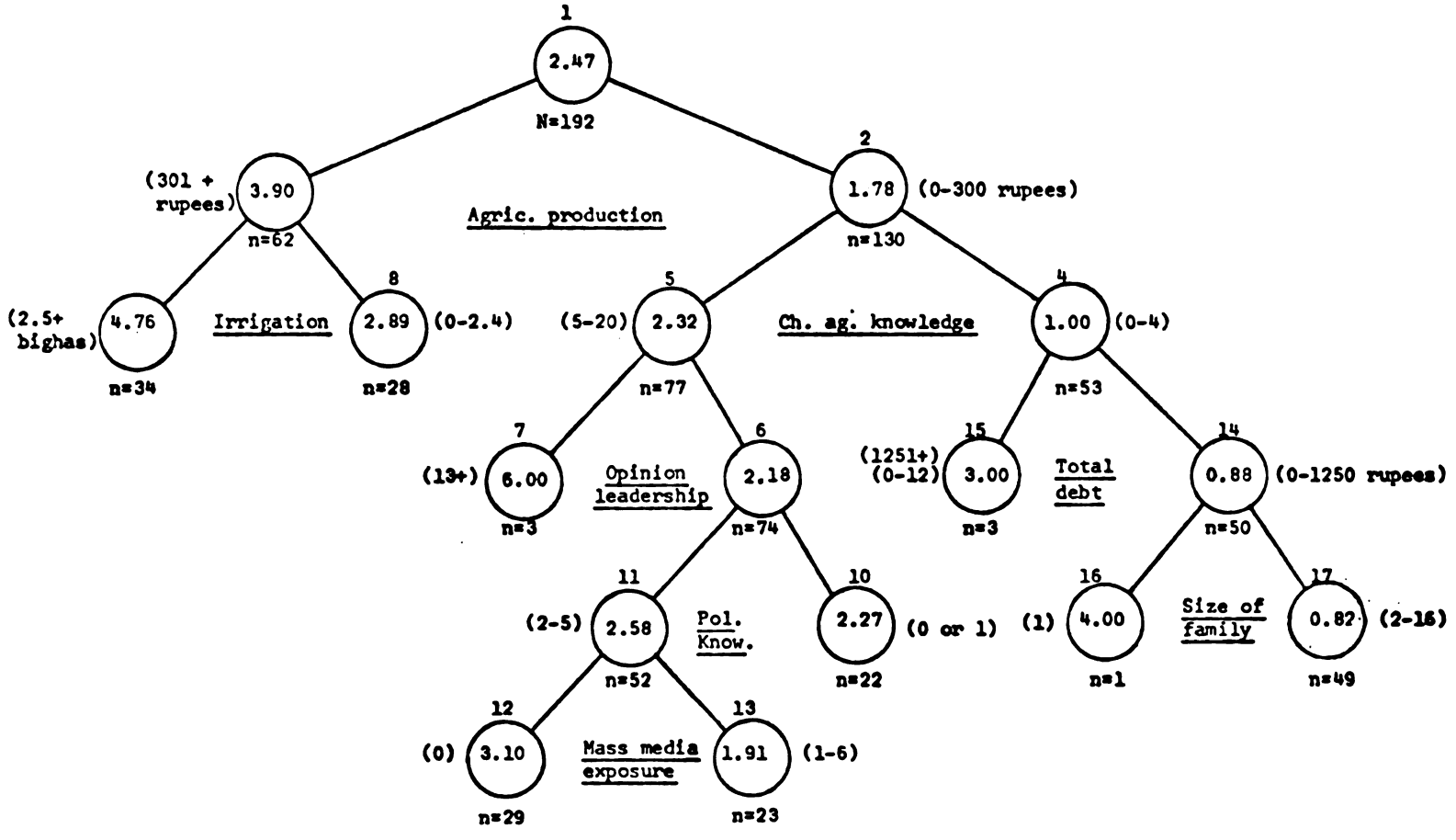

Figure 6. Configurational Analysis on t1 (1964) Data for Predictors of Agricultural Adoption.

Note: The numbers inside the circles are mean scores on agricultural adoption. Group (or circle) number 4, for example, shows a mean score of 1.00; the 53 respondents in this group have an index score of 4 or less on change agent knowledge and their agricultural production was valued at 300 rupees or less in the past year.

The "high" agricultural producers (group 3 in Figure 6) were further split into subgroups high and low on irrigation. The defining characteristics for these candidate substructures thus became the "high-highs" and "low-lows" on both agricultural production and irrigation. Again, these subgroups had 30 or more members across all three time periods. They are shown in Table 14 (substructure number 1) under the label "Agricultural production and Irrigation."

Figure 6 is constructed such that the groups on the far left and right represent the extremes in subgroup variation on the variable. Group 4 is characterized by "low" change agent knowledge and "low" agricultural production. With a membership of 53, at its specified range of codes it became a candidate substructure in conjunction with its "high-high" counterpart. The subgroup numbers, however, became too small by t2 or t3. As mentioned in the "guidelines" (page 52), a search would then be made for either: (a) the next best partition point within the codes of change agent knowledge, or (b) a variable which would divide the variance almost as well as change agent knowledge, and do so in a fairly symmetrical pattern (such that subgroups were not less than 30 in size). Thus, other candidate substructures were identified, and then examined to see whether sufficient members were included across all three points in time.

Although agricultural production maximally partitioned the population variance in agricultural adoption at t1, other variables with reasonably high eligibility criteria* were examined in order to define

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*Between sum of squares/Total sum of squares.

as many substructures as possible. These included land area cultivated and education, predictors which were almost as efficient as agricultural production for the first stage partition in agricultural adoption at t1. These variables with their optimal split points then constituted candidate substructures, which in turn were traced over time to ensure 30 or more members. Through these procedures, substructures were defined for both land area cultivated and education (Table 14, substructure nos. 4 and 5). It is interesting to note that education had not been among the "best" predictors of agricultural adoption in the earlier multiple correlation analyses at either t1 or t2 (See Table 6, p. 70).

Substructures numbered 1 through 5 in Table 14 were defined on t1 data, and substructures 6 through 9 were defined by carrying out a similar analysis on t2 data.

Table 14 also shows the means, the mean differences between the "highs" and the "lows", and the number of respondents in each substructure, at each of the three points in time. The mean differences are not directly comparable, since the mean for the whole population increased over time. For this reason, it was decided to standardize the mean differences by dividing by the population variance at each point in time. It was thought that this adjusted mean difference statistic would allow for comparisons across time in terms of gaps tending to widen or close. (These adjusted mean differences are shown in Table 14 with a double asterisk). As briefly indicated in the last chapter, however, there is a methodological flaw in using

Table 14. Differences in Mean Levels of Adoption Over Time of Ten Agricultural Innovations by Selected Substructures

Substructure	Means and Mean Differences in Agric. Adoption					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	**2.47**		**3.30**		**4.42**	
1. Agric. prod. & Irrigation						
--over 300 rupees & 2.5 bighas or more	4.77	(34)*	5.22	(37)*	6.73	(37)*
--300 rupees or less & less than 2.5 bighas	1.64	(106)	1.77	(64)	3.48	(64)
	3.13		3.45		3.25	
	.71**		.59**		.47**	
2. Agric. production						
--over 300 rupees per year	3.90	(62)	4.10	(125)	4.86	(125)
--300 rupees or less	1.78	(130)	1.79	(67)	3.60	(67)
	2.12		2.31		1.26	
	.48		.40		.18	
3. Irrigation						
--2.5 bighas or more	3.79	(58)	5.00	(40)	6.67	(40)
--less than 2.5 bighas	1.90	(134)	2.85	(152)	3.82	(152)
	1.89		2.15		2.85	
	.43		.37		.42	
4. Land area cultivated						
--6.5 bighas or more	3.77	(53)	3.97	(70)	5.04	(70)
--less than 6.5 bighas	1.97	(139)	2.90	(122)	4.06	(122)
	1.80		1.07		.98	
	.41		.18		.14	
5. Education						
--1 or more years	3.83	(46)	4.20	(74)	5.32	(74)
--less than a year	2.04	(146)	2.73	(118)	3.85	(118)
	1.79		1.47		1.47	
	.41		.25		.22	

(Table continued...)

* n's of substructures.
** Mean differences adjusted by dividing by the variance.

Note: Underlined figures are differences between the means immediately above them.

Table 14 (Contd)

Substructure	Mean and Mean Differences in Agric. Adoption					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	2.47		3.30		4.42	
6. Agric. prod. & Opinion l'ship.						
--over 300 rupees & 1 or more choices	4.27	(33)	5.11	(45)	5.87	(45)
--300 rupees or less & no choices received	1.67	(95)	1.85	(58)	3.64	(58)
	2.60		3.26		2.23	
	.59		.56		.33	
7. Level of Living						
--score of 5 or more	3.30	(90)	4.17	(100)	4.98	(100)
--score of 4 or less	1.74	(102)	2.35	(92)	3.80	(92)
	1.56		1.82		1.18	
	.35		.31		.17	
8. Social Participation						
--score of 1 or more	3.08	(111)	3.96	(122)	5.47	(116)
--score of zero	1.63	(81)	2.14	(70)	2.82	(76)
	1.45		1.82		2.65	
	.33		.31		.39	
9. Functional L'ship						
--2 or more choices received	2.88	(65)	5.05	(38)	6.26	(38)
--1 or fewer choices received	2.26	(127)	2.86	(154)	3.96	(154)
	0.62		2.19		2.30	
	.14		.38		.34	

Table 15. Differences in Mean Levels of Knowledge Over Time of Ten Agricultural Innovations by Selected Substructures

Substructure	Means and Mean Differences in Agric. Knowledge					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	6.15		8.52		8.91	
1. Irrigation & Pol. Knowledge						
--irrigation & index score of 2 or more	7.22	(74)*	9.34	(77)*	9.55	(71)*
--no irrigation & score of 1 or less	4.25	(32)	7.50	(42)	7.94	(33)
	2.97		1.84		1.61	
	.56**		.45**		.82**	
2. Irrigation & Education						
--irrigation & 1 or more years	7.90	(29)	9.36	(50)	9.42	(50)
--no irrigation & less than a year	5.11	(76)	7.78	(72)	8.56	(72)
	2.79		1.58		0.86	
	.52		.39		.44	
3. Irrigation & Level of Living						
--irrigation & score of 6 or more	7.55	(42)	9.38	(58)	9.28	(58)
--no irrigation & score of 5 or less	4.80	(70)	8.01	(71)	8.54	(71)
	2.75		1.37		0.74	
	.51		.33		.38	
4. Irrigation & Soc. Participation						
--irrigation & score of 2 or more	7.67	(30)	9.07	(41)	9.55	(47)
--no irrigation & score of 1 or less	5.21	(83)	7.92	(79)	8.62	(77)
	2.46		1.15		0.93	
	.46		.28		.47	
5. Level of Living						
--score of 6 or more	7.29	(65)	8.81	(83)	9.27	(83)
--score of 5 or less	5.57	(127)	8.30	(109)	8.63	(109)
	1.72		0.51		0.64	
	.32		.12		.32	

* n's of substructures.

** Mean differences adjusted by dividing by the variance.

Note: Underlined figures are differences between the means immediately above them.

Table 15 (Contd)

Substructure	Mean and Mean Differences in Agric. Knowledge					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	6.15		8.52		8.91	
6. Irrigation						
--irrigation	6.95	(99)	9.10	(96)	9.09	(96)
--no irrigation	5.30	(93)	7.94	(96)	8.72	(96)
	1.65		1.16		0.37	
	.31		.28		.19	
7. Political Knowledge						
--score of 2 or more	6.60	(135)	8.90	(131)	9.35	(134)
--score of 1 or less	5.09	(57)	7.71	(61)	7.88	(58)
	1.51		1.19		1.47	
	.28		.29		.75	
8. Irrigation & Mass Media Exposure						
--1.5 bighas or more & score of 1 or more	7.29	(38)	9.64	(56)	9.38	(60)
--less than 1.5 bighas & score of zero	4.80	(55)	7.08	(30)	8.32	(44)
	2.49		2.56		1.06	
	.47		.62		.54	
9. Irrigation & Ch. Ag. Contact						
--1.5 bighas or more & score of 5 or more	7.52	(52)	9.65	(52)	9.51	(55)
--less than 1.5 bighas & score of 4 or less	5.03	(63)	7.34	(73)	8.18	(40)
	2.49		2.31		1.33	
	.47		.56		.68	
10. Irrigation & Agric. prod.						
--1.5 bighas or more & over 200 rupees	7.46	(49)	9.71	(62)	9.26	(62)
--less than 1.5 bighas & 200 rupees or less	5.20	(70)	7.43	(35)	8.31	(35)
	2.27		2.28		.95	
	.42		.56		.48	

Table 15 (Contd)

Substructure	Means and Mean Differences in Agric. Knowledge					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	**6.15**		**8.52**		**8.91**	
11. Agric. Production						
--more than 500 rupees	7.38	(34)	9.28	(91)	9.26	(91)
--500 rupees or less	5.89	(158)	7.84	(101)	8.58	(101)
	1.49		1.44		0.68	
	.28		.35		.34	
12. Change Agent Contact						
--score of 5 or more	6.90	(92)	9.21	(104)	9.19	(140)
--score of 4 or less	5.46	(100)	7.70	(84)	8.14	(52)
	1.44		1.51		1.05	
	.27		.37		.53	
13. Mass Media Exposure						
--score of 2 or more	6.74	(53)	8.94	(121)	9.14	(138)
--score of 1 or less	5.93	(139)	7.80	(71)	8.32	(54)
	.81		1.14		.82	
	.15		.28		.42	

the indices (rather than items on specific innovations) as criteria for gaps in an across-time analysis of gaps. More will be said later on this aspect of across-time comparison.

Table 15 shows the thirteen substructures that were able to be defined for agricultural knowledge as the dependent variable. The procedures were identical in type to those just described for agricultural adoption. More interactive substructures were able to be defined; seven, as against only two when agricultural adoption had been the dependent variable. Substructures numbered 1 through 7 were defined on t1 data, and those numbered 8 through 13 were defined on t2 data. Again, comparisons across time in the adjusted mean statistic may be misleading; more will be said on this shortly.

Moving to health innovations, Figure 7 illustrates the results of configurational analysis on t1 data for predictors of health adoption. The pattern of subgroups contrasts sharply with the pattern just examined in Figure 6. Presumably because of relatively less variance, the 4 configurational patterns of health adoption and knowledge were far less symmetrical than the subgrouping observed for agricultural adoption and knowledge.

Although level of living makes the first stage partition in the variance (Figure 7), the "high" subgroup is comprised of only 7 members. The best split-point in the scores had been between 10 and 11 in a 0-12 index. By selecting the next best split-point (between scores 5 and 6), a more symmetrical division in numbers was obtained at the cost of an optimal division in variance. (Level of living is labelled substructure number 2 in Table 16).

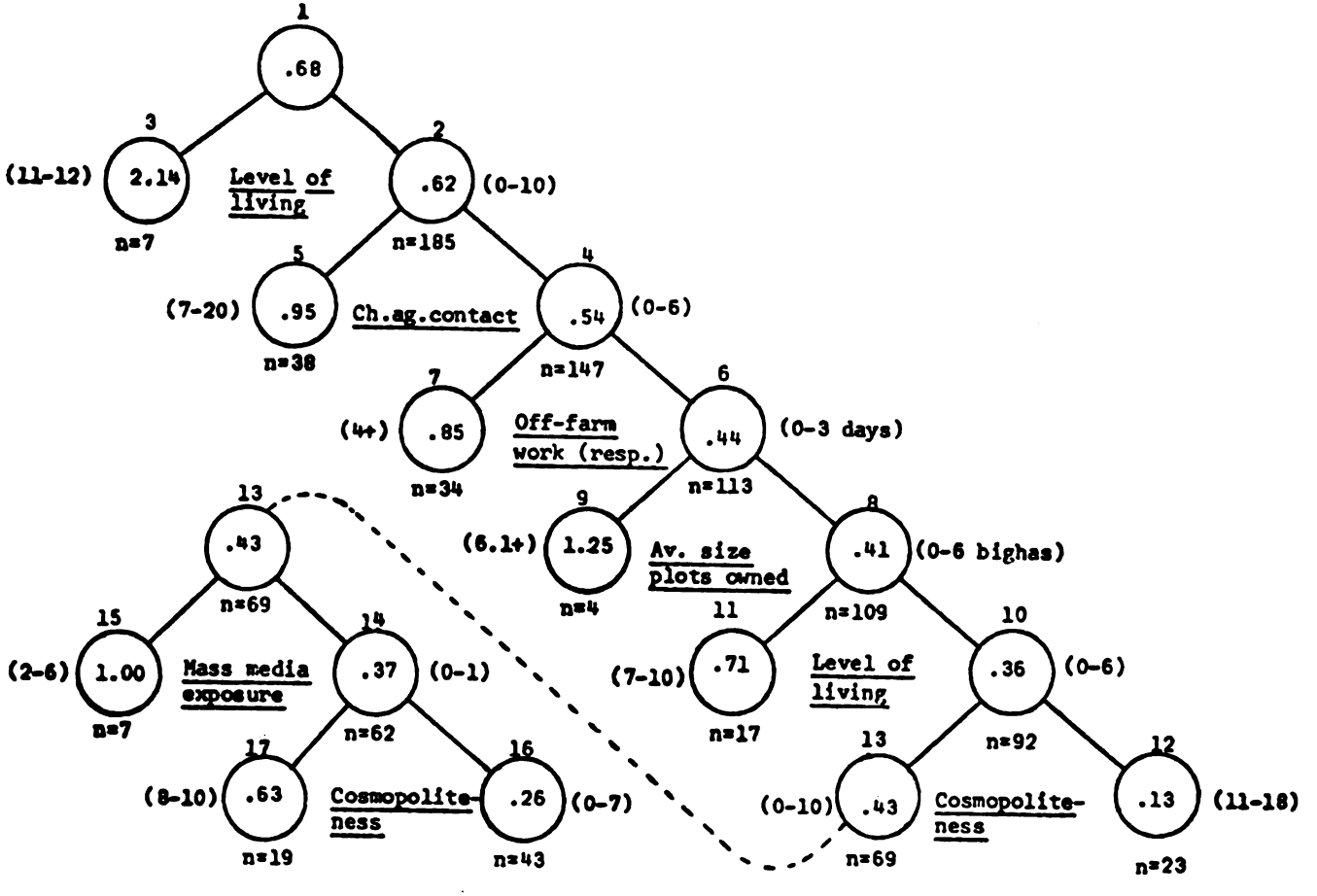

Figure 7. Configurational Analysis on t1 (1964) Data for Predictors of Health Adoption.

Note: The numbers inside the circles are mean scores on health adoptions. For example, the 34 respondents in Group 7 have a mean adoption score of .85; all worked outside their farms for four or more days in the past year, and all had change agent contact and level of living scores of 0-6 and 0-10 respectively.

Table 16. Differences in Mean Levels of Adoption Over Time of Five Health Innovations by Selected Substructures

Substructure	Means and Mean Differences in Health Adoption					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	0.68		1.00		0.92	
1. Change Agent Contact						
--score of 7 or more	1.10	(42)*	1.19	(52)*	1.24	(106)*
--score of 6 or less	.56	(150)	.94	(140)	1.54	(86)
	.54		.25		.70	
	1.17**		.29**		.77**	
2. Level of Living						
--score of 6 or more	.97	(65)	1.24	(83)	1.12	(83)
--score of 5 or less	.53	(127)	.83	(109)	.77	(109)
	.44		.41		.35	
	.95		.47		.38	
3. Education						
--2 or more yrs. of school	.97	(36)	1.41	(59)	1.29	(59)
--1 yr. or less of school	.61	(156)	.83	(133)	.76	(133)
	.36		.58		.53	
	.78		.66		.58	

* n's of substructures.
** Mean differences adjusted by dividing by the variance.

Note: Underlined figures are differences between the means immediately above them.

Table 17. Differences in Mean Levels of Knowledge Over Time of Five Health Innovations by Selected Substructures

Substructure	Means and Mean Differences in Health Knowledge					
	t1(1964)		t2(1966)		t3(1967)	
Population (N=192)	1.76		3.27		3.95	
1. Functional literacy						
--can read all 7 words	2.67	(39)*	3.80	(61)*	4.46	(57)*
--can read less than 7	1.53	(153)	3.02	(131)	3.73	(135)
	1.14		.78		.73	
	.77**		.57**		.50**	
2. Level of living						
--score of 6 or more	2.45	(65)	3.59	(83)	4.27	(83)
--score of 5 or less	1.41	(127)	3.02	(109)	3.71	(109)
	1.04		.57		.56	
	.70		.41		.39	
3. Political Knowledge						
--score of 3 or more	2.56	(43)	3.46	(97)	4.34	(103)
--score of 2 or less	1.53	(149)	3.06	(95)	3.49	(89)
	1.03		.40		.85	
	.70		.29		.58	
4. Education						
--1 or more years	2.46	(46)	3.57	(74)	4.35	(74)
--less than 1 year	1.54	(146)	3.08	(118)	3.70	(118)
	.92		.49		.65	
	.62		.36		.45	
5. Agric. production						
--over 500 rupees	2.53	(34)	3.69	(91)	4.24	(91)
--500 rupees or less	1.60	(158)	2.88	(101)	3.68	(101)
	.93		.81		.56	
	.63		.59		.39	

* n's of substructures.
** Mean differences adjusted by dividing by the variance.

Note: Underlined figures are differences between the means immediately above them.

Table 16 shows contrasting substructures defined by change agent contact, the variable which partitioned the variance in health adoption at the second stage of configurational analysis. These were the only two substructures able to be defined from the t1 data analysis. A third, education, was added from the analysis of the t2 data.

Through comparable procedures it was possible to define five substructures in relation to health knowledge. These are shown in Table 17, along with their means, mean differences, adjusted mean differences, and number of respondent members in each substructure.

Having defined substructures for all four main indices, we now turn to an examination of the problem with the adjustment mean difference statistic (Tables 14 through 17).

Since a study objective is investigation of widening and closing tendencies in criterion gaps, one approach could be to compute across-time changes in the standardized mean difference statistic. This would indicate net changes in gaps which have as their criteria the four main indices. Gaps which widened between earlier and later points in time would have positively signed changes in the adjusted mean difference statistic; gaps which narrowed would have negatively signed changes in this statistic. Sign tests would then indicate probabilities associated with observed widening or narrowing tendencies. That is, tendencies for the indices, each of which references a number of innovations.

The "findings" of such an analysis are shown in Tables 18 and 19. On the basis of the above reasoning, the entries in Table 18 would

suggest that most agricultural adoption gaps show narrowing tendencies across all of the change periods; also, that there are mixed findings for widening or narrowing gaps in the case of agricultural knowledge. Additionally, Table 19 would indicate that most gaps for health innovations show narrowing tendencies.

Conclusions such as these would be spurious. As the findings in the next section of this chapter show, gaps which have indices as criteria and gaps which have the specific innovation-items as criteria "behave" quite differently. Indices derived from the simple summation of innovations adopted or known about are satisfactory for "within-time" analyses--and, therefore, for defining substructures. However, different innovations make up the indices, such that different gaps can be referenced by the same index scores. The across-time changes in different levels of an index, therefore, may represent "cancelling out", or "summing together", of specific gaps which are responding quite differently across time based on the different innovations. The results based on indices could well be meaningless simply because gaps for <u>each</u> innovation may be increasing or decreasing over time. Table 18 and 19 have been included in the presentation of findings purely for methodological reasons. The Tables will be referred to again later, after examining the "behavior" of gaps based upon criteria about specific innovations rather than indices.

In summary, as many substructures as possible each with 30 or more members have been determined directly through configurational analysis, and indirectly through a modifying set of guidelines. A

Table 18. Net Changes Over Time between Substructures in Adjusted Mean Differences in Agricultural Adoption and Agricultural Knowledge

Substructures*	Net Changes in Adjusted Mean Differences in Dependent Variable		
	t1 to t2	t2 to t3	t1 to t3
Dependent variable: Agric. Adoption			
1. Agric. prod. & Irrigation	-.12	-.12	-.24
2. Agric. production	-.08	-.22	-.30
3. Irrigation	-.06	+.05	-.01
4. Land area cultivated	-.22	-.04	-.27
5. Education	-.16	-.03	-.19
6. Agric. prod. & Opinion l'ship	-.03	-.23	-.26
7. Level of living	-.04	-.14	-.18
8. Social participation	-.03	+.08	+.06
9. Functional leadership	+.24	-.04	+.20
Sign Test (two-tailed) p =	.04	.18	.18
Dependent Variable: Agric. Knowledge			
1. Irrigation & Pol. knowledge	-.11	+.37	+.26
2. Irrigation & Education	-.13	+.05	-.08
3. Irrigation & Level of living	-.18	+.05	-.13
4. Irrigation & Soc. participation	-.18	+.19	+.01
5. Level of living	-.20	+.20	.00
6. Irrigation	-.03	-.09	-.12
7. Political knowledge	+.01	+.46	+.47
8. Irrig. & Mass media exposure	+.15	-.08	+.07
9. Irrig. & Change agent contact	+.09	+.12	+.21
10. Irrig. & Agric. production	+.14	-.08	+.06
11. Agric. production	+.07	-.01	+.06
12. Change agent contact	+.10	+.16	+.26
13. Mass media exposure	+.13	+.14	+.27
Sign Test (two-tailed) p =	.50	.26	.14

* The substructures correspond to those defined in Tables 14 and 15.

Note: The adjusted mean differences between substructures are reported in Tables 14 and 15. This table and the next one show net changes in this statistic separately to enable a clearer evaluation of whether gaps widen or close.

Table 19. Net Changes Over Time between Substructures in Adjusted Mean Differences in Health Adoption and Health Knowledge

Substructures*	Net Changes in Adjusted Mean Differences in Dependent Variable		
	t1 to t2	t2 to t3	t1 to t3
Dependent variable: Health Adoption			
1. Change agent contact	-.88	+.48	-.40
2. Level of living	-.48	-.09	-.57
3. Education	-.12	-.08	..20
Dependent variable: Health Knowledge			
1. Functional literacy	-.20	-.07	-.27
2. Level of living	-.29	-.02	-.31
3. Political knowledge	-.41	+.29	+.12
4. Education	-.26	+.09	-.17
5. Agric. production	-.04	-.20	-.24
Sign Test (health knowledge only; two-tailed) p=	.06	.50	.32

*The substructures correspond to those defined in Tables 16 and 17.

preliminary analysis of widening and closing substructural criterion gaps encountered problems with across-time comparisons in a standardized difference statistic. Indices of responses about specific innovations appear satisfactory for defining substructures, but not for over-time changes in the criterion gaps.

Across-Time Changes in Substructural Criterion Gaps

There appear to be two main ways to classify adoption and knowledge gaps: those based on the same substructures but different innovations, and those based on the same innovations but different substructures.

For the 10 agricultural innovations, 9 substructures were defined in terms of being applicable to adoption gaps and 13 were defined in terms of being applicable to knowledge gaps. To analyze whether gaps widen or close, therefore, we have samples available of 90 adoption gaps and 130 knowledge gaps for agricultural innovations.

With respect to the 5 health innovations, only 3 substructures were defined in terms of being applicable to adoption gaps, and 5 substructures in terms of knowledge gaps. Thus, there are smaller samples available for the health innovations: 15 adoption gaps and 25 knowledge gaps.

Three sets of findings will be presented: (1) frequencies of widening and narrowing gaps in each of the four samples of gaps, and then cross-classifications (2) by innovation, and (3) by substructure.

Before turning to the findings we need to be clear about the measures of gaps, the applicability of the substructures defined for them, and the criteria for widening or closing tendencies.

Within each substructural classification, the percentage of adopters (or knowers) at each of the three points in time was obtained. For example: in 1964 (t1) the innovation, superphosphate, had been adopted by 29 percent of those "high" on agricultural production and irrigation, and by 7 percent of those "low" on these two variables.* By 1966 (t2), the percentage adoption among the "highs" was 46 percent, and 14 percent for "lows". The 1967 (t3) survey found that 76 percent of those classified as "high" by the same criteria had adopted superphosphate, and 58 percent of the "lows" had adopted. The three "within-time" differences are, respectively, 22, 32 and 18 percentage points. The t1 to t2 difference is +10 percentage points; this adoption gap widened by that amount. The t2 to t3 difference is -14 percentage points; the gap narrowed by this amount. And the t1 to t3 difference is -4 percentage points; in the longer term situation the gap narrowed by 4 percentage points. Computations of this type were carried out for all gaps in the four samples.

Were the substructures defined on the basis of variance in the indices suitable for the analysis of criterion gaps for specific innovations? The four samples and three sets of data gave a total of

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*Over 300 rupees per year and 2.5 bighas or more for the "highs" category, and 300 rupees or less and less than 2.5 bighas for the "low" category.

780 "within-time" comparisons of adoption and knowledge levels between "highs" and "lows". In only 11 of the comparisons was a percentage on a criterion variable for a "low" category higher than the percentage for the "high" category.* In other words, differences in adoption and knowledge at each point in time were in the expected directions for all but one percent of the comparisons for criteria on specific innovations. Therefore, the substructures defined on the basis of variance in the overall indices seemed to be well suited to the analysis of gaps concerning specific innovations.

In summarizing the findings for widening and closing tendencies, our focus will be directed mainly toward certain patterns which were of theoretical interest in the earlier chapters. Briefly stated, these are as follows:

(1) adoption or knowledge gaps which initially widen (t1 to t2) and then show narrowing tendencies (t2 to t3). This was the earlier stated general working hypothesis.

(2) adoption gaps which either:

(a) widen over the period of the media forums (t1 to t2) and continue to widen (t2 to t3),

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*Although the sign is negative on such reversed "within-time" gaps, conceptually we are interested in across-time widening or closing. Hence, it was assumed in these few cases that the gap had closed, and the difference at that point in time was zero.

or

(b) narrow over the period of the media forums and continue to narrow.

These last-mentioned situations will be of interest later in terms of a predominance either way having possible social change implications.

The frequencies of widening and narrowing tendencies among the four samples of gaps are shown in Table 20. According to the general working hypothesis, gaps were expected to widen over the period when the media forums were in progress (between t1 and t2), because of selective processes. Fifty of the adoption gaps for agricultural innovations did widen over this period, against 36 which narrowed; 4 showed no change. The difference between the widening and narrowing gaps is not statistically significant, although it approaches the usual 10 percent level for exploratory studies ($p < .12$). More adoption gaps narrowed that widened between t2 and t3 (45 versus 37). This fits our theoretical expectations although the difference is not statistically significant or close to being so. The overall t1 to t3 observations showed no clear trend: 44 gaps widened and 41 narrowed. Thus, the general hypothesis with respect to adoption gaps for agricultural innovations is not confirmed.

Knowledge gaps for agricultural innovations showed strong narrowing tendencies across all three time periods. Three Chi-square tests between narrowing and widening gaps were all significant beyond the .001 level. The hypothesis is obviously not confirmed.

Table 20. Frequencies of Widening or Narrowing Gaps in Adoption and Knowledge of Innovations

Criterion & Change Period	Narrowing Gaps (-)	No Change (0)	Widening Gaps (+)	p value* (exc. no change)	
	f	f	f		
Adoption of Agric. Innovations					
t1 to t2	36	4	50	2.28	n.s.
t2 to t3	45	8	37	0.78	n.s.
t1 to t3	41	5	44	0.11	n.s.
N of gaps = 90					
Knowledge of Agric. Innovations					
t1 to t2	86	8	36	20.49	p<.001
t2 to t3	89	7	34	24.59	p<.001
t1 to t3	110	4	16	70.13	p<.001
N of gaps = 130					
Adoption of Health Innovations					
t1 to t2	5	2	8	0.50	n.s.
t2 to t3	7	0	8	0.50	n.s.
t1 to t3	4	3	8	0.38	n.s.
N of gaps = 15					
Knowledge of Health Innovations					
t1 to t2	16	2	7	0.09	p<.10
t2 to t3	11	1	13	0.50	n.s.
t1 to t3	16	2	7	0.09	p<.10
N of gaps = 25					

*Two-tailed tests--Chi-square on the Agricultural frequencies, and Sign test on the Health signs

More important than the working hypothesis disconfirmation, however, is that a number of previous "knowledge-gap" studies in mass communication research are not supported. Most studies have examined across-time patterns for one knowledge gap only, and between categories "high" and "low" on education only. They have also not been associated with a planned change program, and the research has been mostly in less traditional and larger social systems. Thus, the present findings are not directly comparable; they are therefore non-supporting, rather than disconfirming, of the work by Tichenor and his associates.

Turning to health innovations, the number of adoption gaps is too small to give much indication of narrowing or closing tendencies. However, the pattern does appear to more closely fit the adoption gap findings for agricultural innovations than the knowledge gap findings. In other words, as with agricultural adoption gaps, the health adoption gaps show no marked trend either toward widening or closing.

The knowledge gaps for health innovations show a similar trend to the knowledge gaps for agricultural innovations, but the trend is less pronounced. Although the number of gaps is small (N=25), sign tests are significant at the 10 percent for more closing than widening gaps in the t1-t2 and t1-t3 periods.

Thus, the working hypothesis is not confirmed by findings in any of the four samples of gaps. Given the exploratory nature of the study, however, the status of the hypothesis is of less importance than the substantive findings. Of a total one hundred and five adoption gaps no clear trend is shown either way, toward widening or

closing; of a total one hundred and fifty five knowledge gaps there is a strongly pronounced trend toward closing gaps rather than widening gaps.

It was earlier argued that indices of adoption and knowledge are not suited to across-time "gap" analyses; for the gaps associated with the specific innovations when treated in the aggregate tend to "cancel" or "sum" in a meaningless fashion. The earlier "findings" (Tables 18 and 19) are clearly different to the main findings just discussed on gap tendencies (Table 20). The earlier cautions appear to be justified about the use of indices in across-time studies of substructural criterion gaps.

Given the main findings, we now turn to whether certain innovations rather than others, or certain substructures rather than others, showed adoption gap tendencies with possible social change implications. For which innovations or substructures did adoption gaps continue to widen or continue to narrow? This question can be viewed in either of two ways: in terms of the frequencies of signed changes within each change period, or in terms of the average amounts of change in percentage points. Table 21 through 24 summarize the adoption-gap findings as far as both frequencies and amounts of change are concerned. The discussion below, however, gives relatively greater emphasis to the average amounts of change.

Table 21 shows adoption-gap changes for each agricultural innovation, across all nine substructures previously defined via configurational analysis on the agricultural adoption index. In terms of the

Table 21. Changes Over Time in Adoption Gaps of Agricultural Innovations by Innovation

Innovation	Changes in Adoption Gaps of Agric. Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
Jap. meth. paddy cult.	3	0	6	+6.3	4	1	4	+0.6	2	0	7	+8.0
Line sowing	4	2	3	-1.7	5	0	4	-0.4	6	0	3	-2.1
Imp. potato seed	0	0	9	+22.2	7	1	1	-13.7	2	0	7	+8.6
Green manure	6	0	3	-3.2	5	0	4	-3.2	6	1	2	-5.3
Ammonium sulphate	3	1	5	0.0	7	0	2	-3.4	5	0	4	-4.4
Insecticide	1	0	8	+7.8	3	1	5	+2.3	0	1	8	+9.8
Modern plough	5	1	3	-5.8	7	2	0	-13.3	9	0	0	-19.1
Tine cultivator	7	0	2	-1.8	2	3	4	+0.5	7	1	1	-1.1
Animal dis. innoc.	2	0	7	+8.2	1	0	8	+9.0	0	1	8	+17.2
Superphosphate	5	0	4	-0.1	4	0	5	+5.9	4	1	4	+5.8
Total =	36	4	50		45	8	37		41	5	44	
$\bar{X}$ =				+3.2				-1.7				+1.7
N of substructures = 9					N of gaps in each change period = 90							

Note: Entries in the first row and first columns read as follows: Of 9 substructural gaps in percentage adoption of Japanese method of paddy cultivation observed at t1, 3 narrowed and 6 widened between t1 and t2. The mean change in percentage points for all 9 changes between t1 and t2 for this innovation was +6.3.

Table 22. Changes Over Time in Adoption Gaps of Agricultural Innovations by Substructure

Substructure*	Changes in Adoption Gaps of Agricultural Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
Ag. prod. & irrig.	4	1	5	+4.4	4	1	5	-1.5	4	1	5	+2.9
Ag. prod.	4	0	6	+3.3	8	0	2	-10.0	7	0	3	-6.6
Irrigation	3	1	6	+3.1	3	2	5	+6.7	3	0	7	+10.8
Land area cult.	7	0	3	-7.1	5	1	4	-1.1	8	1	1	-8.2
Education	5	1	4	-2.9	4	1	5	0.0	6	0	4	-2.9
Ag. prod. & Op. l'ship	4	1	5	+7.0	8	1	1	-10.5	5	1	4	-3.5
Level of living	5	0	5	+2.8	7	0	3	-6.6	5	2	3	-2.8
Soc. participation	4	0	6	+3.5	3	1	6	+8.4	2	0	8	+11.9
Functional l'ship	0	0	10	+14.7	3	1	6	-0.7	1	0	9	+14.0
Total =	36	4	50		45	8	37		41	5	44	
$\bar{X}$ =				+3.2				-1.7				+1.7
N of innovations = 10					N of gaps in each change period = 90							

*Definitions of each substructure are given in Table 14.

Note: Entries in the first row & columns read as follows: Between t1 & t2, 4 innovations defined on the basis of agric. prod. & irrigation had narrowing gaps, 1 had no change, & 5 had widening gaps. The mean change in percentage points for all changes in all innovations for this type of substructure was +4.4.

Table 23. Changes Over Time in Adoption Gaps of Health Innovations by Innovation

Innovation	Changes in Adoption Gaps of Health Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\overline{X}$%	(-)	(0)	(+)	$\overline{X}$%	(-)	(0)	(+)	$\overline{X}$%
PRAI latrines	1	1	1	+0.7	1	0	2	+0.3	1	1	1	+0.3
Bed-bug killer	2	0	1	-2.0	2	0	1	+1.7	1	1	1	-0.3
Mod. child birth pr's	0	1	2	+0.7	0	0	3	+9.7	0	0	3	+10.3
Typhoid & cholera innoc.	2	0	1	-6.3	1	0	2	+10.3	1	0	2	+4.0
Family planning	0	0	3	+4.3	3	0	0	-5.7	1	1	1	-1.3
Total =	5	2	8		7	0	8		4	3	8	
$\overline{X}$ =				-0.5				+3.3				+2.6

N of substructures = 3

N of gaps in each change period = 15

Note: Entries in the first row and columns read as follows: Of 3 substructural gaps in percent adoption of PRAI latrines observed at t1, 1 widened, 1 showed no change and 1 narrowed between t1 and t2. The mean change between t1 and t2 for this innovation was +0.7.

Table 24. Changes Over Time in Adoption Gaps of Health Innovations by Substructure

Substructure	Changes in Adoption Gaps of Health Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
Ch. ag. contact	2	0	3	-3.8	2	0	3	+7.6	0	2	3	+3.8
Level of living	1	2	2	-0.6	3	0	2	-1.0	3	0	2	-1.6
Education	2	0	3	+2.8	2	0	3	+3.2	1	1	3	+5.6
Total =	5	2	8		7	0	8		4	3	8	
$\bar{X}$ =				-0.5				+3.3				+2.6

N of innovations = 5

N of gaps in each change period = 15

*Definitions of each substructure are given in Table 16.

hypothesis, gaps for only one of the ten innovations (improved potato seed) are shown to widen initially (t1-t2) and then narrow (t2-t3). (Although the averages in amounts of change for all innovations do show this trend, consistent with the overall frequencies mentioned before). Turning to tendencies with possible social change implications, gaps for one innovation do continue to narrow over time (the modern plough). However, this appears to be partially off-set by gaps for another innovation which continue to widen over time (animal disease innoculation). The adoption of neither was earlier shown to be causally related to many structural changes. Thus, there are no strong trends either way; the slight tendencies which are present are "balanced" with respect to longer-term influences leading toward social change.

Different substructures might be expected to have different influences on increasing or decreasing adoption gaps. In general, however, there is less variation in amounts of change in gaps among substructures (Table 22) than among innovations (Table 21). Although five substructures against only one innovation fit the hypothetical pattern of widening and then closing gaps, the amounts of change are not great. Thus, the hypothesis appears to receive slightly more support when analyzed by type of substructure, rather than type of innovation. But it is clearly not supported even in this analysis, for only five out of the nine substructures show this pattern and rather weakly in terms of magnitude.

Adoption gaps for agriculture for only two of the nine substructures show further widening tendencies across both change periods (irrigation, and social participation). Again, the amounts of change are not great within the study time periods, although with continuing divergence they could become sizeable. No adoption gaps for any substructures show continuing tendencies to narrow. However, the net effect for the total study period (t1-t3) is for more substructures to show slightly narrowing tendencies than widening tendencies. Thus, as far as social implications are concerned there is once again no clear-cut trend. The agricultural adoption gaps, whether analyzed by innovation or substructure, show neither frequent nor strong signs of either widening consistently or closing consistently.

The much smaller number of adoptions gaps for health innovations (N=15) show a similarly mixed pattern. Table 23 summarizes the findings for the analysis by health innovations. Adoption gaps for family planning fit the hypothesized trends, but the amounts of change are only a few percentage points. There is a continually diverging pattern across substructures for the innovation, modern child-birth practices; and adoption of this innovation was evidenced earlier to lead to increased levels of change agent knowledge. Again, however, this is only one innovation out of four, rather than being a dominant pattern for this class of innovations. Table 24 shows changes in health adoption gaps by substructures. Only three substructures had been defined, and adoption gaps for none of the three deviate from the (mixed) trends that have been described.

The situation is quite different for knowledge gaps. Table 25 and 26 summarize the findings for knowledge gaps about agricultural innovations, by innovation, and by substructure, respectively. Although the odd innovation or the odd substructure has widening and then closing gaps, the percentage-point changes are quite small. In other words, there is only an occasional instance of signed support for the hypothesis, and then only very weakly in terms of magnitude. The dominant and strong trend in both types of cross-classifications is for knowledge gaps to narrow over the intermediate and overall change periods.

Which knowledge gaps about agricultural innovations narrowed the most or the least? Over the total study period (t1-t3), knowledge gaps about superphosphate, the modern plough, line sowing, and green manure, all narrowed by an average of 16 or more percentage points (Table 25). All four innovations were widely known in the study population by t2 or t3. By t3, ninety percent or more of the respondents were aware of each of these particular innovations (Table 3). On the other hand, the only agricultural innovation for which knowledge gaps did not decrease over the study period was the tine cultivator; knowledge gaps for this innovation widened by an average of 6 percentage points (Table 25). This was among the least widely known agricultural innovations, and it was the least widely adopted one (Table 2). Thus, it appears that "ceiling effects" were influential. Where they were greatest, knowledge gaps for those innovations tend to show stronger narrowing tendencies. Where "ceiling

Table 25. Changes Over Time in Knowledge Gaps about Agricultural Innovations by Innovation

Innovation	Changes in Knowledge Gaps about Agricultural Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
Jap. meth. paddy cult.	10	3	0	-10.8	8	1	4	-3.4	12	0	1	-14.2
Line sowing	13	0	0	-16.9	8	1	4	-0.8	13	0	0	-17.7
Imp. potato seed	8	2	3	-2.3	9	0	4	-4.9	10	2	1	-8.4
Green manure	11	0	2	-14.9	6	0	7	-1.5	12	0	1	-16.3
Ammonium sulphate	2	2	9	+5.2	13	0	0	-13.5	11	1	1	-8.2
Insecticide	10	0	3	-6.2	11	2	0	-5.5	13	0	0	-11.7
Mod. plough	13	0	0	-17.2	7	3	3	-0.6	13	0	0	-17.7
Tine cultivator	6	0	7	+7.9	5	0	8	+2.8	5	0	8	+6.0
Animal dis. innoc.	6	0	7	+1.0	9	0	4	-5.2	8	1	4	-4.2
Superphosphate	7	1	5	-0.4	13	0	0	-23.1	13	0	0	-23.5
Total =	86	8	36		89	7	34		110	4	16	
$\bar{X}$ =				-5.6				-5.6				-11.6

N of substructures = 13

N of gaps in each change period = 130

Table 26. Changes Over Time in Knowledge Gaps about Agricultural Innovations by Substructure

Substructure*	Changes in Knowledge Gaps about Agricultural Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
Irrig. & pol. know.	7	0	3	-11.3	5	1	4	-2.2	7	1	2	-13.5
Irrig. & educ.	9	0	1	-11.8	8	0	2	-7.1	10	0	0	-18.9
Irrig. & level of liv.	10	0	0	-14.8	8	1	1	-5.6	9	0	1	-20.4
Irrig. & soc. partic.	9	1	0	-13.1	4	1	5	-2.2	9	0	1	-15.3
Level of liv.	10	0	0	-12.2	3	1	6	+1.6	8	1	1	-10.6
Irrig.	7	1	2	-7.5	8	0	2	-7.2	10	0	0	-11.7
Pol. know.	6	0	4	-3.0	4	0	6	+2.6	9	0	1	-5.2
Irrig. & mass media	6	0	4	+0.5	9	1	0	-15.1	9	0	1	-14.6
Irrig. & ch. ag. contact	5	2	3	-3.9	9	0	1	-8.8	7	2	1	-12.7
Irrig. & ag. prod.	3	1	6	+0.3	10	0	0	-13.4	10	0	0	-15.7
Ag. prod.	4	1	5	-0.4	10	0	0	-7.6	9	0	1	-8.0
Change ag. contact	5	1	4	+0.1	6	1	3	-4.1	7	0	3	-4.0
Mass media exp.	5	1	4	+1.4	5	1	4	-3.1	6	0	4	+0.2
Total =	86	8	36		89	7	34		110	4	16	
$\bar{X}$ =				-5.6				-5.6				-11.6

N of innovations = 10 — N of gaps in each change period = 130

*Definitions of each substructure are given in Table 15.

Table 27. Changes Over Time in Knowledge Gaps about Health Innovations by Innovation

Innovation	Changes in Knowledge Gaps of Health Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
PRAI Latrines	4	0	1	-8.8	1	0	4	+10.4	2	1	2	+1.6
Bed-bug killer	2	0	3	-0.8	3	0	2	-1.4	3	1	1	-2.2
Mod. child birth pr's	0	2	3	+8.0	2	1	2	-2.0	1	0	4	+6.0
Typhoid & cholera innoc.	5	0	0	-15.8	2	0	3	-13.0	5	0	0	-28.8
Family planning	5	0	0	-25.6	3	0	2	-0.6	5	0	0	-26.2
Total =	16	2	7		11	1	13		16	2	7	
$\bar{X}$ =				-8.6				-1.3				-9.9

N of substructures = 5

N of gaps in each change period = 25

Table 28. Changes Over Time in Knowledge Gaps about Health Innovations by Substructure

Substructure*	Changes in Knowledge about Health Innovations											
	t1 to t2				t2 to t3				t1 to t3			
	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%	(-)	(0)	(+)	$\bar{X}$%
Functional lit.	4	0	1	-8.6	1	0	4	-1.4	4	0	1	-10.0
Level of living	3	1	1	-9.2	3	0	2	-0.6	4	0	1	-9.8
Pol. know.	4	1	0	-14.4	2	0	3	-3.2	3	0	2	-17.6
Education	3	0	2	-8.4	2	0	3	+3.2	2	2	1	-5.2
Agric. prod.	2	0	3	-2.4	3	1	1	-4.6	3	0	2	-7.0
Total =	16	2	7		11	1	13		16	2	7	
$\bar{X}$ =				-8.6				-1.3				-9.9

N of innovations = 5

N of gaps in each change period = 25

*Definitions of each substructure are given in Table 17.

effects" were either not encountered or were less severe, knowledge gaps did not narrow as rapidly.

The analysis of agricultural knowledge gaps by substructures (Table 26), shows a generally similar pattern to the analysis by innovations. Nine of the thirteen substructures had mean decreases over the whole period of 10 or more percentage points. The substructure defined by mass media exposure was the only one not to show an average decrease in knowledge gaps over the whole period (+.02). This would seem to have a degree of face validity, in that the more highly exposed persons had channels additional to interpersonal ones to "keep ahead" of knowledge increases through interpersonal channels among the less-exposed.

Findings on knowledge gap tendencies for health innovations are shown in Tables 27 and 28. The patterns for the smaller number of gaps are generally similar to those for the agricultural knowledge gaps. The "ceilings effects" relationship with decreasing knowledge gaps is again evident. The most marked narrowing tendencies were found for the innovations, typhoid and cholera innoculations, and family planning. These were also the most widely known innovations, with over ninety percent of all respondents aware of both innovations by t3.

In summary, findings on the across-time changes in adoption gaps presented no distinct trends. Gaps for different innovations, or those defined by different substructures, did vary to some extent. However,

these were mostly small variations and they tended to "cancel" each other as far as net effects were concerned. By contrast, knowledge gaps showed strong overall narrowing tendencies, although almost none had actually "closed" by 1967. Differences in rates of decrease were suggested to be mainly a result of "ceiling effects" on overall knowledge levels.

CHAPTER V

SUMMARY AND DISCUSSION

Summary

The present study was designed to explore intra-system differences in diffusion criteria and consequences of adoption in an across-time analysis. Emphasis was placed on the degree to which inequalities in diffusion criteria, and perhaps social inequalities, may tend as a result of planned change to become equalized or further differentiated over time.

The study had three main interrelated objectives. These were to explore: (1) different rates of adoption and knowledge gains in different segments of a social system, particularly whether "gaps" in adoption or knowledge between segments tended over time to widen or close; (2) causal relationships between adoption and later changes in structural criteria; and (3) implications for social change in terms of an altered overall structural form, depending upon certain antecedent conditions relating to the first and second objectives. Only the first and second objectives were directly tied to data analysis. The third objective has been referred to from time to time in reporting findings related to the other objectives; it rests upon a set of assumptions and will be considered in more detail shortly from a joint consideration of the other findings.

Reanalysis was carried out for a set of three-time panel data with 192 Indian villagers as the respondents. These villagers had been members of the target population of a planned change program to diffuse new ideas about agricultural and health-related practices. Their adoption levels of these practices were significantly higher than the adoption levels of members of control villages which had not been part of the change program.

Substructures were stated to be specified parts of a social system defined by reference to certain statuses or roles. Indices of adoption and knowledge of the innovations were used as criterion variables to empirically define sets of substructures for each of the indices; that is, for the first and second of the three sets of data only. Each substructure represented a close to maximal partition in the variance of index scores at each stage of procedures in the analysis which defined the substructures. The substructures then became units of analysis, with at least thirty members although the N's could vary over time depending upon structural changes within the system. "High" and "low" categories for the criterion indices were thereby contrasted, such that "gaps" for adoption or knowledge of specific innovations were able to be identified. On the basis of the applicability of the substructure (the criterion index which has been used to define it), and the type of innovation (agricultural or health), four samples of gaps were able to be identified: adoption gaps of agricultural innovations (total=90), knowledge gaps of agricultural innovations (130), adoption gaps of health innovations (15), and

knowledge gaps of health innovations (25).

In the absence of previous and directly related findings, a general working hypothesis was advanced. Gaps were expected to widen initially because of selective processes, and to then narrow via "strategic" interpersonal and cross-substructural communicators spreading information and influence on the new ideas. This conceptual distinction between earlier and later time periods was made in terms of the processes thought to be involved following the change program. The distinction was a relative one. It was difficult to specify what might constitute "sufficient" time periods, given the actual time periods between panel measures in the available data.

The hypothesis was not supported for either adoption or knowledge gaps. Adoption gaps of both agricultural and health innovations neither showed major differences in time periods, nor clear trends toward either narrowing or widening. Across the same substructures, there were numerous but not important differences between the innovations for narrowing or widening tendencies. The direction and size of gap changes for one innovation tended to be cancelled by another innovation. This was also the pattern for differently defined substructures, across the same set of innovations. Thus, for adoption gaps the observed pattern was not that of "more-advantaged" segments increasing their rates of adoption relative to "less-advantaged" segments; nor, however, was it that the "less-advantaged" segments were "catching-up". There were different <u>levels</u> of adoption; but the <u>rates</u> of adoption of "more-advantaged" relative to "less-advantaged" segments were approximately the same.

On the other hand, gaps in knowledge about innovations did show clear trends--by far the greatest number narrowed rather than widened ($p<.001$). This pattern was observed almost regardless of the time period involved, the substructure type, or the innovation. However, there were different degrees of narrowing in knowledge gaps. The major factor seemed to be whether "ceiling effects" had been encountered for a particular innovation. Innovations which were the most widely known in the study population as a whole, were also those for which knowledge gaps tended to decrease the most. Conversely, innovations which were less well-known at large showed weaker narrowing tendencies. Thus, those in "more-advantaged" segments in terms of various status and role criteria knew of more innovations than those in "less-advantaged segments"; but limits were reached for the "more-advantaged" segments such that nearly everyone was informed. The increasing rates of knowledge-gain had been slowed down. However, rates of knowledge-gain could and did continue to increase in the "less-advantaged" segments.

Thus, although clear and strong narrowing tendencies were observed for knowledge gaps, these findings should be viewed with caution. Had there been more knowledge able to be acquired by the "more-advantaged" segments, the fairly clear-cut narrowing tendencies may not have been found. The findings may be an artifact of the ceiling effects. On the other hand, for a discrete set of messages input to a social system, there is likely to be an upper limit as to what can be known about that particular set. Ceiling effects to some degree and at some

eventual stage, are probably inherent in the nature of change programs which are not "on-going". That is, where there are discrete numbers of topics to cover or innovations to advocate.

Causal relationships between adoption of innovations and later changes in structural criteria were examined by means of cross-lagged panel correlations which can be assessed against a "no cause" baseline statistic. Certain additional criteria for determining causality were also specified, in part because of the large number of associations examined and sampling theory considerations.

Indices of adoption of agricultural and health innovations were found to be fairly strong predictors of later structural changes. Agricultural adoption led to increases in variables which reflected farm-operating activity and productivity, as well as increases in status and familiarity with change agents. Health adoption also led to increases in status and familiarity with change agents, and to amounts of work and income outside the respondent's farm. When the relationships for adoption of specific innovations were examined, seven of the ten agricultural innovations were found to be causally associated with later increases in certain variables that had shown up in the index associations. Fewer of the health index relationships, however, were able to be traced to specific innovations. Furthermore, the specific health relationships were suspect to some extent, because of the very small numbers of adopters of the innovations that appeared to have consequences in terms of structural effects. Consequences of the adoption of health practices are probably of a longer-term nature

(e.g. family planning) than is the case for many agricultural practices. Thus, it seems that more reliance can be placed on the findings for the adoption of agricultural innovations; several of them do lead to changes within the structure.

Social Change Implications

Although structural changes may be consequences of adoption, they do not necessarily mean that social change has been effected. Social change is generally defined in terms of significant alterations in the overall structural form of a social system.

Planned "change" programs may not necessarily bring about social change, at least that can be detected within the period of a few years. Nonetheless, within such a period, tendencies toward social change that can be attributed to the change program might be able to be determined.

Three antecedent conditions were assumed, such that a change program may either tend to influence reinforcement of a pre-existing structural form, or lead (in the long-run) to an altered structural form. The first condition involved field-experimental evidence that the change program had significantly increased levels of adoption in the advocated innovations by members of the social system. Previous research reports (esp. Kivlin et al., 1968) and summary findings earlier presented, indicate that in this case the change program did increase levels of adoption significantly more in the study population than a control group.

The second condition concerned adoption of those innovations

leading over time to structural changes within the system. The findings have just been summarized which show this to have been the case for seven of the ten agricultural innovations advocated in the change program.

The third condition involved substructural rates of adoption of the innovations. Given that the first and second conditions had been met: if the "more-advantaged" segments adopted at a faster rate than the "less-advantaged" segments, so that the gaps in innovation-acquisition between the segments tended to increase rather than decrease, then it was assumed that the change program had tended to reinforce the pre-existing structural form rather than alter it. On the other hand, given that the first and second conditions had been met: if the rates of adoption between the "more-advantaged" and "less-advantaged" segments were such that the gaps in innovation-acquisition tended to decrease rather than increase, then it was assumed that the change program had tended to alter the pre-existing structural form rather than reinforce it.

As already indicated, the findings relating to this condition are that the gaps in innovation-acquisition tended neither to increase nor decrease. Thus, a conclusion cannot be reached either way under the assumptions stated. The change program in the present study did increase adoption levels, and the innovations did lead over time to structural changes within the system. However, since adoption gaps tended neither to increase nor decrease over time, it is concluded that the change program tended "significantly" neither to reinforce

the pre-existing structural form nor alter it within the period of the study.

Discussion

The present study had several limitations, some deriving from the data and some not. Reanalysis is always likely to be fraught with problems when the data have been collected for other purposes. Among the most important of these was that twenty of the thirty-five structural variables had two measures rather than three. It was assumed that membership in a substructure defined by such variables at t2, was valid again at t3. Although the word "structure" often connotes stability, it was found that the N's of many substructures did actually vary over time to a considerable extent. Furthermore, the cross-lagged correlational analysis was able to make use of what were assumed to be "replications" only for those structural variables which had measures at all three points in time. Thus, different criteria were used for variables supposedly similar at the conceptual level.

In order to achieve comparability of measures, it became necessary for some indices to have fewer items or for variables to have less comprehensive sets of response codes than would have been preferred. Although every effort was made to avoid or minimize such compromises, it is not known to what extent they may have distorted the findings. Cosmopoliteness, for example, had been indexed by five items at t1 and three items at t2. Only two items were comparable, and the multiple correlation analysis showed that its relationships were somewhat contrary to expectations.

In order to define as many substructures as possible all 192 respondents were taken to comprise the study population, whereas there were actually two types of forums and four villages. The radio forums had been more successful than the literacy reading forums; and forum participants had higher adoption and knowledge levels than non-participants (Kivlin et al., 1968; Roy et al., 1969). These distinctions were not made in the present analysis.

A number of additional "guidelines" were developed to supplement the computerized configurational analysis definitions of substructures. This was done in order to define as many substructures as possible among a fairly small-sized population. Although certain criteria were specified, they were no more than "guidelines" involving a fair degree of subjectivity. Thus, an important issue is that of reproducibility. Could an independent investigator determine the same results in the same population.

A related question conerns the matter of generalizability. The findings are not claimed to be generalizable in that this was essentially a case study of intra-system effects of planned change. To the extent that the study villages are similar to a population of other peasant villages and the change program similar to other change programs, however, it could be perhaps argued that the findings have limited applicability to those situations. Given the exploratory nature of the study, on the other hand, a more prudent conclusion is for similar studies to be conducted in other situations. These should be carried out in less traditional and relatively modern social systems, as well

as in other underdeveloped communities.

Temporal Factors

Two of the four main elements in the "classical" diffusion model are: that diffusion occurs over time, among the members of a social system (Rogers with Shoemaker, 1971). There have been few studies which have examined substructural or subsystem rates of diffusion. Rather, the "over time" element of rates of adoption or knowledge-gain have been mostly studied for a system as a whole; for example, rates of changes for hybrid corn in a farming community, new drugs among medical practitioners, new math in district schools, and modern ploughs in peasant communities. Implicit is the assumption of homogeneity; for its converse, heterogeneity, implies that there are likely to be different rates within the same system.

The study by Kivlin and Fleigel (1967) mentioned earlier is a notable exception, and throws light on an underemphasized reason in the present study concerning why substructural rates of diffusion are likely to differ. Thirty-three innovations were investigated and their rates of diffusion among Pennsylvanian farmers, in what was "judged to be part of a homogeneous farming area." Subsamples were the large-sized and small-sized farmers mentioned earlier. Sizable amounts of variance in the rates of adoption were able to be explained in terms of the different perceptions of the innovations that were held by farmers in the different subsamples. The data available in the present study did not have measures on perceptions of attributes of the innovations. Such measures would seem to be particularly desirable

in any future research along these lines.

The time periods themselves represented some conceptual problems in the present study. It is difficult in such across-time analyses to attach meaning to what should be considered a "sufficient" period in relation to various processes. Had the first of the two post-surveys been conducted earlier, might the results have been different?

An ideal design should obviously include more points of measurement; especially in the immediate "post" periods where the effects of selective processes, if present, could be more readily detected with respect to the gap tendencies. Measures could be taken over longer intervals later, perhaps after one or two years. Such an ideal panel study would actually resemble an "interrupted time series", with the interruption being the change program the consequences of which were being studied.

This "ideal" design may well run into problems because of response bias through frequent interventions in the system to gather data. However, for the adoption of certain innovations (if not knowledge), unobtrusive measures might represent a quite feasible and realistic alternative in many situations. Agricultural innovations are often large and readily visable; but there are also detailed records kept for many innovations both larger and smaller, as, for example, in the medical and family planning fields.

Liaisonness and Planned Change

Where substructural knowledge or adoption gaps are observed to narrow over time, there are likely to be important "strategic" linking roles across substructural lines. It would seem that the examination of patterns of interpersonal relationships in a social system should enable the identification of communication role occupants who appear to serve critical linking functions.

Sociometric nominations about communication relationships were not available in the present study. However, in future research along these lines it would seem highly desirable to gather such data and attempt to identify critical linkers across specific substructural boundaries.

One such key role and a possible candidate for investigation is sociometric opinion leadership. The concept is an important one in diffusion theory. However, the particular sociometric definition that has become associated with the concept over a period of two decades appears to have a number of shortcomings. These have been detailed elsewhere.* One shortcoming concerns limitations inherent in the use of a binary matrix to directly construct the index.

Since the 1950's advances in identifying key roles and handling sociometric data have been made in other communication areas than diffusion research. In particular, researchers investigating informal

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*Galloway (1974)

patterns of communication in organizations have refined their techniques and studied the "liaison" as a key role concept.

This particular tradition of research began with a study by Jacobson and Seashore (1951). They describe liaisons as follows:

> ...some individuals appear to function as 'liaison' persons between groups, and characteristically have many, frequent, reciprocated and important contacts which cut across the contact group structure. [They] participate widely in the communication system but are not identifiable in any simple way with a single subgroup...These liaison persons appear to be of critical importance...in communication terms as they are in a position to influence significantly or to control the communications to and from certain groups (italics added).

In the Skinnerian sense of "control" as argued by Zaltman and others (see Chapter II), liaison role occupants seem likely to be key persons for change agents to identify and contact.

Since the Jacobson and Seashore study, several studies have verified the importance of this linking role.* Also, Richards (1971) has developed computerized procedures for network analysis which allow researchers to more readily identify the role. Central to network analysis is the identification of groups, where the main criterion for membership is that members talk mostly with other members. Sociometrically, this means that members have a majority of two-step links between them derived from a binary matrix that has been squared. A liaison is defined not to have a majority of two-step links (shared contacts) with

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*The most recent review of these studies is by Farace, Richards, Monge, and Jacobson (1973).

any one group, but to serve a linking function between groups.

The role seems to logically fit the description by Liu and Duff (1972) of "strategic" linkers.

Rogers and Shoemaker (1971) have pointed out, that for purposes of diffusion research it is preferable to conceptualize the opinion leader concept in continuous terms as opinion leadership. For the same reasons, and to the extent that liaisons do actually function as "strategic" linkers, it seems preferable to both conceptualize and measure the role in continuous terms, as liaisonness.

Although not so far investigated within the context of diffusion research, the liaisonness concept appears to hold promise, particularly with respect to research on substructural rates of change. Our discussion has been extended on this concept for these reasons. In addition, the Appendix contains a worked example of a recently devised index of liaisonness.

Much research is needed on "strategic" linkers who may serve to narrow gaps in adoption and knowledge between the "more advantaged" and "less advantaged" segments of social systems. It would appear from the present study that influence was not as widely channeled across substructural lines as information; for knowledge gaps tended to decrease but not adoption gaps. Ideally, therefore, "strategic" linkers should be conveyors of influence as well as information.

It has been suggested that planned change programs may serve to further differentiate, or lessen pre-existing levels of adoption or knowledge of innovations. Students of planned change have not paid a

a great deal of attention to some of the matters explored in the present study. Especially where there are likely to be social structural consequences of adoption, it seems important to examine whether planned change programs tend to further differentiate or equalize social inequalities in the social system.

BIBLIOGRAPHY

Anderson, Charles H.
1971 Toward a New Sociology: A Critical View. Homewood, Illinois: The Dorsey Press.

Atkin, Charles K.
1970 Re-assessing Two Alternative Explanations of de Facto Selective Exposure. Paper presented to American Association for Public Opinion Research, Lake George, New York.

_____.
1974 Instrumental Utilities and Information Seeking. In P. Clarke (ed.) New Models for Communication Research. Beverley Hills: Sage Publications.

Becker, Marshall H.
1970 Sociometric Location and Innovativeness: Reformulation and Extension of the Diffusion Model. American Sociological Review. 35:267-282.

Bendix, Reinhard and Seymour Martin Lipset (eds.)
1966 Class, Status, and Power (2nd ed.). New York: Free Press.

Bennis, Warren G.
1969 Theory and Method in Applying Behavioral Science to Planned Organizational Change. In W.G. Bennis, K.D. Beene and R. Chin (eds.) The Planning of Change (2nd ed.). New York: Holt, Rinehart and Winston.

Blumler, Jay G., J.R. Brown and D. McQuail
1970 The Social Origins of the Gratifications Associated with Television Viewing. Unpublished report. Leeds: Television Research Center, University of Leeds.

Bogantz, G.A. and S. Ball
1971 A Summary of the Major Findings in "the Second Year of Sesame Street": a Continuing Evaluation. Princeton, New Jersey: Educational Testing Service.

Carlson, Richard O.
1965 Adoption of Educational Innovations. Eugene, Oregon: University of Oregon Press.

Coleman, James S.
1958-59 Relational Analysis: the Study of Social Organizations with Survey Methods. Human Organization. 17:28-36.

Coleman, James S., Elihu Katz and Herbert Menzel
1966 Medical Innovation: A Diffusion Study. New York: Bobbs-Merrill.

Donohue, G.A., P.J. Tichenor and C.N. Olien
1974 Mass Media and the Knowledge Gap: An Hypothesis Reconsidered. Paper presented to American for Public Opinion Research, Lake George, New York.

Engel, James F., H.F. Fiorillo and M.A. Cayley
1972 Market Segmentation Concepts and Applications. New York: Holt, Rinehart and Winston.

Esman, Milton J.
1972 Some Issues in Institution Building Theory. In D. Woods Thomas and others (eds.) Institution Building: A Model for Applied Social Change. Cambridge, Mass.: Schenkman Publishing Company.

Farace, Richard, William Richards, Peter Monge, and Eugene Jacobson
1973 Analysis of Human Communication Networks in Large Social Systems. Unpublished paper, Department of Communication, Michigan State University.

Galloway, John J.
1974 Planning for Innovation: Social Structural and Cognitive Extensions to the Classical Diffusion of Innovations Model. Unpublished paper, Department of Communication, Michigan State University.

Graham, Saxon
1956 Class and Conservatism in the Adoption of Innovations. Human Relations. 9:91-100.

Havelock, Ronald G.
1969 Planning for Innovation. Ann Arbor, Michigan: Institute for Social Research, The University of Michigan.

Homans, George
1967 The Nature of Social Science. New York: Harbinger Books.

Hyman, Herbert H.
1972 Secondary Analysis of Sample Surveys: Principles, Procedures, and Potentialities. New York: Wiley.

Jacobson, Eugene and Stanley Seashore
1951 Communication Practices in Complex Organizations. Journal of Social Issues. 7:28-40.

Kaufman, Ira
1972 Change Management: The Process and the System. In G. Zaltman, P. Kotler and G. Kaufman (eds.) Creating Social Change. New York: Holt, Rinehart and Winston.

Kivlin, Joseph F. and Frederick Fliegel
1967 Differential Perceptions of Innovations and Rate of Adoption. Rural Sociology. 32:78-91.

Kivlin, J., P. Roy, F. Fliegel, and L. Sen
1968 Communication in India: Experiments in Introducing Change. Hyderabad: National Institute of Community Development.

Kotler, Philip and Gerald Zaltman
1971 Social Marketing: An Approach to Planned Social Change. Journal of Marketing. 35:3-12.

Kuhn, Thomas K.
1962 The Structure of Scientific Revolutions. Chicago: The University of Chicago Press.

Lewin, Kurt
1963 Field Theory in Social Science: Selected Theoretical Papers (1939-1947). Edited by D. Cartwright. London: Tavistock.

Liu, William and Robert Duff
1972 The Strength in Weak Ties. Public Opinion Quarterly. 36:361-366.

Martindale, Don
1961 Social Life and Cultural Change. Princeton: Van Nostrand.

McNelly, John T.
1972 The Broadcast Media and the Redistribution of Information About Population and Family Planning. Paper presented to UNESCO seminar, National Broadcasting Training Center, Kuala Lumpur, Malaysia.

McNelly, John T. and Julio Molina
1972 Communication, Stratification and International Affairs Information in a Developing Urban Society. Journalism Quarterly. 49:316-326.

Moore, Wilbert E.
1963 Social Change. Edgewood Cliffs, N.J.: Prentice Hall.

Nisbet, Robert A.
1972 Introduction: The Problem of Social Change. In R. Nisbet (ed.) Social Change. New York: Harper & Row.

Parsons, Talcott
1961 An Outline of the Social System. In Talcott Parsons et al. (eds.) Theories of Society. New York: Free Press, 30-79.

Richards, William D.
1971 An Improved Conceptually-based Method for Analysis of Communication Network Structures of Large, Complex Organizations. Paper presented to International Communication Association, Phoenix, Arizona.

Riley, John W. and Matilda White Riley
1972 Sociology: An Approach to Human Communication. In R.W. Budd and B.D. Ruben (eds.) Approaches to Human Communication. New York: Spartan.

Rogers, Everett M.
1962 Diffusion of Innovations. New York: Free Press of Glencoe.

_____.
1973a Conceptual Biases in Communication Research. Unpublished paper, Department of Communication, Michigan State University.

_____.
1973b Diffusion of Innovations Perspectives on National R & D Assessment: Communication and Innovation in Organizations. Paper presented to National Science Foundation National R & D Assessment Program, Georgia Institute of Technology.

Rogers, Everett M. and Dilip K. Bhowmik
1971 Homophily-Heterophily: Relational Concepts for Communication. Public Opinion Quarterly. 34:523-538.

Rogers, Everett M. and Sanford Danziger
1974 Non-Formal Education and Communication Technology: Little Media and the Second Dimension of Development. In Thomas J. La Belle (ed.) Out-of-School Education in Latin America. Los Angeles: University of California at Los Angeles. (forthcoming)

Rogers, Everett M. with Floyd F. Shoemaker.
1971 Communication of Innovations: a Cross-cultural Approach (2nd. ed.). New York: Free Press.

Rosengren, K.E. and S. Windahl
1972 Mass Media Consumption as a Functional Alternative. In D. McQuail (ed.) Sociology of Mass Communications.

Roy, Prodipto, Frederick Waisanen and Everett Rogers
1969 The Impact of Communication on Rural Development: An Investigation in Costa Rica and India. Paris: UNESCO, and Hyderabad, India: National Institute of Community Development.

Rozelle, Richard and Donald Campbell
1969 More Plausible Rival Hypotheses in the Cross-Lagged Panel Correlation Technique. Psychological Bulletin. 71:74-80.

Schramm, Wilbur
1973 Channels and Audiences. In I. de Sola Pool et al.(eds.) Handbook of Communication. Chicago: Rand McNally.

Sinha, B.P. and P. Mehta
1972 Farmers' Need for Achievement and Change-proneness in Acquisition of Information From a Farm-telecast. Rural Sociology. 37:417-427.

Sonquist, James A. and J.N. Morgan
1964 The Detection of Interaction Effects. Survey Research Center Monograph No. 35, Ann Arbor, Institute for Social Research, The University of Michigan.

Springle, Herbert A.
1972 Who Wants to Live on Sesame Street? Paper presented at Annual Conference of Association for Childhood Education, Denver, Colorado.

Tichenor, P.J., G.A. Donohue and C.N. Olien
1970 Mass Media Flow and Differential Growth in Knowledge. Public Opinion Quarterly. 34:159-170.

Williams, Walter and John Evans
1969 The Politics of Evaluation: the Case of Head Start. The Annals. 385:118-132.

Zaltman, G., C.R. Pinson and R. Anglemar
1973 Metatheory and Consumer Research. New York: Holt, Rinehart and Winston.

APPENDIX

APPENDIX

ILLUSTRATION OF BASIC COMPUTATION PROCEDURES FOR AN INDEX OF LIAISONNESS

Assumptions

In brief, the liaisonness index is based upon the assumption that degrees of approximation in structural-functional characteristics are possible with respect to a nominal-level role or "ideal type" liaison. The assumption is that non-liaisons may possess some characteristics such that they score more than zero on the index. Also, some nominally-classified liaisons possess more of the characteristics and score higher on the index than other nominally-classified liaisons.

These "ideal" characteristics are used as index criteria and are assumed to be as follows:

(1) Linking function. The liaison serves a linking function between others in the network.

An individual with a high liaisonness score should link groups or sets of interrelated persons. At the most minimal level, however, an individual should link at least two persons. Individuals who do not meet this requirement are probably isolates, and are assigned a score of zero.

(2) Diversity of Contacts. The persons a liaison talks with do not regularly talk with each other (on the specified topics).

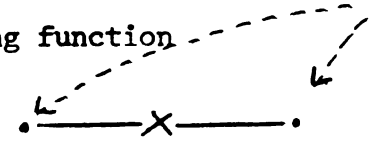
An individual with a high liaisonness score should have a low number of two-step links between the persons he is in direct contact with. That is, there are few links between his contacts.

(3) Numbers Characteristic. The liaison has the potential to relay information and opinions to many persons located in the network at a relative short distance.

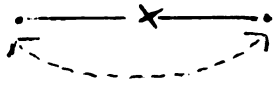
An individual with a high liaisonness score should be so located as to have many links between the contacts of his contacts. That is, there should be a high number of two-step links between the persons an individual is in direct contact with. This is assumed to reflect "group" features, or shared contacts and integration, in whatever the subsystems are that the individual serves to link.

In summary, the characteristics can be stated in graphic form as follows:

(1) Linking function

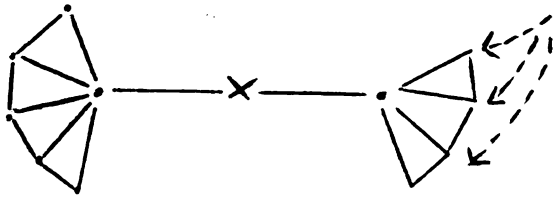


(2) Diversity of contacts:



Few shared contacts between the persons directly linked

(3) Numbers characteristic:



Illustration

The following three Figures illustrate the computation procedures. Figure 8 depicts a hypothetical communication network; it also shows the nominal-level role classifications and computed index scores for liaisonness and opinion leadership*.

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*The two indices are not directly comparable since (1) they have not been standardized, and (2) the relationships in the illustration are predominantly symmetrical (opinion leadership is usually based on advice-seeking relationships which are predominantly asymmetrical).

Figure 9 shows the matrix representations of the communication contacts in the hypothetical network. Entries in the squared matrix (M^2) are the number of two-step links or shared contacts between i and j. Finally, Figure 10 shows the actual procedures involved in computing liaisonness index scores from entries in both binary and squared matrices.

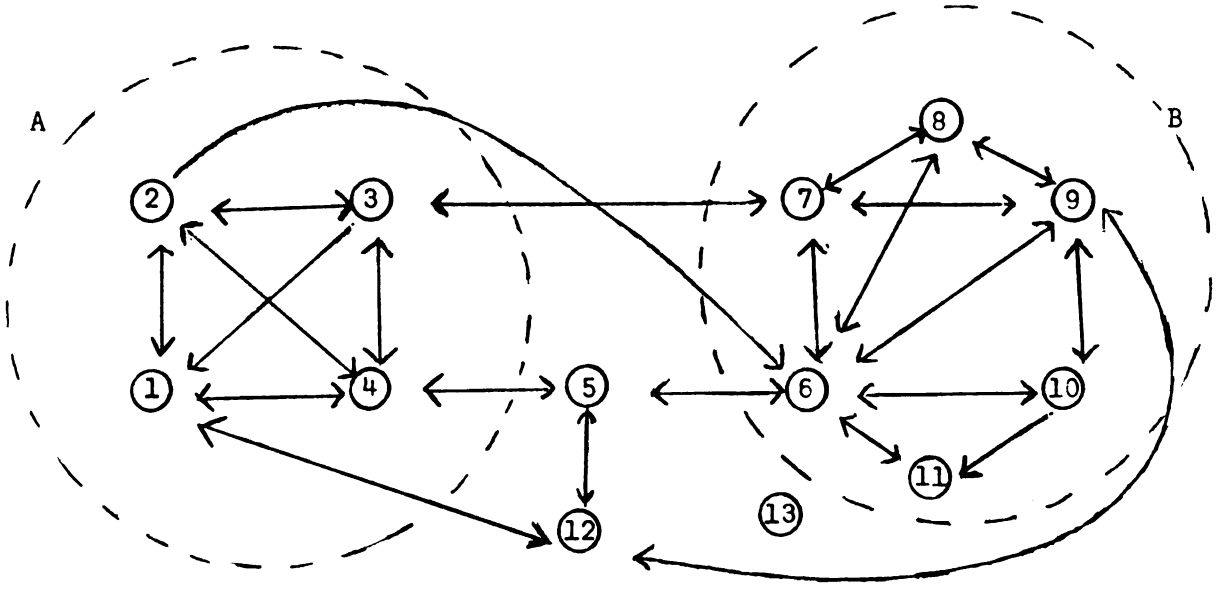

Figure 8. Hypothetical Communication Network, and Role Descriptions.

Network Analysis Classifications		Liaisonness Index		Opinion L'ship Index	
Resp.#	Role	Resp.#	Value	Resp.#	Value
1	Group member	5	17.0	6	7
2	Bridge	12	10.0	9	5
3	Bridge	10	6.0	1	4
4	Group member	11	6.0	4	4
5	Liaison	7	5.7	7	4
6	Group member	1	5.0	8	4
7	Bridge	2	5.0	2	3
8	Group member	8	3.8	3	3
9	Group member	9	3.8	5	3
10	Group member	3	3.0	10	3
11	Group member	4	2.6	11	3
12	Liaison	6	2.5	12	3
13	Isolate	13	0.0	13	0

(Two groups, A & B)

Binary matrix (M)

	1	2	3	4	5	6	7	8	9	10	11	12
1		1		1								1
2	1		1	1		1						
3	1	1		1			1					
4	1	1	1		1							
5				1			1					1
6					1		1	1	1	1	1	
7			1			1		1	1			
8						1		1	1		1	
9						1	1	1		1		1
10						1			1		1	
11						1		1		1		
12	1				1				1			
	4	3	3	4	3	7	4	4	5	3	3	3

Opinion Leadership scores

Squared matrix (M^2)

	1	2	3	4	5	6	7	8	9	10	11	12
1	0	1	2	1	2	1			1			
2	2	0	1	2	2		2	1	1	1	1	1
3	2	2	0	2	1	2		1	1			1
4	2	2	1	0		2	1					2
5	2	1	1		0		1	1	2	1	1	
6			1	1		0	2	3	3	2	2	2
7	1	1		1	1	2	0	2	2	2	2	1
8			1		1	3	2	0	2	3	1	1
9	1		1		2	3	2	2	0	1	3	
10					1	2	2	3	1	0	1	1
11					1	2	2	1	3	1	0	
12		1		2		2	1	1		1		0

Figure 9. Matrix Representations of Communication Contacts in Figure 8.

Resp.# (i)	Direct contacts$_i$	Σ 2-step links$_i$	Σ 2-step links$_j$		Liaisonness score = $\frac{\Sigma \text{ 2-step links}_j}{\Sigma \text{ 2-step links}_i}$
1	2, 4, 12	2	5+5+0	= 10	5.0
2	1, 3, 4, 6	5	2+6+5+12	= 25	5.0
3	1, 2, 4, 7	6	2+5+5+6	= 18	3.0
4	1, 2, 3, 5	5	2+5+6+0	= 13	2.6
5	4, 6, 12	0	5+12+0	= 17	17.0
6	5, 7, 8, 9, 10, 11	12	0+6+8+8+4+4	= 30	2.5
7	3, 6, 8, 9	6	6+12+8+8	= 34	5.7
8	6, 7, 9, 11	8	12+6+8+4	= 30	3.8
9	6, 7, 8, 10, 12	8	12+6+8+4+0	= 30	3.8
10	6, 9, 11	4	12+8+4	= 24	6.0
11	6, 8, 10	4	12+8+4	= 24	6.0
12	1, 5, 9	0	2+0+8	= 10	10.0

Figure 10. Illustration of Basic Computation Procedures for a Liaisonness Index Using the Matrix Entries of Figure 9.

Note: The computation for respondent number 1 is as follows: From M in Figure 9, no. 1 is seen to have direct contacts with nos. 2, 4 and 12. From M^2 in Figure 9, no. 1 has a total of 2 two-step links with nos. 2, 4 and 12. This figure becomes the denominator in the formula on the right. No. 1's direct contacts, 2, 4 and 12, each have two-step links with their direct contacts of 5, 5 and 0 respectively. This sum is entered as the numerator to obtain an index score of 5.