

AN ABSTRACT OF THE THESIS OF

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Title A PRELIMINARY STUDY OF EXPRESSED PREFERENCES
AND TASK EFFICIENCY IN DIFFERING COMMUNICATION
NETWORKS

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The present study is an attempt to investigate some of the relationships between certain personality characteristics and expressed preferences for various communication structures; it is also an examination of the relative efficiency of the networks used.

Subjects drawn from the university population participated in experimentally formed five-person groups. These groups were given a defined task to solve in each of three communication networks: an "open", or unstructured network; an "X", or structured network; and a "line" network, which lies between the "X" and the "open". Each subject was tested on a number of criteria in relation to the subject's expressed structural preference.

The three networks used were compared on the basis of the number of errors and time required for completion of task.

The following conclusions were derived from the study:

1. The amount of interaction is not related to preference of communication structure.
2. Females have high needs for structure and tend to avoid the unstructured networks; males are nearly equally distributed between the high and low structure networks.
3. The needs of control-certainty and affection-inclusion, as measured by the modified FIRO-B scale, do not accurately differentiate the subjects into groups based on expressed preference.
4. The modified California F-scale accurately differentiates the test subjects into groups based on expressed preference; suggesting authoritarian needs, or their absence, as a criterion for discrimination.
5. The pupillary response analysis accurately discriminates between the subjects who chose the "X" network and those who chose the "open" network.
6. The "X" communication network is the most efficient of the three networks tested for short-term, task-oriented, five-person groups.

A PRELIMINARY STUDY OF EXPRESSED PREFERENCES
AND TASK EFFICIENCY IN DIFFERING
COMMUNICATION NETWORKS

by

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To Dr. Charles S. Goetzinger and Dr. Milton A. Valentine:

. . . . for supervision and direction.

To my wife:

. . . . for love, encouragement, and help.

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A PRELIMINARY STUDY OF EXPRESSED PREFERENCES
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COMMUNICATION NETWORKS

INTRODUCTION

What is distinctly human comes from the primary fact that man lives his life in groups, with other people. (7, p. 325)

The central proposition in much contemporary behavioral research is the fundamental importance of the group.* Individual behavior is influenced by the number and variety of groups in society. Groups tend to control and direct both behavior and attitudes through the establishment of norms and to delineate the range of experience by imposing structure and by enforcing established behavior through complex systems of reward and punishment. Of the many groups within which the individual interacts, the small group probably is one of the more significant. Through the small group, the individual is able to cope with the larger society, learn its values, attitudes, and acceptable behaviors. "The small group is an essential mechanism of socialization and a primary source of social order!" (79, p. 1).

The small group is defined not only by the criterion of size,

* One recent review of literature in this field, A. Paul Hare, Handbook of Small Group Research (29) q. v. , cites 1385 publications; another review, A Bibliography of Publications Relating to the Small Group, by Bertram H. Raven (58), cites 3137 items.

but also by that of interaction:

Small groups include all those having from two up to about twenty members. However, even larger groups may be considered 'small' if face-to-face (sic) interaction is possible, and collections of fewer than twenty individuals may actually include several smaller groups (29, p. 10).

A less formal but more direct definition of the small group is given by Robert F. Bales:

A small group is defined as any number of persons engaged in a single face-to-face (sic) meeting or series of meetings, in which each member receives some impression or perception of each other member distinct enough so that he can, either at the time or in later questioning, give some reaction to each of the others as an individual person, even though it be only to recall that the other person was present (3, p. 33).

A later and more comprehensive definition is given by Berelson and Steiner:

. . . an aggregate of people, from two up to an unspecified but not too large a number who associate together in face-to-face (sic) relations over an extended period of time, who differentiate themselves in some regard from others around them, who are mutually aware of their membership in the group, and whose personal relations are taken as an end in itself (7, p. 325).

Face-to-face interactions may reasonably be supposed to relate to individual "behavioral goals", "orientations", "acts", "preferences", etc., to use terms frequently found in the literature (19, 32). Such interactions may also be related to presumed properties of the communication networks in which they occur (20).

This study attempts to focus on certain individual behaviors

as they relate to various communication networks in small groups. Specifically, this study is a preliminary investigation of individuals' expressed preferences and the task efficiency of small groups using selected communication networks.

The three communication networks used in this study were selected from the 14 possible permutations of the five-man group (39). The patterns chosen are in agreement with those most frequently encountered in contemporary research, and represent the two extremes and the median on a continuum of structure (i. e. from highly structured to unstructured) (6, 49).

Because of the hypothesized relationship between the type of network preferred, the efficiency of task completion, and the individual characteristics of the participant, each individual was rated on a scale of authoritarianism and located on a continuum of control-certainty versus affection-inclusion. This rating was then compared to his choice of communication network, and the subsequent task efficiency, as well as an analysis of the pupillary response.

The choice of networks, individual characteristics, and methods of procedure and of analysis were based in part on a review of the literature.

REVIEW OF LITERATURE

The review of literature relevant to the present study is presented in approximately chronological order; the review is divided into three topics: (1) small group research in general to 1948, (2) communication networks from 1948 to present, and (3) methods.

Small Group Research in General to 1948

One of the earliest studies on small groups is Triplett's (84), 1898, on the influence of the presence of others on children performing a string winding task. Triplett used the "together" and "apart" design (29, p. 344) which is still found in contemporary research.

The period that followed to approximately 1931 is characterized by Hare as falling into seven basic types of research: (1) theoretical, (2) together and apart, (3) child study, (4) gangs, (5) industrial, (6) problem solving, and (7) psychiatric. Figure 1 shows the major contributions in each of these areas. The number of articles increased from an average of one per decade in the 1890's to an average of 21 per year in the 1930's (24).

The period from the 1930's to the late 1940's was characterized by Shils in 1947 by ". . . a new focusing of interest on the small group" (80, p. 8).

In 1932, Shaw (64) found that groups were more accurate than

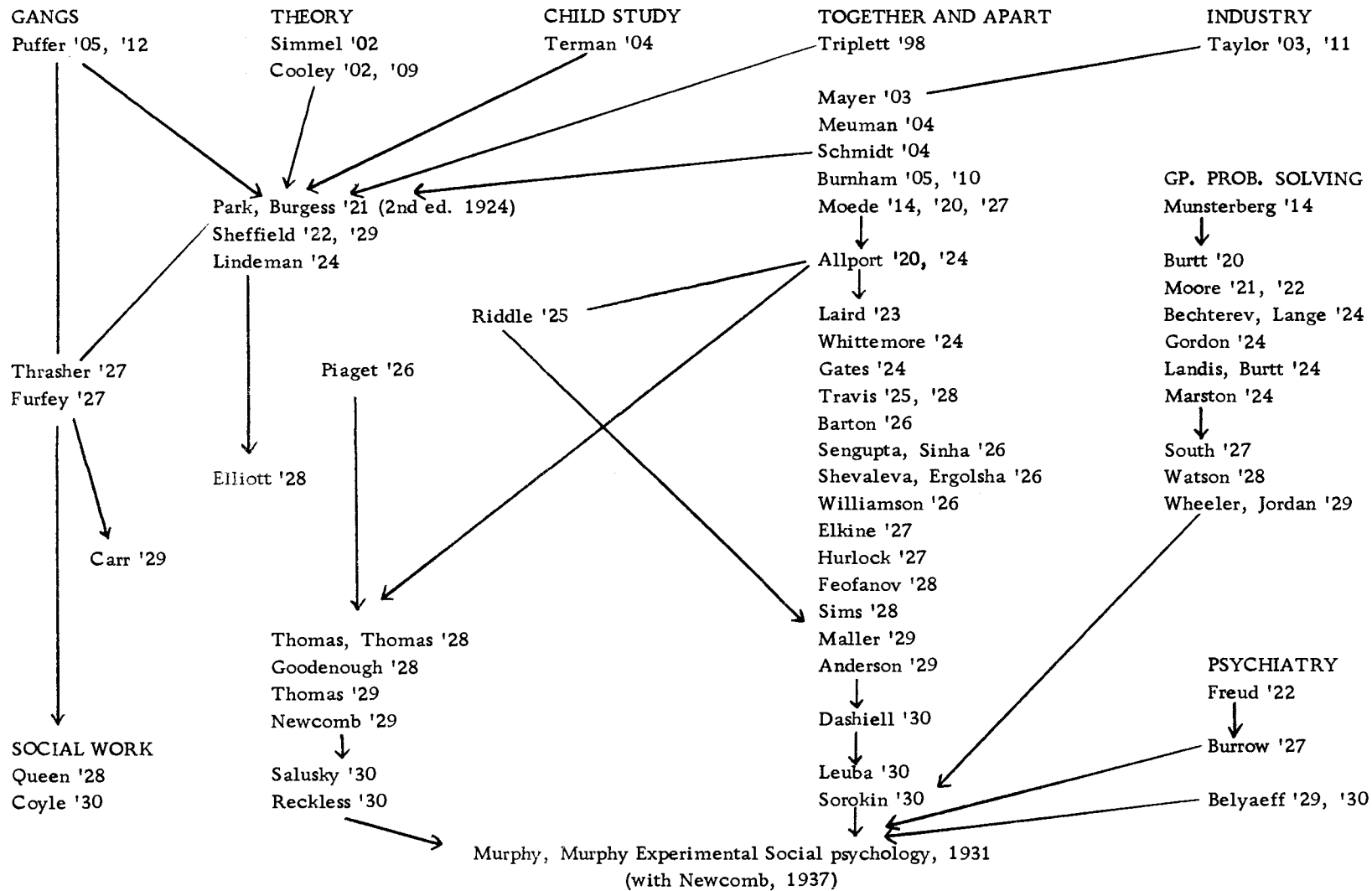


Figure 1. Major contributions to small group research 1898 to 1931. Influence of early works on later contributions is indicated by arrows (29, p. 340).

individuals in solving complex problems. In the same year, Stroop (81) tested the accuracy of the group judgement against the judgement of the average member of the group. Partridge in 1934 (57) found that leadership in his test groups was associated with: intelligence, dependability, appearance, athletic ability. Abel in 1938 (1) found that social facilitation, or stimulation, improved motor performance, and that intelligence was positively related to the degree of improvement. Majority influence on correctness of group decisions was demonstrated by Thorndike in 1938 (83). The efficiency of the group against the efficiency of the individual was investigated by Husband in 1940 (38). He found in manipulative tasks the group was more efficient; but for arithmetic problems the individual was the more efficient. In 1942 the equilibrium of groups was studied by Chapple and Coon (14) and the relationship of group emotion and leadership by Redl (59). The accuracy of group versus individual judgement was again examined in 1944 (40) and 1945 (41) by Klugman. Klugman found the group judgement to be better than the individual when appraising unfamiliar objects.

The most significant work of this period which relates to the present study was published by Lewin in 1947 (50, 51). He introduced field theory and the problems of perception to the study of group dynamics. The analysis of group functioning as a process of first perception (subjective element), followed by action (objective

element), influenced much of the early work of Bavelas, who was to give shape and direction to the main body of research in communication.

Communication Networks from 1948 to Present

The formal literature on communication networks begins with the Bavelas studies in 1948 (5) and 1950 (6). Bavelas translated the Lewinian concept of "boundary" into the channel or communication link; he further developed a set of assumptions concerning the relationship between distance and position, and the subsequent effects on group efficiency. The communication networks introduced by Bavelas have become standard experimental arrangements used in research with five-person groups. In 1950 Bavelas introduced the concept of "relative centrality" to group structures in the form of an Index of Relative Centrality.* Figure 2 illustrates the four patterns used by Bavelas with the relative centrality index for each position (6, p. 726).

The effects of certain communication networks on group performance, stemming from Bavelas' work in 1948, was examined by Leavitt (49) and published in 1951. Leavitt utilized the same basic

* Index of Relative Centrality: ratio of sum of all internal distances to sum of distances from a particular position (6, p. 727). c. f. Shaw (65) who presents a somewhat different method of determining the relative centrality of a group member.

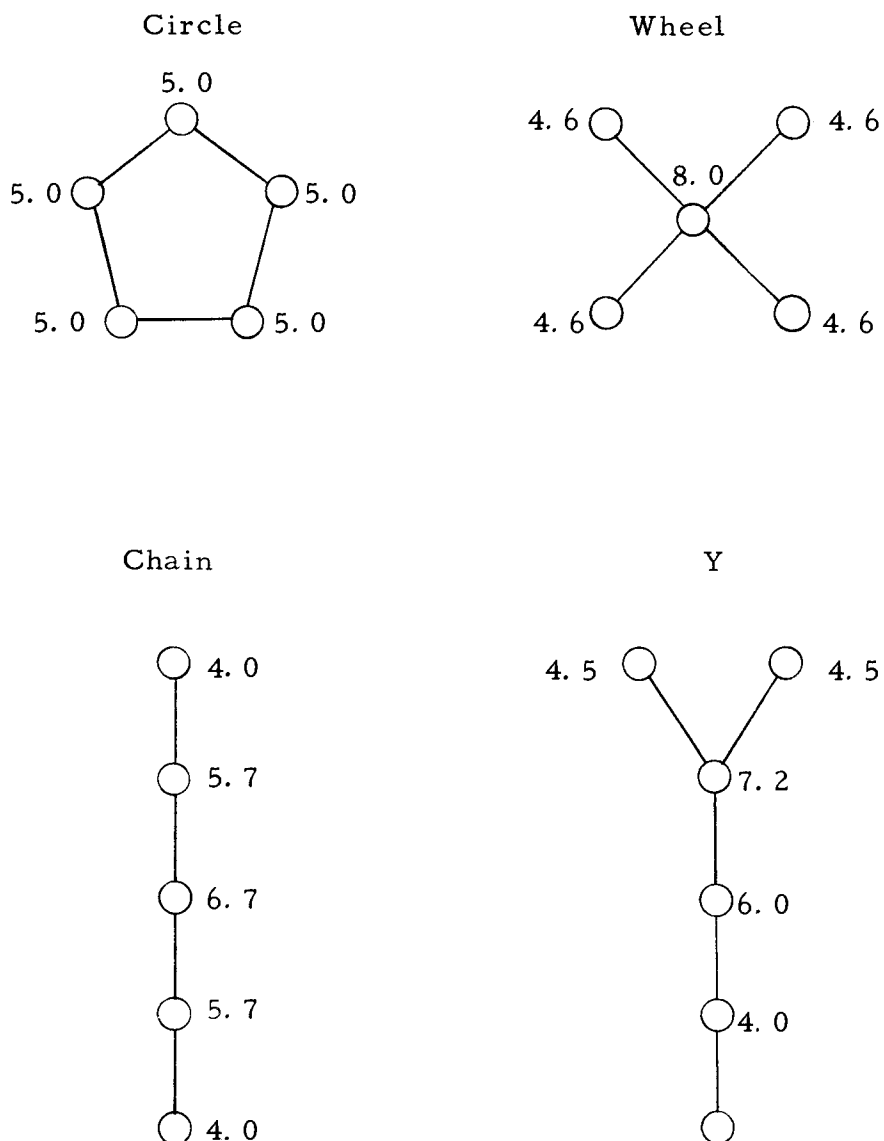


Figure 2. Communication networks used by Bavelas with indices of relative centrality (6, p. 726).

networks as Bavelas, but presented his subjects with the task of locating the common symbol held by all members of the group (see Figure 3). A modified form of Leavitt's task is used in the present study.

The work by Leavitt was repeated in 1955 by Guetzkow and Simon (27); in 1957 by Guetzkow and Dill (26); in 1960 by Guetzkow (25). The same problem was used but two-minute breaks between trials were allowed for the groups to organize. The type of activity during the breaks was observed. Comparisons of networks with hierarchy development were made.

Heise and Miller in 1951 (32) employed similar methods and problems to those of Bavelas and Leavitt, but they introduced four variations: (1) communication was by an intercom system instead of by written messages, (2) subjects were restricted to a given word list for communication, (3) three-man networks were used, and (4) one-way as well as two-way channels were used. The networks used by Heise and Miller are shown in Figure 4.

In 1952 Christie, et al. (16) studied "pure" structural characteristics in five-man networks using both one way and two way communications, as did Heise and Miller, but used more elaborate networks (see Figure 5). The same basic patterns were used in their studies in 1953 (53) and 1954 (15). They used detailed mathematical and logical analysis in the evaluation of data; the data on speed and

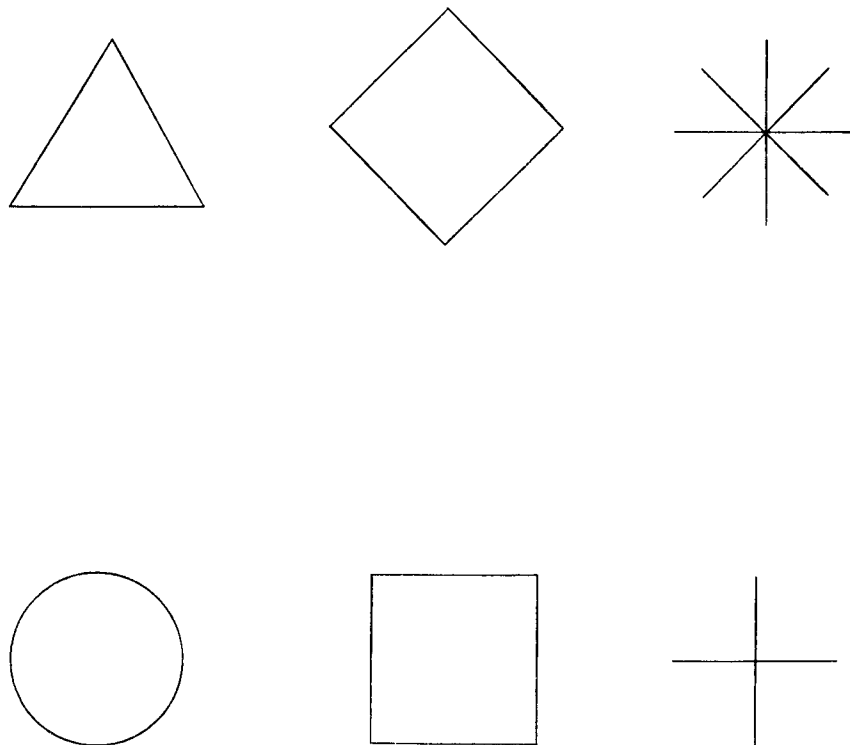


Figure 3. Task symbols used by Leavitt (49, p. 7).

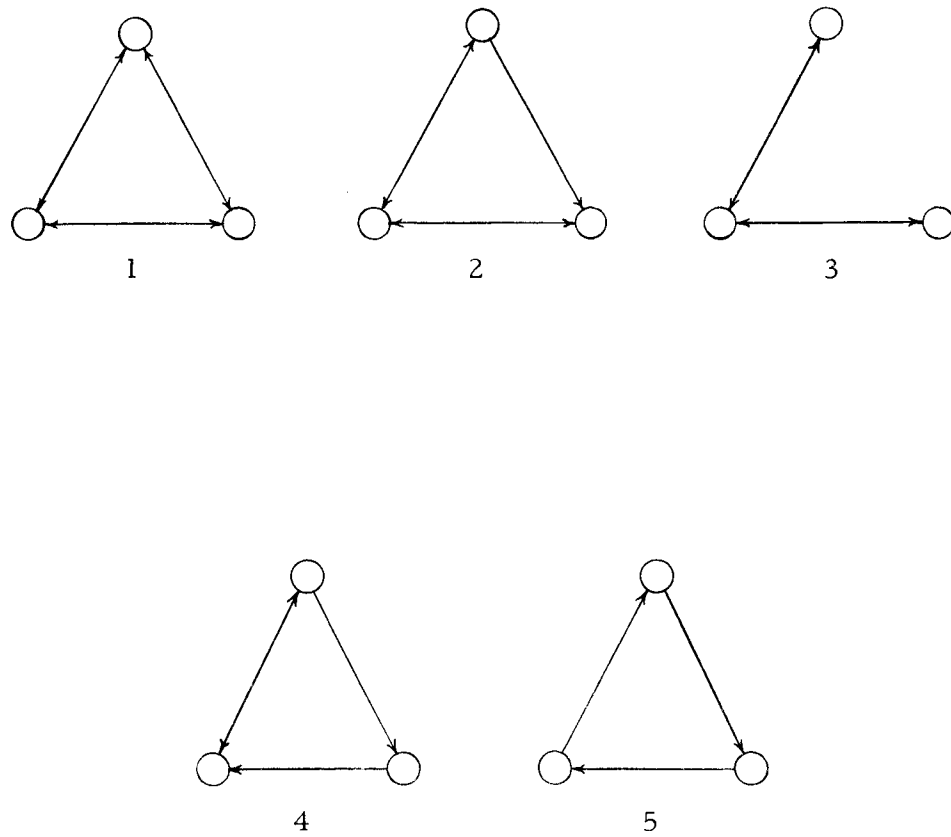
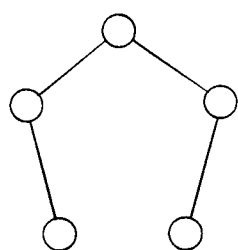
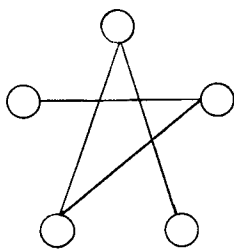


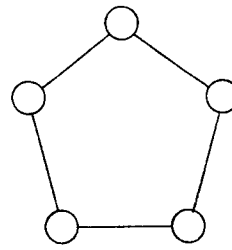
Figure 4. Communication networks used by Heise and Miller (32, p. 328).



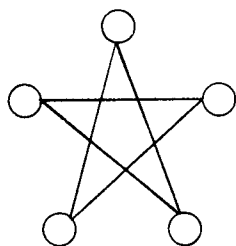
Chain



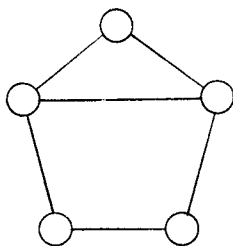
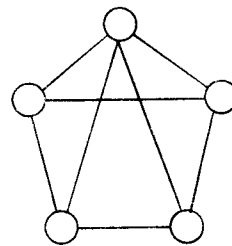
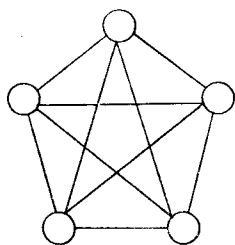
Chain-(X)



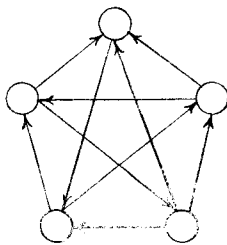
Circle



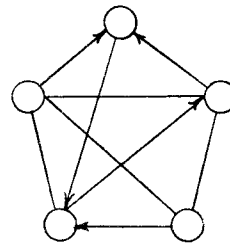
Circle-(X)

Barred
CircleTriple
Wheel

All-Channel



Pinwheel



Alpha

Figure 5. Communication networks used by Christie, et al. (15, 16, 53).

number of messages agreed with Leavitt's work.

In 1954 Shaw (66) used four-person networks and examined leadership, problem complexity, and information distribution. He introduced the concepts of position independence and saturation. Figure 6 shows the four-man networks used in Shaw's study. Shaw also used the three-man networks of Heise and Miller in another study in 1954 (67). Shaw expanded these findings in 1955 (68), 1956 (69, 77), 1957 (78), 1958 (70), 1959 (71), 1960 (72), 1961 (73), 1962 (76), 1963 (74), and 1964 (75).

Goldberg in 1955 (23) introduced the unstructured group task and used influence as the dependent variable. Influence was measured by the amount of change the subject demonstrated from the subjects initial estimate in the experimental situation. Goldberg found a positive relationship between centrality and influence.

The relative importance of personality versus position in the communication network was studied by Berkowitz in 1956 (8). When a central person was necessitated by the network, the personality of the individual was of secondary importance; when the network was relatively undefined, or "open", the personality was the dominating variable. Satisfaction was also positively related to centrality.

In 1957, Trow (85) found that the perceived value of a person was independent of the individual's autonomy in the task situation, but directly correlated to the centrality of position within the network.

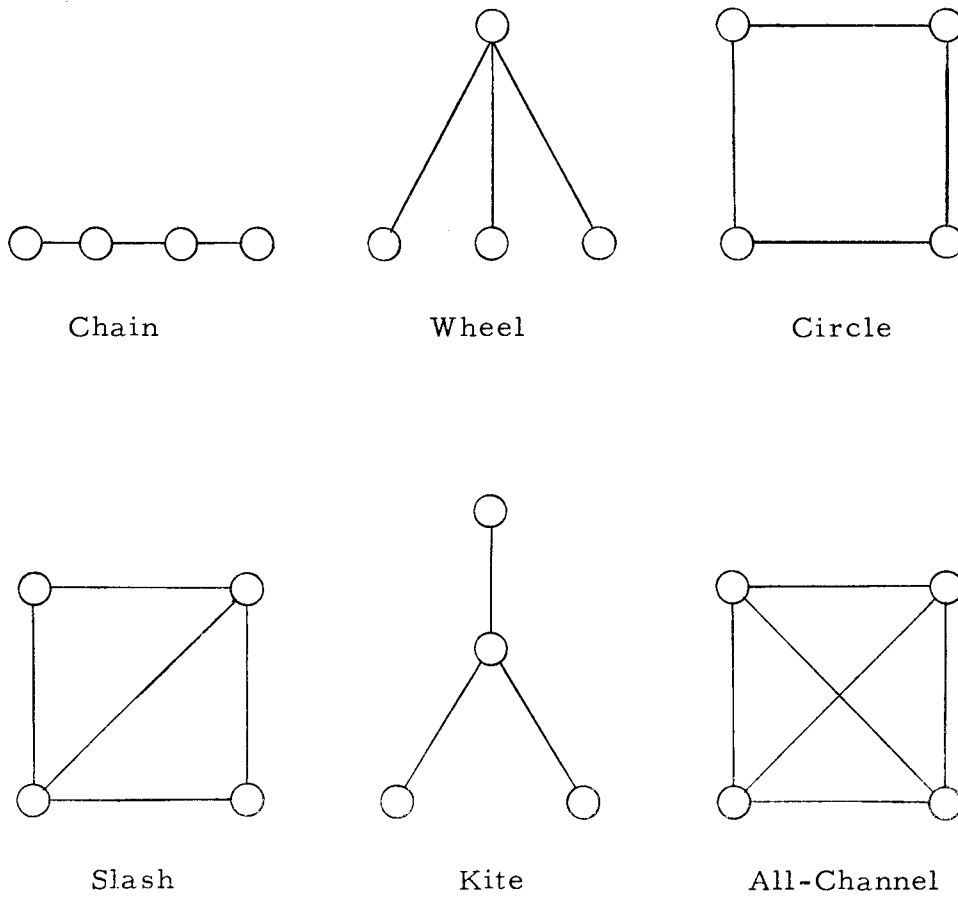


Figure 6. Communication networks used by Shaw (66, p. 212).

Lanzetta and Roby in 1956 and 1957 (45, 46, 47, 48, 60) applied the theoretical findings of previous network studies to real groups. They used the military work team as the experimental group and varied the communication structure by restricting relevant information or specific functions by position. Their studies demonstrated that dependence on others for information impeded productivity. Lanzetta and Roby reported that the most efficient distribution of information in separate function tasks required that each individual's autonomy be maximized for decision making.

The productivity or effectiveness of a group is dependent not only on the relative dependence for information, but also the centrality of the decision maker after the transmission of information (55).

Hare in 1960 (30) discussed the parameters of social interaction in relation to group structure. A number of the formal properties associated with groups were presented by Borgatta in 1961 (9); also some of the properties of the three person group in 1963 (10). Hamblin and Miller in 1961 (28) reported on the relationship between size of the group and the interaction that occurred. Cohen in 1961 (17), and 1962 (18) studied the effects of change in small group communication networks on behavior. The dimensions of status and physical position as they related to communication networks were studied by Barnlund in 1963 (4). Both Howells and Becker in 1962

(37), and Hare in 1963 (31) worked on the seating arrangements in small groups and the effects on interaction and the emergence of leadership.

The present study developed from the original work done by Goetzinger and Valentine in 1962 (20), 1963 (21, 22), and Valentine in 1963 (86). In these studies the relationships of communication, structure, and behavior were developed. In 1963-64 Goetzinger and Valentine directed a joint research project which examined the effects of communication networks, personality, comfort, language and other interaction variables on small task groups (56, 87). It is from this research project that the present study takes its form and direction.

Methods

The review of literature concerning the methods used in this study focuses on three areas: (1) the California F-scale, (2) the Fundamental Interpersonal Relations Orientation and (3) the measurement of the pupillary response.

The studies on the authoritarian personality began as a study of anti-Semitism and developed into the exploration of the relationship between personality, social discrimination, and political ideology. The work culminated in 1950 with The Authoritarian Personality by T. W. Adorno, et al. (2). The California F-scale was

devised by Adorno as a measure of the authoritarian needs for control and certainty. Adorno established reliabilities of 0.83 to 0.87 (2, p. 13) for the F-scale with the earlier California E-scale. In 1952, Brownfain (12) used the F-scale to distinguish between rigid and stable behavior in individuals; the F-scale was used as a measure of rigidity. Brownfain found a high correlation (-0.25 ; P less than 0.05) between the F-scale and his index of stability. Brown in 1953 (11) demonstrated the relationship between rigidity and authoritarianism using the F-scale. Autocratic behavior measured on a scale devised by Huffman correlated 0.73 with a modified version of the F-scale (54, p. 460).

In 1952 at the Naval Research Laboratory, Schutz developed the original FIRO scale (62, p. 205). The postulated interpersonal needs of inclusion, control, and affection were presented by Schutz in 1958 (62). He felt that these three areas were sufficient for the prediction and explanation of interpersonal behavior. Schutz characterized the individual with needs for control as either the "abdicrat" (submission and abdication of power-responsibility), or the "autocrat" (domination, power seeking, competition) (63, p. 127). At the other end of the scale is the democrat, ". . . who has successfully resolved his relations with others in the control area. . . , power and control present no problems" (63, p. 128).

The FIRO-B scale has been checked for concurrent validity

with conformity behavior, political attitudes, and occupational choice. A validity of 0.91 was established. Correlation of the FIRO-B scale with measures of expressed control range from 0.91 to 0.94 (87, p. 43).

Measurement of the pupillary response was used in the present study as a means of distinguishing between two groups of subjects; the two groups were formed on the basis of expressed preference for the "X" or the "open" communication structure. The techniques and procedures used in measuring the response of the human eye to various stimuli were devised by Hess and Polt.

In 1960, Hess and Polt (34) reported that the pupil size of the human eye varies with the subject's interest in visual stimuli. With visual stimuli maintained at a constant brightness, subject's pupil size was found to vary systematically with changes in stimuli. Because the pupillary response is not under conscious control or awareness, the subject can neither manipulate nor report the response. It was suggested that the pupil response would therefore represent a more accurate index of subjective response to visual stimuli than other methods.

Hess and Polt in 1964 (35) studied the pupil response in relation to the mental activity of subjects engaged in simple problem-solving. When the problem is presented to the subject, the pupil size increases until the subject arrives at the solution and then

starts to decrease after the answer is verbalized.

Hess, Seltzer, and Schlien in 1965 (36) used the pupil response to differentiate between a group of homosexual and heterosexual males. They were able to clearly discriminate between the two groups on the basis of the pupil response to nude pictures of males and females: "There is no overlap between the groups in that the lowest heterosexual response is to + 06.3 while the highest homosexual response is no higher than + 05.7" (36, p. 166-167).

Attitude and pupil size were further related by Hess in 1965 (33), and included a summary of the previous work. Attitude changes concerning political candidates after reading statements on the candidates was presented.

In studies undertaken with auditory stimuli and with words rather than pictures, emotional and pupil response behavior was observed. Saunders, Scott, Valentine, and Weimer in 1966 (61) were able to determine anti-Negro prejudice by direct observation of pupil deviation while subjects read a list composed of neutral and emotionally loaded words. Individuals scoring high on measures of prejudice also scaled highest on pupillary response. Correct identification was approximately 80 percent.

Herbert E. Krugman has further elaborated on the work that has been done on the pupil response (42, 43, 44).

METHODS AND PROCEDURES

A total of 80 subjects were divided into 16 five-man groups. Each group was given a similar task to solve within each of three different communication networks. The subjects were selected from Speech 111 and 112 courses at Oregon State University during Winter and Spring terms of 1966.

Tasks

Variations of two similar tasks were used throughout the present study. The first required the test group to compose the highest possible poker hand from a set of ten cards; the second required the isolation of an abstract symbol held in common by all members of the group (see Figure 7). In both cases the group as a whole received a grade depending on their efficiency (time) and accuracy. If the group solved the task correctly within seven minutes, they received an "A"; within ten minutes a "B"; if the group required more than ten minutes or failed to arrive at the correct solution, they were given a grade of "C". (The teachers from whose classes the students were drawn, cooperated by assigning a value to these grades by making it a "class project" which would be part of the course grade.)

In the card task, each member was given two cards selected

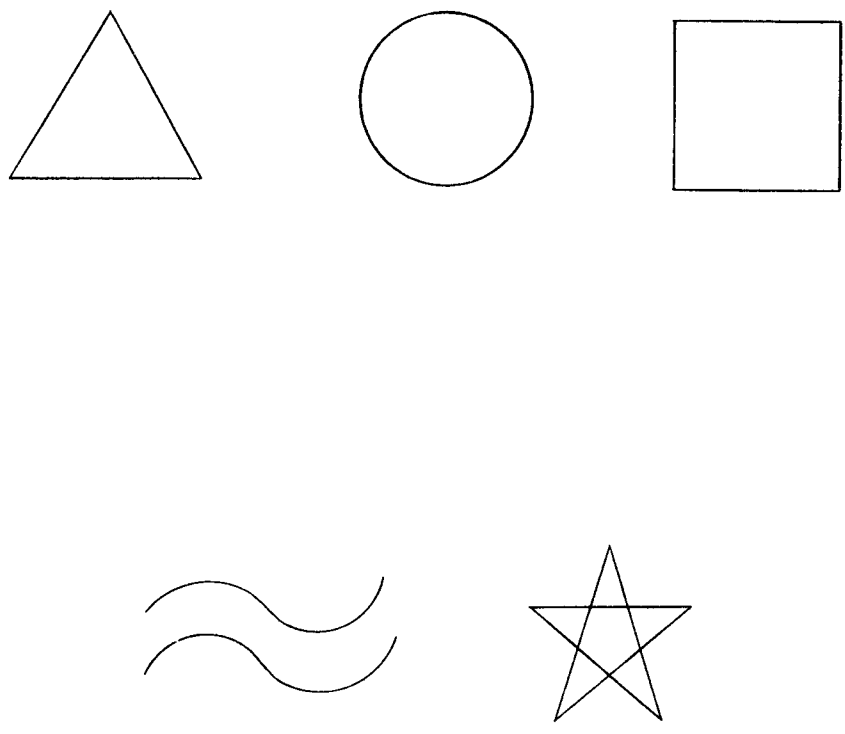


Figure 7. Symbols used in the present study.

from a standard deck. From the ten cards held by the group, they were to find the highest possible poker hand of five cards. Each member was given a sheet of paper describing the possible hands and their order or hierarchy of winning. Variations of the card task to prevent familiarity involved the use of different ten card sets.

Because a card oriented task may have been more familiar to some participants than to others, a second task was employed. The symbol task required that the group find which symbol, from a set of five abstract symbols, was held in common by all members. Each member was given a sheet of paper with the complete list of symbols; this was followed by a list with four symbols which were different for each member. Variations of this task involved the same five basic symbols, but required the finding of a different common symbol each time.

In both the card task and the symbol task, the subjects were not allowed to show or pass their original cards or symbol sheets to the other group members. The communications were restricted to messages written to the other members on note-pad size papers which were provided. (The notes, or messages, were numbered and the sender and receiver marked on each by the subjects; they were collected at the end of each trial.) The communications were also restricted to the designated channels depending on the network being tested. The tasks were chosen on the basis of their simplicity,

applicability to five-man groups (poker hand), and previous use in communication network studies (6, 49).

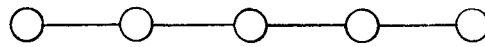
Communication Networks

Three basic types of communication networks were used in the present study (see Figure 8). The three forms used were selected on the basis of the frequency of their appearance in contemporary literature, their relationship to organizational structures in real situations (86), and their representation of the possible permutations of the five person group (39).

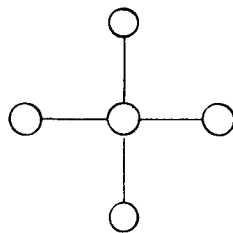
The "open" network is an all-channel communication structure which allows each member of the group to communicate with every other group member. The five members in the open group were seated around a table in a closed circle facing each other; the circle was approximately six feet in diameter in each trial.

The "X" network is a relatively closed or centralized structure. All members were required to communicate with, or through the central person only. The five members were again seated in a closed circle of approximately six feet in diameter; but in this structure the formal lines of communication were designated by strips of masking tape on the table top.

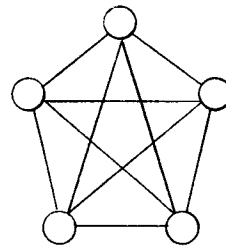
The "line" network is an intermediate structure: it is relatively closed, as in the "X" form, but lacks the designated



Line



X



Open

Figure 8. Communication networks used in the present study.

centrality. The group members were seated in a line of chairs at approximately three foot intervals.

Observational Instruments and Tests

The present study attempted to measure two relatively objective factors in the experimental setting: task efficiency and expressed preference for a communication structure; a third objective was to relate the expressed preferences to some measurable personality variable, or set of variables.

Task efficiency was determined in relation to time required for completion (maximum limit of ten minutes), and the accuracy of the group decision (only one answer was accepted).

Expressed preference was determined in a questionnaire administered at the completion of each group's exposure to all three networks (see Appendix A). The questionnaire was also used to determine if the subject's position, desired position, or group efficiency could be related to the expressed preference.

Modifications of the FIRO-B (see Appendix B) and the Californai F-scale (Appendix C), noted in the review of literature on methods, were used in testing the personality variables relating to expressed preferences.

The modified FIRO-B was administered to 45 subjects following completion of the experiment for each group. This test rated

each subject on a continuum of high needs for control and certainty to high needs for affection and inclusion. Arbitrary numerical values of 1 through 4 (respectively) were assigned to the continuum for scoring purposes. The ratings were then grouped in three categories on the basis of network chosen.

Authoritarianism was measured for each of 16 subjects using the modified California F-scale. In this case the scale was used in conjunction with the pupillary response test which is described below. The 16 subjects were previously grouped into two categories on the basis of their preferences: "open" group and "X" group. Nine subjects were in the "X" category and seven in the "open" category. This sample was selected at random from the original test population of 80 students. The test was used in the attempt to separate the subjects into their respective preference categories.

Testing of the pupillary response utilized the basic techniques of Hess noted in the review of literature. The equipment was located in a small test room with a waiting room attached. Both rooms were maintained in semi-darkness. Subjects remained in the waiting room for approximately 15 minutes. During this period, the modified California F-scale was administered and a brief orientation talk given. The subject was then seated at the apparatus illustrated in Figure 9. A Bolex H 16 Reflex camera with Kodak 16 mm high speed film was used to photograph the subject's eye. One frame was taken

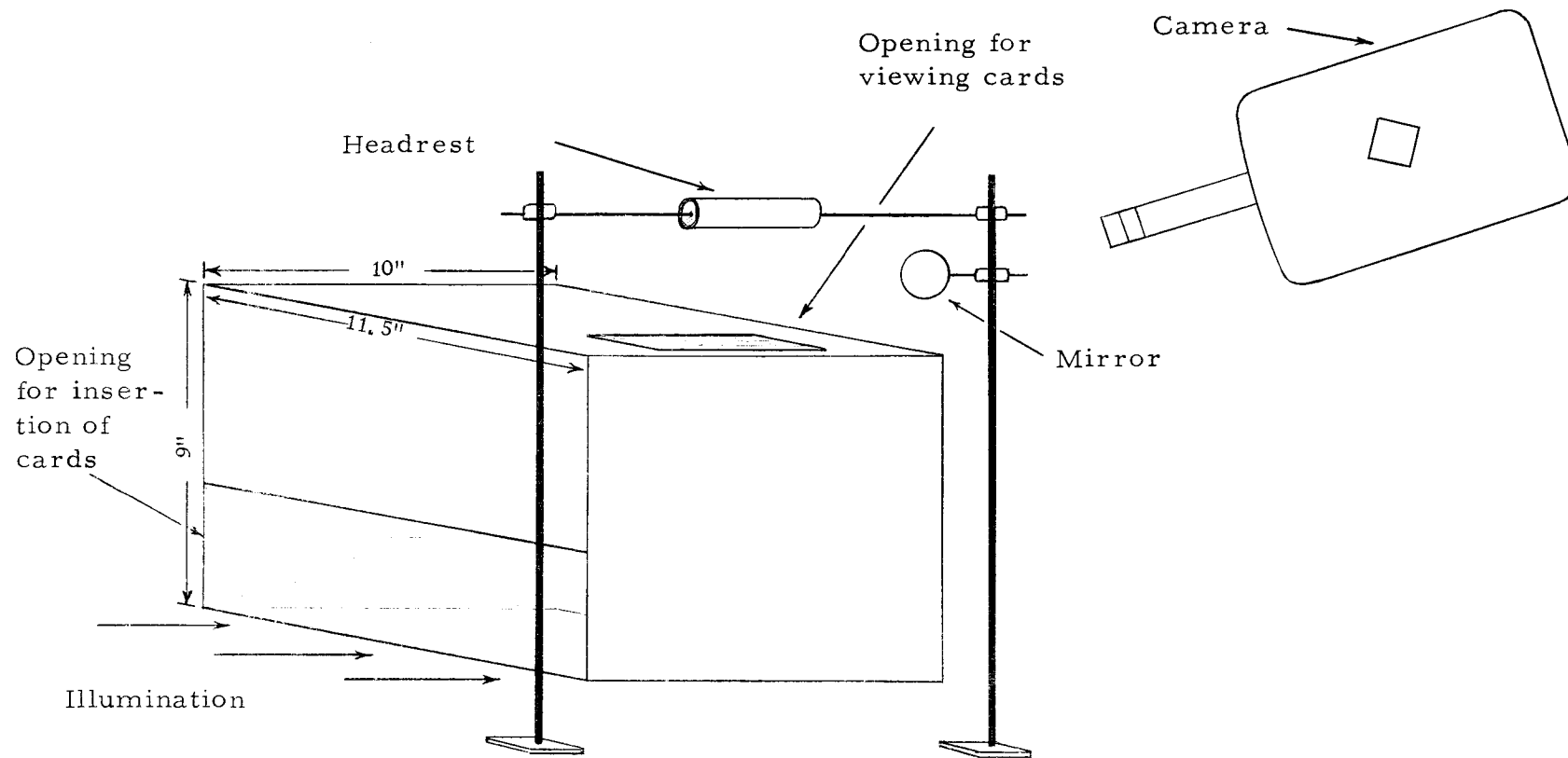


Figure 9. Equipment used in measuring pupillary response.

every two seconds, 11 visual stimuli were presented to the subject for ten seconds each. Therefore there were a total of 55 frames per subject.

The visual stimuli consisted of 11 9 1/4 by 11 inch cards selected from the Thematic Apperception Test (2, 6 GF, 8 BM, 9 BM, 12 M, 13 MF, 14, 15, 17 BM, 18 GF, and 18 BM). The TAT cards chosen were assumed to have interest value or emotional content which would elicit a significant response. See Appendix D for description of the TAT cards.

Statistical Methods

The statistical methods employed in the interpretation of results were as described in Li (52).

The chi-square goodness of fit test was used for testing the hypothesis that the relative frequencies of a multinomial population are equal to certain specified values:

$$\chi^2 = \sum^r \frac{(f - h)^2}{h}$$

The observed frequencies, f , are the number of observations in the r categories; the hypothetical frequencies are represented as h .

This statistic approximately follows the χ^2 distribution with $(r - 1)$ degrees of freedom (52, p. 489).

The t statistic was used to test the hypothesis that the difference between two population means is equal to zero:

$$t = \frac{\bar{y}_1 - \bar{y}_2}{\sqrt{S^2_p \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

The pooled estimate of the common variance of the two populations is represented by S^2_p , and the means of the two independent samples by \bar{y}_1 and \bar{y}_2 . With normal populations and equal variances, the statistic follows the Student's t -distribution with $(n_1 + n_2 - 2)$ degrees of freedom (52, p. 146).

Testing the hypothesis that the difference between two population means was zero for a set of binomial observations, the following statistic was used:

$$u = \frac{\tilde{y}_1 - \tilde{y}_2}{\sqrt{\bar{y}(1 - \bar{y}) \left[\frac{1}{n_1} + \frac{1}{n_2} \right]}}$$

The general mean of the samples is represented by \bar{y} , and the sample means by \tilde{y}_1 and \tilde{y}_2 . The statistic approximately follows the normal distribution with mean equal to zero and variance equal to 1 (52, p. 461).

RESULTS

The results of the study are presented in two categories: preference and efficiency.

Preference

A number of parameters were investigated in an attempt to isolate the determinants of the expressed preferences for specific communication structures. The amount of interaction in the task situation was measured by counting the number of messages (or notes) passed to and from each individual. This was done for the first 35 subjects (Table 1). The subjects were then grouped by the networks they preferred working in, and the average number of messages determined for each. A comparative measure of interaction was determined in this manner. The average number of messages for the subjects who chose the "X" network was 20.70; 20.92 for the "open" network; and 21.0 for those who preferred the "line" structure.

The sex of each subject (1 through 80) was compared to the expressed preference (Table 2). There were 47 males and 33 females. Table 3 shows the total choices by sex for each communication network. The difference between the choice of the "X" or the "open" network by males was not significant at the five percent level

Table 1. A comparison of interaction and expressed preference.

| Subject number | Line | | X | | Open | | Total messages | Structure preference |
|----------------|------|------|----|------|------|------|----------------|----------------------|
| | To | From | To | From | To | From | | |
| 1 | 0 | 1 | 13 | 5 | 7 | 5 | 31 | open |
| 2 | 0 | 1 | 0 | 1 | 4 | 4 | 10 | X |
| 3 | 0 | 1 | 2 | 4 | 4 | 6 | 17 | open |
| 4 | 0 | 2 | 0 | 1 | 4 | 5 | 12 | open |
| 5 | 5 | 0 | 3 | 7 | 5 | 4 | 24 | open |
| 6 | 1 | 1 | 15 | 9 | 4 | 3 | 33 | open |
| 7 | 3 | 3 | 2 | 4 | 1 | 4 | 17 | X |
| 8 | 3 | 2 | 2 | 5 | 5 | 3 | 20 | open |
| 9 | 3 | 3 | 4 | 3 | 4 | 3 | 20 | X |
| 10 | 1 | 2 | 4 | 6 | 4 | 6 | 23 | X |
| 11 | 1 | 2 | 1 | 2 | 6 | 3 | 15 | line |
| 12 | 2 | 2 | 1 | 1 | 4 | 4 | 14 | X |
| 13 | 3 | 3 | 8 | 4 | 5 | 6 | 29 | X |
| 14 | 5 | 2 | 2 | 3 | 5 | 6 | 23 | X |
| 15 | 3 | 5 | 1 | 3 | 5 | 6 | 23 | open |
| 16 | 1 | 1 | 12 | 6 | 7 | 5 | 32 | X |
| 17 | 3 | 2 | 3 | 4 | 5 | 6 | 23 | X |
| 18 | 1 | 2 | 2 | 4 | 6 | 5 | 20 | X |
| 19 | 2 | 2 | 2 | 5 | 6 | 6 | 23 | line |
| 20 | 1 | 1 | 3 | 3 | 5 | 7 | 20 | X |
| 21 | 1 | 2 | 13 | 1 | 4 | 3 | 24 | X |
| 22 | 1 | 2 | 0 | 3 | 3 | 6 | 15 | X |
| 23 | 1 | 2 | 1 | 5 | 5 | 6 | 20 | open |
| 24 | 2 | 3 | 1 | 2 | 4 | 2 | 14 | open |
| 25 | 5 | 1 | 0 | 4 | 3 | 2 | 15 | open |
| 26 | 0 | 1 | 14 | 3 | 5 | 8 | 31 | X |
| 27 | 0 | 1 | 2 | 7 | 7 | 3 | 20 | X |
| 28 | 0 | 1 | 3 | 6 | 3 | 5 | 18 | X |
| 29 | 1 | 4 | 2 | 2 | 6 | 4 | 19 | open |
| 30 | 6 | 1 | 1 | 4 | 6 | 7 | 25 | line |
| 31 | 1 | 1 | 9 | 2 | 4 | 4 | 21 | X |
| 32 | 1 | 1 | 2 | 6 | 6 | 2 | 18 | X |
| 33 | 1 | 1 | 3 | 3 | 3 | 6 | 17 | X |
| 34 | 3 | 2 | 1 | 2 | 7 | 2 | 17 | open |
| 35 | 8 | 3 | 1 | 3 | 3 | 9 | 27 | open |

Table 2. A comparison of sex and expressed preference.

| Subject number | Sex | Structure preference | Subject number | Sex | Structure preference |
|----------------|-----|----------------------|----------------|-----|----------------------|
| 1 | M | open | 41 | F | X |
| 2 | F | X | 42 | F | line |
| 3 | M | open | 43 | M | X |
| 4 | F | open | 44 | M | open |
| 5 | M | open | 45 | F | X |
| 6 | M | open | 46 | M | line |
| 7 | M | X | 47 | F | X |
| 8 | M | open | 48 | M | X |
| 9 | M | X | 49 | M | X |
| 10 | F | X | 50 | F | X |
| 11 | M | line | 51 | F | X |
| 12 | F | X | 52 | M | open |
| 13 | F | X | 53 | M | X |
| 14 | F | X | 54 | M | open |
| 15 | M | open | 55 | F | X |
| 16 | F | X | 56 | M | X |
| 17 | M | X | 57 | M | open |
| 18 | M | X | 58 | M | line |
| 19 | F | line | 59 | F | X |
| 20 | M | X | 60 | M | X |
| 21 | F | X | 61 | M | X |
| 22 | F | X | 62 | M | line |
| 23 | M | open | 63 | F | X |
| 24 | M | open | 64 | M | open |
| 25 | M | open | 65 | M | open |
| 26 | F | X | 66 | F | X |
| 27 | M | X | 67 | F | X |
| 28 | F | X | 68 | M | X |
| 29 | M | open | 69 | M | X |
| 30 | F | line | 70 | F | X |
| 31 | F | X | 71 | M | X |
| 32 | M | X | 72 | F | X |
| 33 | F | X | 73 | F | X |
| 34 | M | open | 74 | M | open |
| 35 | M | open | 75 | M | open |
| 36 | F | open | 76 | M | open |
| 37 | M | open | 77 | F | open |
| 38 | M | open | 78 | M | open |
| 39 | F | line | 79 | M | open |
| 40 | F | X | 80 | M | line |

using chi-square with one degree of freedom; the choice of the "line" over the "X" or the "open" network was significant at the five percent level. The choice of "X" structure over either "line" or "open" structures is significant while the choice between "line" and "open" is not significant for females.

Table 3. Total structure preferences by sex.

| | Line | X | Open |
|--------|------|----|------|
| Male | 5 | 17 | 25 |
| Female | 4 | 26 | 3 |

The modified FIRO-B scale was administered to 45 subjects (36 through 80), and the results compared to the expressed preference of each subject (Table 4). The FIRO scores were separated into three categories on the basis of the preferred structures; the average score of the 24 subjects who chose the "X" structure is 2.44. The average score for the 15 subjects who chose the "open" structure is also 2.44. The six subjects who chose the "line" structure have an average score of 2.52.

A comparison was also made using the modified California F-scale. The test was administered to 16 subjects (the same 16 used in the pupillary response test), and the scores averaged in two groups representing the subjects who chose the "X" and the "open" networks (Table 5). The average F-scale score for the "X" group

Table 4. A comparison of the modified FIRO-B scores and expressed preference.

| Subject No. | Test Scores | Structure Pref. |
|-------------|-------------|-----------------|
| 36 | 1.9 | open |
| 37 | 2.3 | open |
| 38 | 2.5 | open |
| 39 | 2.7 | line |
| 40 | 2.4 | X |
| 41 | 2.9 | X |
| 42 | 2.0 | line |
| 43 | 2.4 | X |
| 44 | 2.5 | open |
| 45 | 2.3 | X |
| 46 | 2.7 | line |
| 47 | 2.6 | X |
| 48 | 2.8 | X |
| 49 | 2.3 | X |
| 50 | 2.2 | X |
| 51 | 2.4 | X |
| 52 | 3.1 | open |
| 53 | 2.5 | X |
| 54 | 2.5 | open |
| 55 | 2.1 | X |
| 56 | 2.0 | X |
| 57 | 2.5 | open |
| 58 | 2.2 | line |
| 59 | 2.4 | X |
| 60 | 2.7 | X |
| 61 | 2.2 | X |
| 62 | 2.7 | line |
| 63 | 2.4 | X |
| 64 | 2.2 | open |
| 65 | 2.7 | open |
| 66 | 2.2 | X |
| 67 | 2.6 | X |
| 68 | 2.5 | X |
| 69 | 2.2 | X |
| 70 | 3.2 | X |
| 71 | 2.5 | X |
| 72 | 2.4 | X |
| 73 | 2.5 | X |
| 74 | 2.3 | open |
| 75 | 2.9 | open |
| 76 | 1.6 | open |
| 77 | 2.4 | open |
| 78 | 2.7 | open |
| 79 | 3.5 | open |
| 80 | 2.5 | line |

was 3.11; the average for the open group was 2.95. The difference between the two groups is significant at the 0.5 percent level using the t-test with 14 degrees of freedom.

Table 5. A comparison of the modified California-F scores and expressed preference.

| Subject No. | Score | Structure pref. |
|-------------|-------|-----------------|
| 36 | 2.69 | open |
| 37 | 3.38 | open |
| 38 | 3.10 | open |
| 45 | 2.28 | X |
| 47 | 3.55 | X |
| 48 | 3.41 | X |
| 49 | 3.03 | X |
| 50 | 3.66 | X |
| 68 | 2.66 | X |
| 69 | 3.97 | X |
| 72 | 2.62 | X |
| 73 | 2.79 | X |
| 74 | 3.24 | open |
| 75 | 2.52 | open |
| 76 | 3.00 | open |
| 78 | 2.72 | open |

The results of the pupillary response to the TAT were compared with the expressed preferences of 16 subjects (Table 6). The subjects were then separated into two groups, "open" and "X". The difference between the groups is significant at the one percent level using the u statistic for binomial populations. The differences between males was also found to be significant, although the difference between females of the "open" group and the females of the "X" group was not significant.

Table 6. A comparison of the pupillary response and expressed preference.

| TAT card index numbers | SUBJECT NUMBER | | | | | | | | | | | | | | | |
|------------------------------|----------------|----|----|----|----|----|----|----|----|------|----|----|----|----|----|----|
| | X | | | | | | | | | open | | | | | | |
| | 68 | 69 | 73 | 72 | 45 | 47 | 48 | 30 | 49 | 75 | 74 | 78 | 76 | 38 | 36 | 37 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6GF | 0 | 0 | 0 | + | + | 0 | 0 | + | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8BM | + | + | + | + | 0 | + | + | + | + | 0 | 0 | 0 | + | 0 | 0 | 0 |
| 9BM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 |
| 12M | + | + | 0 | + | + | + | + | + | + | + | 0 | 0 | 0 | 0 | 0 | 0 |
| 13MF | + | + | + | + | 0 | + | + | 0 | 0 | + | + | + | 0 | + | + | + |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | 0 | + | + | + |
| 15 | + | 0 | + | + | 0 | + | + | + | + | 0 | 0 | 0 | 0 | 0 | 0 | + |
| 17BM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18GF | + | 0 | 0 | 0 | + | + | + | + | + | 0 | 0 | 0 | + | 0 | 0 | 0 |
| 18BM | + | + | + | 0 | + | + | 0 | 0 | + | + | 0 | 0 | 0 | 0 | 0 | + |
| Sex | M | M | F | F | F | F | M | F | M | M | M | M | M | M | F | M |

Efficiency

The relative efficiency of the three communication networks was determined as a function of time and accuracy in completing the task for each group.

Time for the completion of task was averaged for all 16 groups in each of the three communication networks. The averages appear in Figure 10 in the order they were presented in the experimental situation.

The accuracy of the communication networks was determined by either failure to complete the task within ten minutes, or incorrect solution. Table 7 shows the relative accuracy of the three structures. The total number of errors is shown for each structure.

Table 7. Total errors by structure.

| Communication network | Failure to complete task | Incorrect Solution | Total errors |
|-----------------------|--------------------------|--------------------|--------------|
| open | 3 | 5 | 8 |
| line | 3 | 3 | 6 |
| X | 1 | 2 | 3 |

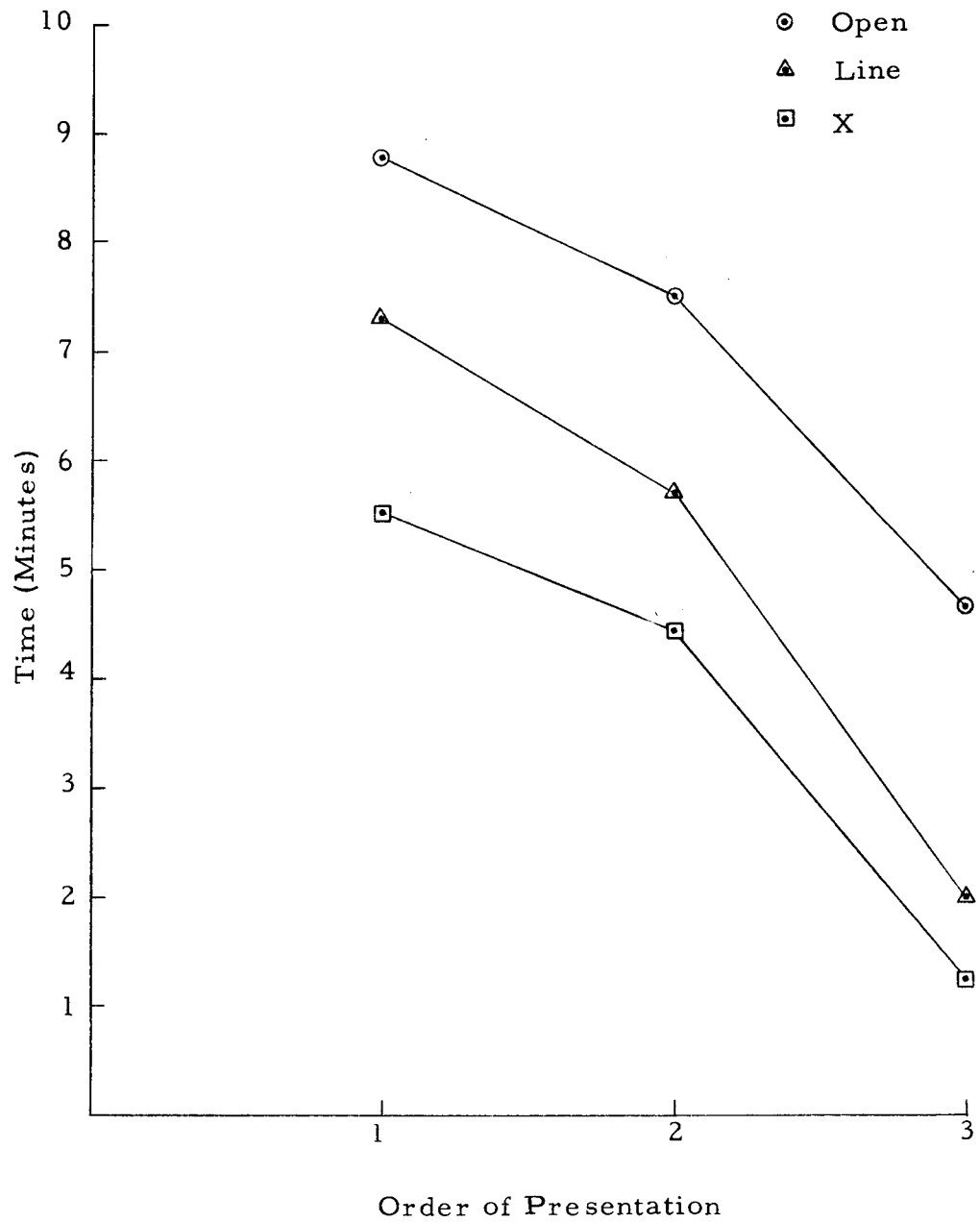


Figure 10. Average task-completion time for communication networks in relation to order of presentation.

DISCUSSION AND CONCLUSIONS

A preliminary study of this nature touches on many areas; although many of these are important, only those areas most significant to the study will be discussed. The conclusions derived from the present study are presented in the order that they will be discussed:

1. The amount of interaction is not related to preference of communication structure.
2. Females have high needs for structure and tend to avoid the unstructured networks; males are nearly equally distributed between the high and low structure networks.
3. The needs of control-certainty and affection-inclusion, as measured by the modified FIRO-B scale, do not accurately differentiate the subjects into groups based on expressed preference.
4. The modified California F-scale accurately differentiates the test subjects into groups based on expressed preference; suggesting authoritarian needs, or their absence, as a criterion for discrimination.
5. The pupillary response analysis accurately discriminates between the subjects who chose the "X" network and those who chose the "open" network.

6. The "X" communication network is the most efficient of the three networks tested for short-term, task-oriented, five-person groups.

In comparing interaction with network preference, no significant correlation could be found. The three averages (20.79, 20.92, and 21.00) are essentially equal (21.00), since the messages should be represented as whole numbers. Apparently the number of messages exchanged was not related to the choice of network.

The examination of sex in relation to structure preference produced several significant findings: (1) the distribution of male choices between "open" and "X" structures was not statistically significant. Either group seemed to be equally acceptable. The choice of the "line" network was significant. The male subjects definitely preferred either the "open" or the "X" network over the "line". (2) Female subjects chose the "X" network over either the "open" or the "line" structure. This apparent need for structure and avoidance of the unstructured situation is in agreement with the study done by Witkin as reported in Chaplin and Krawiec (13, p. 172).

The failure of the FIRO scale to effect a significant separation of the three groups was disappointing. The needs for control-certainty and affection-inclusion were assumed to be accurately reflected by the highly structured "X" group and the relatively unstructured "open" group respectively. The results did not support

this assumption. A possible explanation for this failure was the extremely short duration of the experimental group (ten minutes maximum). This may indicate that the needs measured by the FIRO-B are involved in long-term interaction rather than the short-term experienced in this study.

In the testing sequence using the modified F-scale and the pupillary response, the same group of 16 subjects was used for each. The small size of their sample was one of the major limitations encountered in the present study, although it is felt that the 16 subjects represent an accurate sampling of the original 80 subjects. The "line" category was eliminated from this sample since the distribution of choices was clearly dichotomized in the "open" and "X" networks. The sample was further limited in size because of the high cost involved in testing for the pupillary response. The ability for these tests to accurately differentiate between the two preference groups compensates for the small sample size. On the basis of the F-scale and the pupillary response, the subjects selecting the "open" network and those selecting the "X" network could be differentiated to a high degree of significance.

The results of the F-scale and the pupillary response suggest that authoritarian needs better reflect structure preferences than do the needs measured by the FIRO-B.

The aspects of the present study that deal with efficiency lead

to a single conclusion: for both time and accuracy in short-term task groups the highly structured "X" group is most effective. The "X" network had the lowest time for task completion, independent of its order of presentation in the experimental situation; the "X" network also had the least number of errors, both in solution and completion, of the three structures.

The present study used groups of short duration with a relatively constant task, and subjects from a limited population. Further study would be recommended using groups of longer duration and required to solve a variety of tasks. The pupillary response, which demonstrated a high degree of accuracy in discriminating test groups, also deserves further study with a larger sampling.

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APPENDICES

APPENDIX A

QUESTIONNAIRE TO DETERMINE EXPRESSED
STRUCTURE PREFERENCE

Name: _____

I. Number:

Who was your leader ?

Group performance time? Which position would you have
preferred?

Were you satisfied with this time ?

Did you enjoy working in this type-group ?

II. Number:

Who was your leader ?

Group performance time? Which position would you have
preferred?

Were you satisfied with this time ?

Did you enjoy working with this type of group ?

III. Number:

Who was your leader ?

Group performance time? Which position would you have
preferred?

Were you satisfied with this time ?

Did you enjoy working with this type of group ?

Which group did you like working with the best ?

APPENDIX B

MODIFIED FIRO-B SCALE QUESTIONNAIRE

This check list is intended to help you (and your instructor) learn something about your habitual orientation patterns. There are no right or wrong answers. Please indicate by "X" how you believe you generally act, and by "O" how you believe you ought to act, finally indicate how you feel your subordinates act by "S".

Usually Sometimes Seldom Almost
Never

1. If the outcome of an activity is uncertain, I prefer to let someone else undertake it.
2. I prefer to ask for help on a problem from an authority or a superior before I get stuck.
3. I prefer to give a subordinate help before he gets stuck.
4. I undertake some activities just for the "fun of it".
5. When in a group (not just one related to the job) I like to be the one who directs activities.
6. I prefer "free and easy" groups to those that "go by the book".
7. I prefer not to ask my subordinates for help on my responsibilities.
8. In a group I like to be the one who keeps the group working together.
9. In a new group I like to let some other person take the lead.

Usually Sometimes Seldom Never

19. (cont.) someone fails it's up to him to correct it.

20. The most efficient shops are those where everyone is included and friendships develop out of the job situation.

21. As a subordinate I like to be clearly told under the rules the limitations under which I operate. If I have objections or suggestions, I tell the supervisor about them later, he knows what he's doing or he wouldn't have been put in charge.

22. I make friends quickly, and prefer close informal relationships.

23. Direct supervision of such items as petty cash or the "stamp drawer" is necessary to keep most working groups "in line", and to prevent unnecessary loss.

24-25. I believe people see me as (circle appropriate items): aggressive, athletic, courteous, consistent, confident, friendly, sincere, interesting, intelligent, reserved, tall, fat, punctual, practical, self reliant, honest, talkative, self-centered, threatening.

APPENDIX C

MODIFIED CALIFORNIA F-SCALE QUESTIONNAIRE

This is a study of what the general public thinks and feels about a number of important personal and social questions. There are no right or wrong answers. The best for each statement for you is is your personal feeling or opinion. Please mark each statement in the left margin according to how much or how strongly you agree or disagree. Mark every item. Write 1, 2, 3, 4, 5, or 6 depending on how you react in each case.

- | | |
|----------------------------|-------------------------|
| 1. I DISAGREE VERY MUCH | 4. I AGREE A LITTLE |
| 2. I DISAGREE ON THE WHOLE | 5. I AGREE ON THE WHOLE |
| 3. I DISAGREE A LITTLE | 6. I AGREE VERY MUCH |

Sample Items

- 5 It's natural to fear the future. (This person has marked "5", indicating that he agrees on the whole.)
- 2 Once I get wound up, I can't stop. (This person has marked "2", indicating that he disagrees on the whole.)

Please mark each item with the response which is closest to your own, using 1 through 6.

1. Obedience and respect for authority are the most important virtues for children to learn.
2. A person who has bad manners, habits and breeding can hardly expect to get along with decent people.
3. If people would talk less and work more, everyone would be better off.
4. Business men and manufacturers are much more important to society than artists and professors.
5. Science has its place, but there are many more important things that can never possibly be understood by man.

- ___ 6. Young people sometimes get rebellious ideas, but as they grow up they ought to get over them and settle down.
- ___ 7. What this country needs, more than laws and political programs, is a few courageous, tireless, devoted leaders in whom the people can put their faith.
- ___ 8. No sane, normal, decent person could ever think of hurting a close friend or relative.
- ___ 9. Nobody ever learned anything important except from suffering.
- ___ 10. What youth needs today is strict discipline, rugged determination, and the will to work and fight for family and country.
- ___ 11. An insult to our honor should always be punished.
- ___ 12. Sex crimes, such as rape and attacks on children, deserve more than mere imprisonment; such criminals should be publicly whipped, or worse.
- ___ 13. There is hardly anything lower than a person who does not feel a great love, gratitude and respect for his parents.
- ___ 14. Most of our social problems would be solved if we could somehow get rid of the immoral, crooked, and feeble-minded people.
- ___ 15. Homosexuals are hardly better than criminals and ought to be severely punished.
- ___ 16. When a person has a problem or worry, it is best for him not to think about it, but to keep busy with more cheerful things.
- ___ 17. Every person should have complete faith in some supernatural power whose decision he obeys without question.
- ___ 18. Some people are born with an urge to jump from high places.
- ___ 19. People can be divided into two distinct classes: the weak and the strong.
- ___ 20. Some day it will probably be shown that astrology can explain a lot of things.

- _____ 21. Wars and social troubles may someday be ended by an earthquake or flood that will destroy the whole world.
- _____ 22. No weakness or difficulty can hold us back if we have enough will power.
- _____ 23. It is best to use strong authority, backed by force if necessary, to keep order and prevent chaos.
- _____ 24. Most people don't realize how much our lives are controlled by plots hatched in secret places.
- _____ 25. Human nature being what it is, there will always be war and conflict.
- _____ 26. Familiarity breeds contempt.
- _____ 27. Nowadays when so many different kinds of people move around and mix together, a person has to protect himself carefully against catching an infection.
- _____ 28. Nowadays, more and more people are prying into matters that should remain personal and private.
- _____ 29. The wild sex life of the old Greeks and Romans was tame compared to some of the goings on in this country, even in places where people might least expect it.

APPENDIX D

A BRIEF DESCRIPTION OF THE THEMATIC
APPERCEPTION TEST CARDS

| TAT Card index no. | Description |
|-----------------------|--|
| 2 | Landscape, 3 figures (2 female, 1 male) in farmland setting. |
| 6 GF | Man with pipe leaning over a woman's shoulder; woman seated, man standing. |
| 8 BM | Boy standing, surgical scene in background. |
| 9 BM | Group of 4 men on ground. |
| 12 M | Older man poised over boy lying on couch. |
| 13 MF | Man standing, holding his arm over his face; partially exposed woman on couch. |
| 14 | Figure silhouetted against window. |
| 15 | Man standing in graveyard with hands clasped. |
| 17 BM | Man climbing rope. |
| 18 GF | Two women at bottom of staircase, one supporting other. |
| 18 BM | Man standing with face turned to side and hands (rest of figures not shown) holding him. |