

SOCIAL FEEDBACK MONITORING

BY

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## INTRODUCTION

This research deals with a new blending of experimental cybernetics and social psychology in studying the capability of an individual to measure accurately the extent to which two other persons are interacting with one another in a social tracking task and to influence the interactions of these two persons by giving them social indication of the measured accuracy. To describe the experiment, the interactions of the two persons will be discussed as a social tracking task, whereas the person measuring or estimating the accuracy will be referred to as a social monitor or catalyzer. In this context, the term "social tracking" has been defined as the crossed, closed-looped connections which link the motor and sensory mechanisms of two or more individuals. In such tracking, the movement of one person constitutes a source of self-governed sensory input to the second and vice versa (Smith, 1966). This process of continuous control between individuals linked in closed-looped manner is dynamic rather than static and composed of many different physiological and social components. The social monitor in this three-person group interaction is an

estimator of the accuracy of the social coordination in the motorsensory interaction between the two other individuals. At the same time, he can influence their social tracking by giving them or failing to give them some feedback indication of the accuracy of their social tracking performance. The term, monitor-feedback, will be used to indicate the procedure of supplying the two primary interactors with some continuous or discrete information regarding the measured accuracy of their coordination with one another.

The major problem investigated in this research was to determine whether there exist ways in which the human monitor can influence social tracking performance of two primary interactors. Monitor feedback was investigated by comparing its effects on primary social tracking when it was presented individually to one and to both of the primary trackers. In a third condition neither of the primary trackers received any social feedback. It was then possible to determine whether a human monitor, in the social tracking situation, could produce improvement in social tracking accuracy over that produced by direct social feedback information between the primary trackers themselves.

The way in which these experiments were carried out

and the techniques used may be mentioned in an introductory way. A real-time laboratory computer system made possible the manipulation of variables of the experiment. Computer control programs were used to specify the feedback conditions and to control the magnitudes of feedback, as well as the sequence, time duration and even the length of trials. Graphic records of the interacting motor responses of primary subjects were viewed by the monitor on a continuous basis, who on the basis of the estimated error of the primary social tracking, generated a monitor-measured error feedback to the primary trackers. The efficiency of the group performance was then determined by the computer system in terms of the magnitude of the social tracking error between the two primary social trackers. In such studies as these the computer is an actual part of the closed-loop control system and is arranged to measure error under different feedback conditions and modes.

The studies were made under different feedback conditions and different modes of social control. A trained monitor measured the social tracking of two other persons and provided variable conditions of social feedback to those persons. A preliminary study was first undertaken to

determine if monitor feedback to the two trackers was equal, superior or inferior to social tracking under conditions in which the subjects got an overall indication of their own as well as the other primary trackers error. In a second preliminary experiment monitor error feedback was compared with machine-scored tracking error feedback in determining accuracy of the primary social tracking.

The overall aim of the research was to develop an experimentally-based theory of the behavioral basis of measurement and evaluation of relative social interactions between individuals by observers, supervisors, teachers, conductors and other types of social catalyzers. Additionally, the effort was to evaluate the theory of the mechanisms of systems integration, guidance and control which such social monitors and catalyzers can level over primary social interactors or performers. Theories and experimental methods related to this problem of social monitoring and evaluation have potential application in clarifying how actual social monitors and catalyzers--supervisors, teachers, coaches, conductors, leaders and executives--may operate in judging the accuracy of social interactions and in influencing these interactions by controlling social feedback from their own evaluations.

## HISTORICAL BACKGROUND

As noted above, this experiment is our effort to extend the theory and methods of social tracking to study the human assessment of social interaction. Some limited efforts have been made in the past by others to study similar effects in the areas of (1) human relations, (2) organizational psychology, (3) in sensitivity or encounter groups, and (4) primary social tracking. The present section surveys these prior efforts as they relate specifically to the processes of individual monitoring of the social interactions of others.

### HUMAN RELATIONS APPROACH AND RESEARCH

Two areas of human relations study have been investigated. These include the applied-sociological area in which interviewing and consulting techniques were applied to problems of personnel management and social control of the worker, and the clinical area in which role playing, group motivation and pressure to change attitudes or personality of individuals were investigated. These fields were developed largely with the aim of increasing industrial

productivity in the individual worker. In the industrial setting, the supervisor, or manager was looked upon as a counselor to maintain the motivation of the labor force. Investigators in the human relations and group dynamics fields recognized that, by varying worker supervisory interactions, the entire work force might be improved and workers might become happier and hopefully more efficient.

Group dynamics grew out of the need for analysis of group morale and productivity. Generally, the studies of group morale and productivity (Mann and Baumgartel, 1952) showed that satisfaction with one's own position in a complex organization does not necessarily carry with it a strong motivation toward superior performance within the system. They also showed that productivity may be related only peripherally to the central goals of living, towards which the industrial worker and his group are striving. It was found that absenteeism was related inversely to growing solidarity of the work force.

A first research to obtain quantitative data on the effects of social motivational variables in the industrial setting were the Hawthorne Studies (Roethlisberger and Dickson, 1939). The initial effort was to evaluate the

effect of improved physical working conditions and rest periods in an electrical assembly plant. The aim was to discover possible relationships between physical conditions of work and the incidence of fatigue and monotony among the workers. In the first phase of the study, length of the work week and changes in rest periods and illumination were introduced. After indeterminate results were obtained in these initial studies social variations were introduced. Operators were put on a group salary basis. Besides inducing changes in productivity, these social variations also produced alterations in the social relationships among operators. It was claimed that the relationships between operators and their supervisors had improved.

In trying to give an account of the initial indeterminate results and the later social findings, the investigators decided that the social factors in supervision were decisive. It was deduced that in arranging the physical test conditions, the study had altered the social situation of the operators and personal relationships between workers and their supervisors and that changes of this sort tended to promote productivity. The conclusion was that dynamic group interaction had a marked effect on

productivity and that better supervisory methods were the key to getting high group cohesiveness and thus higher productivity. Using these findings, Mayo (1945) reformulated traditional assumptions to create a psychoanalytic interpretation of the role of supervision. Mayo felt there were two basic administrative problems for every social work group--i.e., the achievement of satisfaction of material economic needs and maintenance of spontaneous cooperation within the organization.

A second series of studies which contained implications regarding the role of supervisory monitoring was that of Levin, Lippett and White (1939). They formed three child work groups or clubs. One was guided by autocratic leadership, one by democratic leadership and the last by laissez-faire organization. Autocratic leaders were able to name the club and decide all the rules. Democratic leaders were able to lead discussions in which decisions were made and laissez-faire leaders were available for advice, but never interfered or volunteered information.

It was found that the authoritarian group completed the most work but, when the leader left, the work immediately stopped. The democratic group, on the other hand,

accomplished less but showed more group cohesiveness and cooperation and continued to work in the absence of the leader. It was found that members of the authoritarian group, although accomplishing more work, were dissatisfied with their leaders and formed cliques. The laissez-faire club accomplished little and most of their activities were completely unorganized.

A variation of this experiment was arranged by Kid and Christy (1961) who set up an experiment using three supervisors who were rotated on three patterns of leadership in a simulated air traffic control system. These three patterns were laissez-faire, active monitoring and direct participation of the supervisor in the work situation. It was found that supervisors, examined as individuals, influenced quality and efficiency more than assigned leadership roles. Supervisors who sensed group feeling and participated in the work situation were more equipped than those who just played the role. The results thus suggest that supervisors may play a significant role in work by special abilities in sensory social interactions.

Stanton (1960) also studied a problem involving supervisory monitoring by comparing two types of industrial

institutions which were organized differently. One was organized along authoritarian lines, the other along democratic lines. He controlled the supervisor's attitudes in terms of judged level of consideration which he felt should be shown for the desires and feeling of an employee, making sure there were no differences. He figured that in authoritarian structures, supervisors desired limited employee control over the job and a rigid operating structure of supervision. In the participative or democratic organizations, worker control over the job was preferred. Stanton concluded that it was situational factors in supervision rather than intrinsic leadership or group-role factors, which determined the effectiveness of leadership in the industrial situation.

#### SMALL GROUPS RESEARCH

Another sector of study of human relations and group dynamics related in a limited way to social monitoring involved study of controlled communication in small groups. Sherif (1936) experimented to determine the effects of group motivation on group members. His subjects made perceptual judgments of the autokinetic effect under conditions in which a tiny dot of light in a darkened room

appeared to move. Subjects were required to make judgments of the movement of an actually stationary dot of light while alone and in the presence of others. The results showed that when alone subjects developed their own unique range of responses, but in the presence of others (in a group situation) the range of their judgments became more narrow, thus indicating the effects of a monitoring social influence on behavior.

A study by Ashe extended findings of the sort obtained by Sherif. This study showed the effect of the group on the individual. He asked subjects to judge the length of the standard line in relation to three comparison lines. Only one was the same length, the other two were obviously of different lengths. Subjects were required to decide aloud and in order. The majority of the participants in this experiment were "stooges" who served to introduce bad judgments that could affect the judgments of the primary subjects. Several "stooges" made identical incorrect answers to see if group pressure on "uninformed" subjects would have any effect. Under such group pressure by others "uninformed" subjects became hesitant and embarrassed. One-fourth of them maintained their independence, despite

unanimous contrary opinion. Others weakened immediately and followed the majority--i.e., the stooges--in making errors. Tests were made to see if discrepancies between the standard and variable lines would affect judgment. They found that even when there were marked differences in line length, under the social pressure some subjects still judged the unequal lines as equal. For the present research this study suggests that the pressure of other monitoring persons in a group can have a marked effect on individual behavior in the group.

#### GROUP PARTICIPATION

Studies of group participation give some clues to the events of social monitoring because they indicate the effects of variable conditions of individual control over communication and efficiency of primary workers. From a social point of view the studies are limited because they failed to consider the influence of unions on worker participation in supervisory processes.

Coch and French (1948) carried out an experiment in this area of worker participation in an Eastern textile mill. The company was reported to have liberal personnel

policies. Work performance was to be measured under different participative conditions, in the main study to see what effect they would have on job transfer acceptance. These groups were matched on the basis of group cohesiveness and degree of change demanded in the new job. One group, the "no participation" group, was simply told that production changes required their being transferred. A second "representative participation" group was permitted to send special workers to meetings in which the job transfers were discussed and a manager worker agreement was made. A third group, the "total participation" group was formed in which all members of the group took part in the discussion about job transfer. It was found that production was highest in the "total participation" group after job transfer. Second best was the "representative participation" group and last was the "no participation" group. It was found in addition that, although in weeks following transfer all three groups showed an initial drop in production, the "no participation" group showed no recovery. The other groups not only recovered fully but even surpassed their previous rates.

Smith and Lawrence (1955) evaluated the French and

Coch experiment. Their objective was to determine whether increased output was due to group determined goals or to group behavior, demonstrated by group discussion. At the onset, subjects were unaware that they were in an experiment. They were asked to be in a so-called "trial study." Four groups of subjects were used: two groups of matched piece-rate workers and two groups of matched salaried workers. Both of the latter groups were divided into discussion groups and a goal group.

The primary data of this experiment dealt with the success with which salaried goal groups and piece-rate goal groups achieved the production goals they set. The salaried group attained its own group-set goals in the first two weeks, and the piece-rate group attained its group set goals the first week. The goal for both groups was then set too high to be completed. It was decided that goal setting was the most important factor rather than group discussion. The findings indicated the factors which most affected productivity included in order: specialization of superior roles as distinct from worker's role, authority delegation, employee centered supervision. Besides suggesting that productivity may be favored by participation, or reciprocal

social interactions in supervision, these studies also indicated that the mode of social supervision in work can have positive feedback effects in worker efficiency.

#### COMMUNICATION NETS

This work was started by Bavelas (1958), who restricted the communication patterns among group members to see which patterns were the most effective in a communication sense. He conducted experiments in which members of small task-oriented groups were positioned to allow communication only with specific members of the group. Results showed some set-ups gave other positions the advantage. Furthermore, set-ups with a high degree of centrality made the fewest errors. However, even highly central groups could suffer from a low group morale due to positioning, which caused isolation of some members. According to these findings, centrality was critical to group communication and productivity, although centrality in itself was not the only decisive factor.

Leavitt (1951) used groups of five students who were given simple problems to solve. The subjects sat in cubicles and communicated with each other by passing written messages through slots. Four patterns of

communication nets were allowed. The chain, the Y, the wheel and the circle were used. A system evolved through the Y and the wheel patterns in which the central person made decisions. Organization developed more slowly in the chain and none occurred in the circle. An important aspect of this study was that, after the completion of the trials, subjects were asked to determine the leader of their group, if they felt one existed. Almost every time members chose the person in the most central position. There were none in the circle. Thus, leadership was given to the person who handled the most information. Perhaps in this way the ideal situation in industry is to give supervisory or leadership positions to those in the social group positioned to handle the most information. Leavitt found, for the most part, that the greater the communication between the leader and the rest of the group, the greater the efficiency. He also found, like Bavelas, that the central position nets were the most efficient but also exhibit the least satisfaction for the other members. Finally, he found that it was the position of the group members which determined their behavior. Heise and Miller (1951) also found results similar to these two studies. They concluded that with

greater communication between group members there was greater productivity.

In later experiments, Shaw (1954) studied arithmetic problems with three communication nets: a wheel, a circle and a circle with a cross communication axis. He discussed results similar to Leavitt, but concluded that centrality alone bears no simple relation to independence of action. There can be many possible factors determining both independence and centrality.

Another study by Guetzkow and Simon (1954) using a wheel, a circle and comcon (a square with an X in it) found similar results to Leavitt. In addition, they found that the most efficient group was one that develops a hierarchical structure of performance.

Mulders (1959) felt that it was the "decision structure" of the group which determined its efficiency and that the decision structure can only be determined by observing the group behavior. When the decision criterion demands a more central structure, then the central structure is the most efficient. Because these decision structures are most likely to occur in centralized nets, there is a greater possibility of efficiency in these nets. He continued the

experiment attempting to determine the difference between the wheel and the circle in terms of time scores and errors in problem solving. He found that decision structure determined time and total error in performance of the net, while centrality determined the total number of messages passed.

Trow (1957) spoke of autonomy of group members in problem-solving situations. This involved the independence of positions in the net. He felt that centrality was really the degree of access to task relevant information, and that satisfaction in performance was related to the need for autonomy.

All of these studies in human relations, group theory, group participation and in communication nets have attempted to look into the very nature of group activity to learn the many factors which comprise relative activity between group members. Much of this evidence is open-ended and indecisive because of the inability of investigators to define the specific social rules and influences of participants.

It was these failures of human relations researchers which gave way to still another attempt to increase

productivity in group situations, through group training.

#### GROUP TRAINING

Group training contains procedures of social monitoring by a trainer to guide training in situations requiring interactions of participants. Such training started out early in the 1920's as training programs for industrial supervisors and managers. Management institutes began to spring up and made claims to train people to supervise others. These programs expanded greatly in the last twenty years. Often they were designed and conducted around information from clinical and social psychology, sociology, and psychiatry to provide a group interpretation of work and its management. Mayo (1933) and Roethlisberger (1945) and Dickenson (1945) used the Hawthorne studies as a basis for counseling and human relations training. They wanted to encourage management to display the traits discovered in the studies of group dynamics. They hoped through these methods of training that the desired characteristics could be taught to all managers and thus a utopian industrial situation would be realized. Unfortunately, it had been found that most of these training techniques are unrealistic, lack generality and cannot lead to persisting changes in

behavior. The basis of their limitations are still not known.

### Techniques of Group Training

There have been three techniques of group training: (1) conference training methods, (2) role-playing training, and (3) sensitivity training. These three techniques shall be discussed as well as a current revision of methods of study in this area.

Conference training methods developed mostly from the work of Bales (1958) which identified different member roles in the group situation. Busch (1949) described conference training programs as useful to communication, education, foreman training, training multiple management, problem-solving and policy-making. Later, Benne and Sheats (1948) attempted to analyze conference training methods in terms of the functioning of the leaders and members of the group in terms of their roles. They attempted to look at group members in their specific roles and felt through understanding, they could learn how to train people for their roles.

Fansler (1950) described how creative power could be

developed through conference discussion and participation. The idea was to learn how obstacles to group discussion in terms of its potential for problem solving and critical thinking. Shoen (1955) was one of the first to show that these discussion techniques could be of value to the business world.

Role-playing training evolved out of concepts of group therapy. Three types of role-playing training have been developed: (1) leaderless discussion methods, (2) participative role learning, and (3) audience role playing. In leaderless discussion groups, roles are not assigned, but are achieved by engaging in training activities. In participation role playing, there is an attempt to identify group participation and role-playing training as techniques of "democratic supervising." Finally, audience role-playing involves members of the group participating in a skit role-playing situation.

The purpose of group participation and role-playing methods is to change attitudes of supervisors and managers, for it is attitudes which determine perception and behavior. If attitudes can be changed, behavior can be altered.

One study by King (1956) attempted to examine the

role-playing procedure in terms of the process of improvising solutions to problems and the factors of satisfaction derived from role-playing sessions. According to King, the factor of improvisation is more important in producing acceptance of persuasive influence than the mere satisfaction of role-playing.

Levine and Butler (1952) compared lecture and group discussion methods in 29 supervisors and 395 factory workers in overcoming biased performance ratings. Results indicated that groups trained in terms of group discussion or role-playing methods were able to overcome biased performance ratings.

Cartwright (1951) showed the importance of group belongingness in changing the attitudes of those in the group. He found the more attractive the group is to the member, the more likely it can produce changes in the group members' attitudes.

Several studies have also been done by Maier (1950, 1953). In one study, results were obtained to show that asking good exploratory questions in discussion groups was superior to trying to "sell" problem's solutions to the group. Another study by Maier (1953) involved leaders

of 44 small groups, trained in group discussion while leaders of 36 similar groups received no training. It was found that, in cases where the group needed to change work methods, the training group was much more successful and had more members willing to compromise, than in the untrained group. Maier and Solem (1952) found that trained leaders could improve acceptance of correct solutions by over 20%.

These approaches to group training were so unsuccessful that there emerged a third attempt, sensitivity training. Sensitivity training extends group therapy beyond the role-playing techniques. Supervisors or managers are supposed in this way to develop "sensitivity" to themselves, others and to ways in which individuals interact with each other in groups.

Tannenbaum, Kallegian and Weschler (1954) felt it was tense relations between executives and subordinates that cause many of the problems in industry. They felt that tenseness occurs because of lack of understanding. They said an "executive neurosis" develops in these men of authority. Executives need to learn to discuss their emotional problems which arise and with the help of a

trained counselor or monitor the executive may develop greater skill in dealing with his emotional problems and with others. Blansfield (1956), Bradford, Lippitt and Gibb (1956), Shepard (1960) and Weschler and Reisel (1958) described these techniques as "a group training" and "action research training." They claimed that "issues become clarified and understood as each trainee is helped to appraise his own behavior in relation to these issues." The procedure used was, first, the trainer asked questions about other group members. Questions were presented whether they liked their partners, their jobs, operations or activities. It was believed that these questions would elicit information about the way each member was perceived by his fellows. Another technique was for the trainer to provide a model of behavior by his own conduct, and his acceptance of criticism from other group members. In still another technique a trained counselor identified barriers between individuals of the group. In a final technique a trained counselor assumed an "export" role. In another technique a trained member used psychotherapeutic counseling and non-directive methods.

Sensitivity training was developed to account for many

of the weaknesses found in role-playing, conference and group discussion methods. It was primarily designed to expose personal emotional attitudes of group members in the group situation to facilitate participation and communication. Group pressure was used to induce conforming activities in the group. Unfortunately, sensitivity training, like other methods of improving human relations, had many drawbacks. For one, group motivation phenomena are not primarily intrinsic to group structure but derive from authority and power relationships of work authority and management controlled economic pressure. Most of these programs worked on the assumption that the group can be modified by the very structure of the group. This does not appear to be the case. Another result was that group dynamics studies produced no clear demonstration that it is group factors which determine motivation and thus failed to confirm an assumption around which the studies were planned. It was true also that studies of group participation and production were indecisive in denoting requirements for design in group training. Further, other experimental research has shown there is no significant relationship between job attitudes or morale and productivity whereas the theories

of sensitivity training assume the opposite. Finally, psychotherapy, which is the basis of all these programs, has failed to modify either individual or group behavior.

Much of the work currently done in the field of group dynamics is done in T-Groups or discussion groups. One study by Cambell and Dunnette (1968) looked at the effectiveness of the T-Group experience in managerial training and development. These researchers found, "that examination of the literature leads to the conclusion that while T-Groups seem to produce observable changes in behavior, the utility of these changes for the performance of individuals in their organizational roles remains to be demonstrated." These investigators also found that the problems of observation and measurement in T-Groups were far larger than the problems they attempted to solve. In an article in Time Magazine, entitled Human Potential: The Revolution of Feeling (1970) about sensitivity training Donald Clark says "it does not lead to old answers but to new puzzles, new problems, new models of experience, new perspectives and subsequently may provide a possible though not guaranteed footing from which one may reach for new answers and new skills."

Another approach related to sensitivity training in the area of psychotherapy is the use of interviews, personality tests, and observed changes in social-emotional traits in group training and performance. The most obvious fault in these techniques is their lack of specificity and individuality. Even the best clinical psychologists, using the best personality test and interviewing procedures probably cannot accurately forecast how well their own students will do in such training.

Randle (1956) found the best criterion indicating the promotability in executive groups were past performance criteria. Whyte (1954) went further to show that already successful executives and scientists often failed to meet standards of normality found on personality tests. These and other studies give evidence that interviews and personality tests are not the answer to these problems.

An Approach by Bass (1962) using a sentence-completion film reaction test attempted to improve on sensitivity training procedures. The test was developed to detect sensitivity to interpersonal phenomena. Unfortunately this test, too, suffers from inability to transfer to a real group situation. The problem is that the clinical

psychologist in industry has no scientific basis for determining when psychotherapy is needed. This is due to a disagreement among psychologists and psychiatrists as to what constitutes behavior disorder (Scott, 1958). So their ability in judging essentially normally people in a work situation may be open to question.

Educational technological innovations have been made in group training. One such innovation is based on the use of television tape recording methods of training. These methods allow almost immediate feedback information to the individual or group. Currently television tape recording has been used by athletic teams whose managers realize the impossibility of monitoring the complex operations of a team effort. A game's video tape recording can be viewed immediately following a game by manager and players alike. They can be viewed over and over catching mistakes in judgment and coordination. These same techniques can be applied to educational processes and to industrial situations. Teachers and supervisors can view tapes of their own performance and receive the essential feedback necessary to alter behavior.

It is with this knowledge of the importance of

immediate sensory feedback in learning training and in both individual and group behavior that alternatives to forementioned approaches to group behavior may be offered.

#### SOCIAL TRACKING RESEARCH

Social tracking studies form the experimental basis and beginning of quantitative measurement of social monitoring, as investigated in this study.

The concepts of social tracking and social feedback were developed by Smith (1968) and Smith and Smith (1966). This cybernetic approach viewed social behavior as a feedback-controlled process of interaction. Social response between individuals was conceived as active closed-looped yokes which can be established between motorsensory systems of two or more people or groups. In this theory, the informational after-effects in team interpersonal interactions and in interpersonal relationships and behavior are not considered as critical in guidance of social tracking as the immediate or real-time dynamic and continuous sensory effects of movement linking individuals together in some group pattern. Two or more people may be linked together in some group pattern. Two or more people may be linked together in this way so they can mutually

control the sensory inputs of each other by dynamic interacting movements. The theory of social tracking considers all social relationships to be of this nature whether they be in the setting of the home between mates or in competitive sports or in the work situation. All such social behavior is believed to involve continuous mutual reciprocal motorsensory control by direct and immediate sensory effects. In this way, each person reacts to another by regulating movement-produced sensory stimuli received from the other person.

There are various kinds of social tracking. Imitation is based on social tracking. In such behavior, one person controls his own movements by matching them with another individual's movements. It is assumed that learning between parents and child, teacher and student, coach and athlete and between fellow workers is achieved by mutual interaction between individuals in feedback-controlled imitation. Another kind of social tracking occurs in individuals who interact on a mutual but more or less equal basis.

It is important to note that in the mutual social tracking situation, two people do not just imitate each other. One person follows the movement of the other but

he in turn generates information. In this way individuals assume different roles of feedback control. The degree of social interaction between members of a group yoked in this way is determined by specialized space-time compliances in the feedback link. The individuals are locked together in closed or partly closed motorsensory circuits, so that compliant movement and sensory input between individuals is essential to sustain the interpersonal or group activity.

One of the main advantages of the concept of social tracking is that specific social feedback parameters, modes, and variables can be specified for the controlled study of social interaction and for the analysis of social factors in development and learning. In experimental arrangements based on such ideas, subjects are positioned so they depend, not only upon their own direct visual feedback, but also on sensory effects from the responses of other members, which in turn are used to affect a particular person's movements. These methods make it easy to vary and control the various feedback parameters of each member of the social group and to measure accurately how well each member performs in the social situation.

Two of the most important ideas involved in social

tracking are that individuals in social relationships form social yokes of different design and quality and the kind of yoke formed will determine the kind and amount of feedback that each individual receives. It has been shown (Smith, 1968) that the type of feedback link is of the greatest importance to team performance. The theory of social tracking, thus has been developed on the basis of experiments evaluating performance of individuals or groups under many different feedback modes and conditions.

#### Results of Experiments on Social Tracking

The background of social tracking research lies in the effort to study compounded reinforcement in tension behavior. Briggs and Naylor (1965), using a simulated radar controlled intercept, examined two situations--i.e., one in which the individuals did the intercept task alone and one in which the subjects were told how to perform by a supervisor. It was found that, in most cases, the verbal assistance of a supervisor interfered with performance and transfer of tracking, and that it was other factors of social interaction which were critical to team performance. In evaluation of this and related studies, Smith (1968) pointed out that these social factors are, in fact, social

feedback and tracking factors critical to the team performance.

One of the first attempts to study social interaction in a tracking situation involving team performance was completed by Rosenberg and Hall (1957). They investigated three modes of feedback: (1) direct feedback information based on error magnitude of the subject's own response; (2) confounded feedback information that combines a simple additive function of the error of both subject's movement and that of his teammates; (3) other feedback information based on error magnitude of the teammate's response only. In this study the independent variable was the three feedback conditions. These conditions dictated the proportion of the subject's own responses to his feedback, relative to the contribution of his teammates response. In the first condition, the subject had full feedback, in the feedback became progressively less direct.

Subjects were used in pairs. Each was given fifty trials of a simple task. Three measures were analyzed: (a) individual response accuracy, (b) team accuracy, (c) response differentiation between team members. Results showed that direct feedback produced the best learning.

With confounded feedback, the subjects were able to produce accurate average by compensating for the confounded feedback. It is important to note that no learning occurred at all when subjects received only "other feedback."

Another study of group social interaction was done by Suppes and Atkinson (1960). They used a continuous-response task in which subjects attempted to predict the location of another subject's target as a function of the other's prediction. They felt that the amount of correct responses for a subject would be a linear function of the amount of responses of the other subject. This is in accordance with what Rosenberg and Hall had found.

Egerman, Gaser and Klaus (1963) also used team arrangements organized on different feedback information. There were three team arrangements used: (1) a series team, where both team members received the team output as feedback, (2) parallel team, where team output was determined by the performance of either member of the team, (3) individual team, where the team output was determined by the performance of one selected team member. The results show significant correlation between the amount of direct feedback information and the effectiveness of team

performance. This study points out the importance of direct sensory feedback of one's own behavior for effective team performance.

Johnston and Nawrocke (1967) were next to evaluate team efforts in terms of social interaction and feedback. They suggested that team social feedback could be represented by an average of the total performance of the team. This team performance was, therefore, considered as average of individual contributions. The purpose was to examine the effects of simulated-social or combined feedback as a learning reinforcement factor on the individual performance of team members. Subjects were told that each had a partner and the feedback he received represented their team performance. Actually, the subject's feedback represented his individual performance relative to lenient, moderate or stringent criterion.

The results of the Johnston and Nawrocke study indicated that criterion difficulty is very important in determining team and individual performance, for the subjects thought that the criterion represented their partner's activities, and, in this way, formed their attitudes towards the other team member. The results showed that good

trackers were not affected to a great degree by criterion difficulty, but poor trackers performed best under moderate criterion. Results indicated that little or no learning occurred in any of the simulated tracking situations. The results, however, that team performance can be improved or inhibited by manipulation of combined team feedback information.

In 1963 Smith, Ansel and Smith conducted an experiment in social interaction using the series-linked arrangement of team members, in which the output of each subject was linked to the input of the other subject. In this experiment it was found that a delayed visual feedback was intrinsic in the linked arrangement and that this delay had a deleterious effect on team performance and learning. It was also found by Smith (1968) that inversion of social feedback can cause many of the same difficulties as delays. This experiment, once again, points to the importance of direct sensory links on team performance.

Kao (1968) investigated inter-operator visuo-manual tracking behavior as a closed-looped feedback controlled mechanism. He studied delayed visual feedback that occurs in many man-machine systems and found many of the same

deleterious effects found in the above studies. Then Smith and Kao (1969) investigated social learning under the premise that it depended on synchronization of feedback control of mutual interaction in continuous social tracking between two or more individuals. The experiment was designed to measure the system's error in team performance in a manual-visual social tracking task. It was found that there was nearly 100 per cent reduction of team error after four days when subjects received direct systems feedback. The experiment went further to show the deteriorating effects of various delays in systems feedback. These delays ranged from .2 seconds to 1.5 seconds. A progressive increase of dissynchronism of movement followed the delay increase. This study demonstrates the importance of direct real-time systems feedback on team learning and coordination. This learning is considered to be a process which requires a great amount of precision and synchronization of motor-sensory interaction between team members.

M. Smith (1970) investigated the effects of various modes of sensorimotor feedback linkages on team performance. He studied a series-linked mode, in which there is mutual exchange of motorsensory feedback among team members, and

a parallel mode, in which there is an admixing of motor-sensory feedback between team members. These feedback conditions were then applied in terms of the type of error feedback that was received by a team or by individual subjects. It was found that parallel systems and series-linked individual conditions produced the most accurate team performance. This research showed the importance of direct sensory feedback to individuals in determining the effectiveness of team performance.

More recently, Ting, Smith and Smith (1971) investigated social feedback in imitation under various delays and in a mutual and unilateral mode. It was their belief that imitation and learning depend a great deal on mutual yoked motorsensory interaction between the individuals involved.

The results included evidence that when visual feedback is present between an imitatee and imitator, the imitatee slowed or reduced the magnitude of their movements or both. Also, when the imitatee was required to add the imitator as in the mutual mode and was required to yoke their movements to visual feedback obtained from the imitator, there was an even more marked slowing of movement and a drop in performance error. Some differences

between males and females were also found. Males who were imitatees generated repetitive movements more rapidly than female imitatees. The female teams were all much slower in their movements than the male teams.

These results indicate that an imitator must synchronize his movement with an imitatee to monitor and track his movement. Therefore, he would have to slow and adjust his movements to fit the capabilities of the imitatee in social tracking. Along with this it was found that imitator error and movement is radically altered as a function of different modes of social interaction and social feedback delay. In a condition in which the imitatee was to simply aid the imitator, he did more. He varied the magnitude and patterns of his movement in accordance with the conditions and modes of imitation and social feedback delay. Finally, a comparison between unilateral and mutual modes of imitative behavior was made. It was found that the unilateral feedback conditions had more than twice the error of mutual feedback conditions.

The newest approach to group behavior is certainly of mention here, especially since it includes some of the same factors used in the concept of social tracking. This

approach involves the use of sound film in the interaction of individuals. W.S. Condon and W.D. Ogston (1968) using variable, micro scanning of sound film found that the body change patterns of a speaker move synchronously with his speech. A listener, in turn, also moves synchronously with the speaker primarily up to and including the word level. They discovered that there was a correlation of eye-blinks between the speaker and listener. Condon and Ogston (1969) also found with the use of micro film, that this communication occurs at many levels in speech and body movements and used instruments to measure the extent of this coordination. Their method of using micro film made it possible to view the film over and over again to observe the synchrony that goes on in a group situation.

Results of the phenomena of movement parallelism raise some questions regarding the techniques of studying group relations and dynamics. Only in the examination of closed-looped feedback links between individuals in groups will it be possible to learn how to increase productivity of these groups, and, at the same time maintain worker and supervisor contentment. One study in the human relation area by Smith and Knight (1959) points these facts out

very well. They found that personalized feedback between group members markedly, and consistently, improved group problem-solving efficiency and even improved self-insight of the group members.

In summary, these studies on social tracking which investigated social feedback compliance factors pointed up the inadequacy of previous learning methods in the analysis of social feedback and performance. The studies by Smith, Ansel and Smith (1963), Smith (1968), Smith and Kao (1969), M. Smith (1970) and Ting Smith and Smith (1971) all showed the necessity of having adequate continuous, real-time social feedback as contrasted to episodic, discrete social rewards and reinforcements in learning. From these studies social monitoring research derived its significance, for they point out the importance of temporal and spatial compliances necessary in any sort of training. Time delay can have a catastrophic effect on behavior and learning as well as space displacement of feedback. It also was demonstrated that in interaction between individuals, groups, teachers and students, team members and coaches, social feedback and tracking relationships are of the utmost importance in defining communication, learning and training.

With knowledge of the specific phenomena of social tracking as a base, social monitoring can be investigated and may be examined as a possible method to increase the spatial and temporal compliances, feedback communication, thus behavior modification, learning and training in the group and individual.

## EXPERIMENTAL THEORY AND METHODS

This research was designed to examine the effect of human monitoring behavior in measurement and control of primary social tracking accuracy in interpersonal performance. The purpose was to compare quantitatively the efficiency of such a monitor under various feedback conditions and modes and to determine the accuracy and effectiveness of his measurements of social tracking accuracy as carried out by two other persons.

As noted earlier the theory underlying this study is based upon the theory of social tracking by feedback control. Social behavior is thought to involve mutual cross-yoking of the motor and sensory systems of two or more individuals. The response of one individual provides dynamic sensory analogs of movements for another and vice versa. Social behavior thus is based on mutual social tracking in which individuals relate to the environment in an interlocking way by controlling each other's sensory inputs (see Figure 1).

The present research was designed to consider the

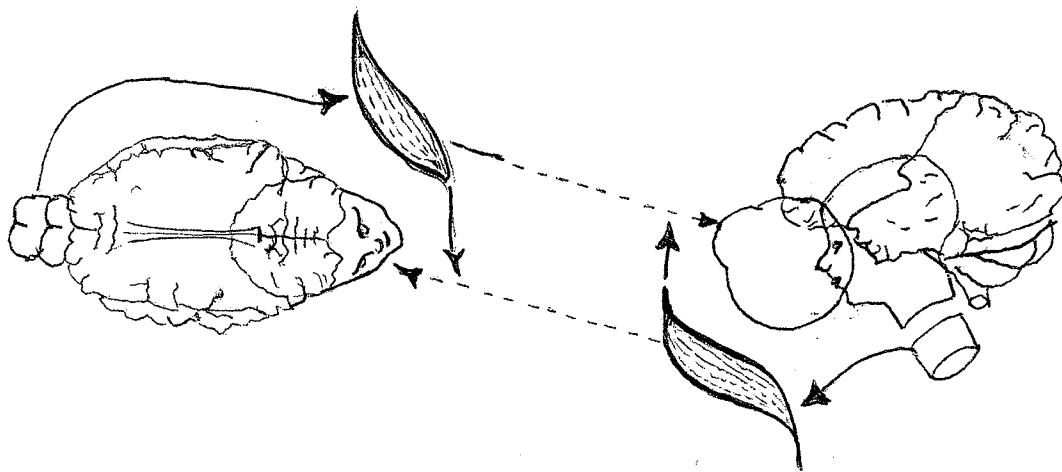


Figure 1. Social Behavior as a Function of Sustained Mutual Cross-Yoking of the Motor and Sensory Systems of Two Individuals.  
(based on Smith, 1966)

effect of a third person on primary social tracking as just described. This third person is defined as a social monitor or catalyzer who not only measured the accuracy of the primary social tracking but also influenced it by providing feedback to the primary trackers based on his social measurements.

Primary social tracking is closed-looped and reciprocal in operation. However, as noted earlier, many feedback conditions and modes can be applied and delays and displacements introduced. One aim of this study was to determine the influence of the human monitor under conditions in which these primary social tracking determinants were varied. In some conditions the imitatee and imitator involved in the primary tracking received nearly immediate sensory effect of their own movements and of each other's movements. In other conditions, the feedback was not as immediate since it was interrupted by a monitor and sent back to the imitatee, to the imitator, or to both. In addition, feedback control was examined in an aiding and non-aiding situation. In the non-aiding situation, the imitatee received an on-going concurrent visual feedback of the imitator's movement but provided no assistance

to the imitator. In the aiding condition, the imitatee tried to adjust his own reactions in generating activity so as to aid or improve the accuracy of the imitator and thus, the team effort.

On the basis of social tracking theory, several expectations regarding the results were set down:

- 1) Statistical differences in the relative error would occur as a result of various feedback conditions.

- 2) Statistical differences of relative error in social tracking would occur as a result of the aiding and non-aiding modes.

- 3) A human monitor whose actions cause a delay or distortion of team feedback would increase the relative error in social tracking.

In the main investigation, the primary objective was to determine the effect of the trained monitor and his compensatory team error information on the performance of two-man teams who were linked in parallel yolks. Several feedback conditions were varied. They were as follows: 1) no feedback condition (imatee initiated movements and the imitator used these movements as a target for his own movements.

The imitator received no feedback of his own movements or any information from the trained monitor); 2) monitor feedback only (the imitator initiated movements and both the imitator and imitator received monitor compensatory feedback only); 3) monitor feedback only to imitator (the imitator initiated movements and received monitor compensatory feedback while imitator saw only the target and received no feedback from his own movements or from the trained monitor); 4) monitor feedback only to imitator (the imitator initiated movements and received no other feedback while the imitator received compensatory feedback from the trained monitor).

Using these four feedback conditions, additional observations were divided into two parts related to the aiding and non-aiding of the imitator by the imitator. All conditions to all subjects of aiding and non-aiding modes were given in block randomized form. The subject pairs and monitor performed the social manual-visual tracking task for forty trials under the particular condition. Twenty trials were given in the aiding mode and twenty in the non-aiding mode.

The experiment was conducted with a real-time analog-digital-analog computer system. Tracking error from the

imitator was registered by means of potentiometer hand transducer which recorded hand movements and transmitted the hand-movement signals to an amplifier. The system also contained a display sector made up of an oscilloscope and closed-circuit television (shown on Figure 2). This set-up converted voltage changes from hand movements into a display that subjects could view. In other words, the hand movements became voltage changes that the subject teams could view themselves and manipulate accordingly.

#### THE SOCIAL TRACKING AND MONITORING TASK

The task in all conditions was for one subject, designated the imitatee, to initiate hand movements with the potentiometer hand transducer. The second person in the team, the imitator, was required to follow with the best of his ability the movement of the imitatee. The information that these two team members receives of their own movement and the amount of information of team error from a trained monitor was varied. All movements of imitatee, imitator and the monitor were seen on the computer-controlled feedback display as a dot of light that could be moved directly with hand movements. Accordingly, on the visual display

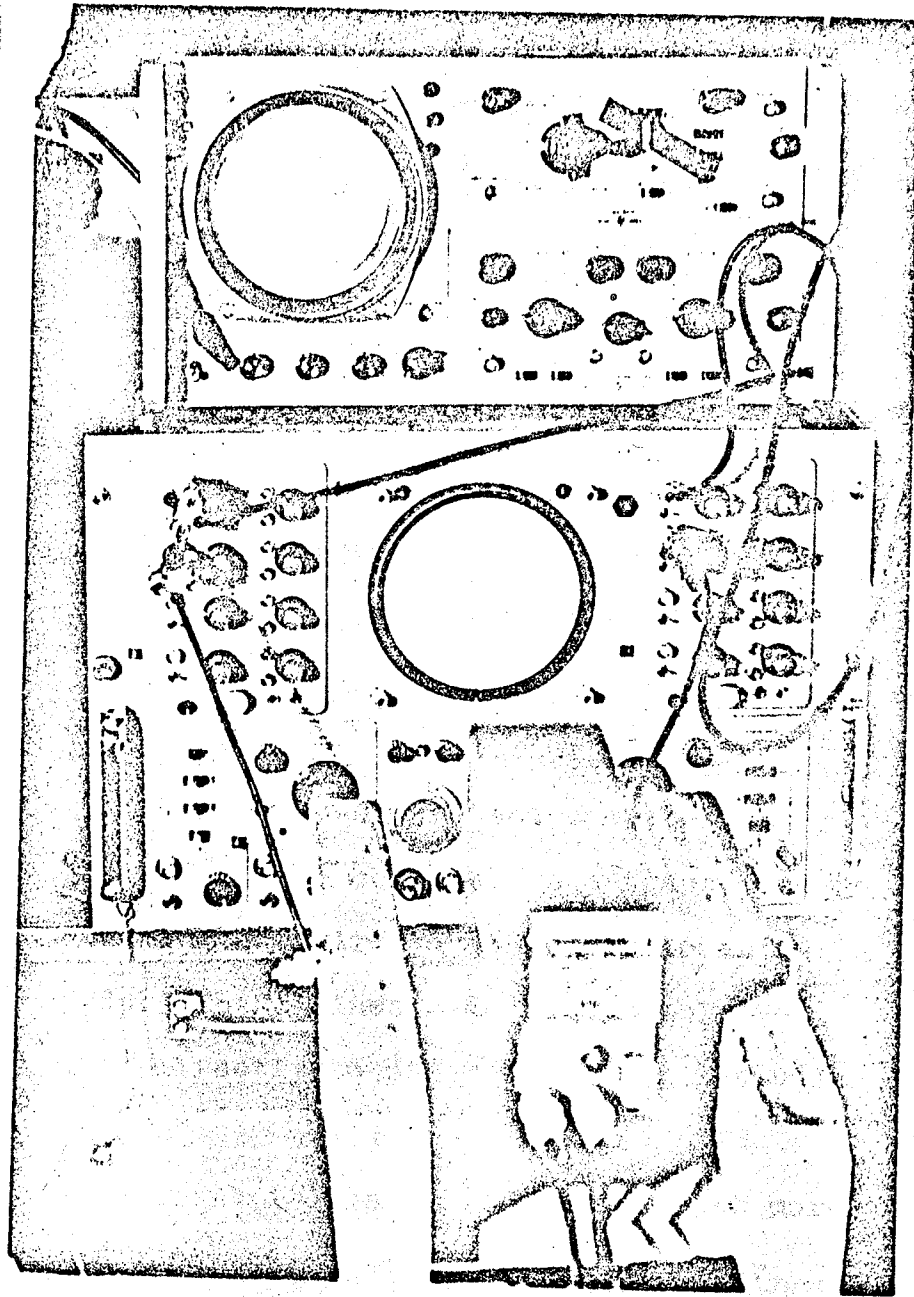


Figure 2. Oscilloscope and television camera used for subject display.

... single-throw switches which were linked  
... to make four double-throw

each team member saw a particular pattern of error information as governed by the condition in which he participated. Only the trained monitor had full view of the relative positions of the social target and the cursor. In contrast, the imitator and imitatee could see only the target (initiated by imitator) and the monitor's compensatory error measurements.

Figure 3 illustrated the experimental station used in social tracking research Smith (1968). The diagram describes the arrangement of the three tracking dots on the television screen. The top dot is the movement of the imitator (the social target), the middle dot represents the movements of the imitator (the social cursor), and the bottom dot represents social tracking error measurements of the trained monitor. The different feedback conditions were produced simply by blocking out the appropriate dots on the screens of the imitator and imitator.

The most difficult tasks associated with the experiment was that of the trained monitor who had to continuously measure the magnitude and direction of the error between the imitator and imitator. If the dot representing his measurements moved to the right of a center line this

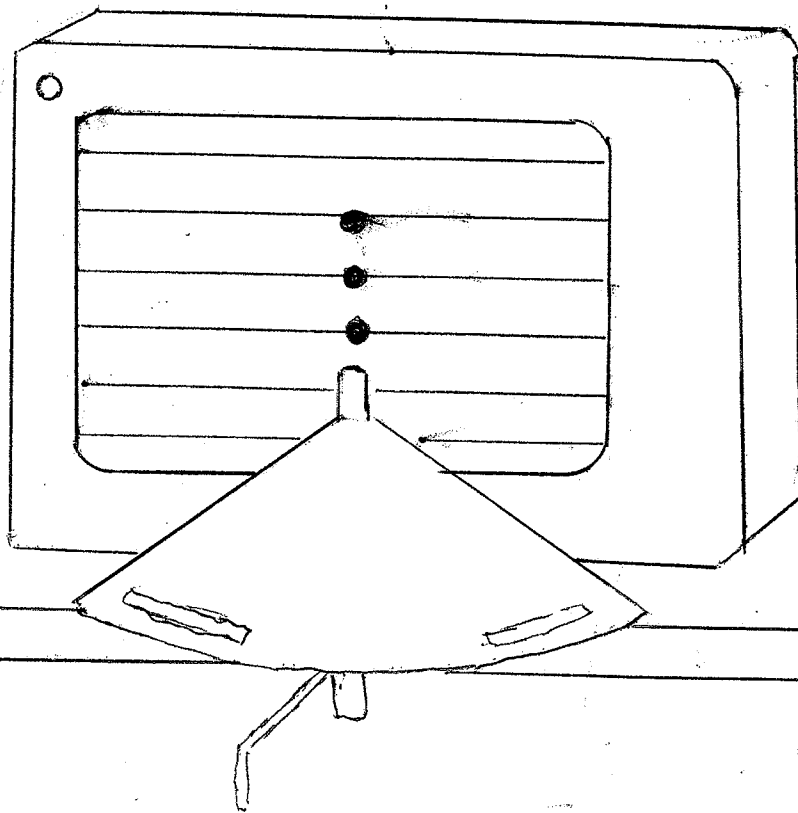


Figure 3. Subject's Experimental Control and display.

indicated to one, or both of the team members, that the imitator was trailing the imitatee as measured by the distance of the monitor's dot from the center line. If, on the other hand, the monitor's dot moved to the left of the center line, this indicated to the imitatee, imitator, or both that the imitator was ahead of the imitatee the distance of the monitor's dot from the center line.

#### PROCEDURE

All subjects were students from psychology classes at the University of Wisconsin. These subjects made up two of the three members of the subject teams involved in this research. The third member of each group was a monitor trained to measure social tracking error consistently and continuously. Each of the two randomly-chosen subjects for each of the twenty-four groups in the main part of this research were first introduced to the trained monitor. They were then seated in front of the television and shown the transducer. They were told that the experiment was a tracking experiment and that the main interest was in their team performance. Instructions were specifically as follows:

"Each of you are seated in front of a hand transducer which

is in control of one of the three dots on the television screen. You (pointing to the imitator) have control over the second dot and it will be your task to try to follow the target dot initiated by your team partner. It may be necessary for you to follow the target dot even without receiving feedback from your own movements. Instead you will receive feedback from the third or bottom dot which will be controlled by my assistant."

Use of the transducer was carefully explained and considerable time was spent in explaining use of monitor error information. Each group was told that the center line on the television screen could be considered the zero point. If the imitator was tracking the imitatee perfectly, the monitor's indication of the error would be zero and his dot would not move from the center line. If, however, the imitatee was ahead of the imitator (as was usually the case) the monitor's dot would move to the right a distance equal to the lag of the imitator. On the other hand, if the imitator moved ahead of the imitatee, the monitor would move to the left a distance equal to the lead of the imitator.

After the procedure was completely understood by the subjects, they were given several practice trials to get a "feeling" for the system. Any questions were answered and the experiment was ready to begin. Each group of subjects acted under one of the four conditions. Each subject group needed approximately thirty minutes to complete the forty trials, after which they were thanked and dismissed.

In one condition neither subject received monitor feedback, in another both received it, in a third condition only the imitator received monitor feedback, and in the fourth condition only the imitatee received monitor feedback. Each group of subjects also had to participate in the aiding and non-aiding modes of the experiment. Half the groups obtained the aiding first and the other half the non-aiding first. The directions were: "You will also be asked to participate in an aiding and non-aiding mode, twenty trials in each mode. In the aiding mode the imitator should try with his movement to help group performance. In the non-aiding mode the imitator should go on with his movements regardless of the team performance. Are there any questions? You will all have a few practice trials. This is a

team task and you may feel free to talk and develop strategy to improve team performance, especially during the aiding condition. You will begin when the red light above your screen flashes on and off. The trial is over when the red light goes off again. Trials are thirty seconds long with fifteen seconds rest between them. You will do twenty trials after which you may rest as long as you wish and then you may do twenty more, this time in the other mode. Then you may leave. If there are no further questions you may begin when the light goes on and then off."

#### APPARATUS

Figure 4 gives a complete diagram of the computer system of the subject experimental station and control apparatus, and the display system used in social tracking experiments. The specific components that were used in this research are shown in figures to follow.

The first of the components of the experimental system consisted of the station where the subjects were seated. The experimental hand transducer and television displays were located for each subject in this station (see Figure 4). The television sets were standard monitors that were connected

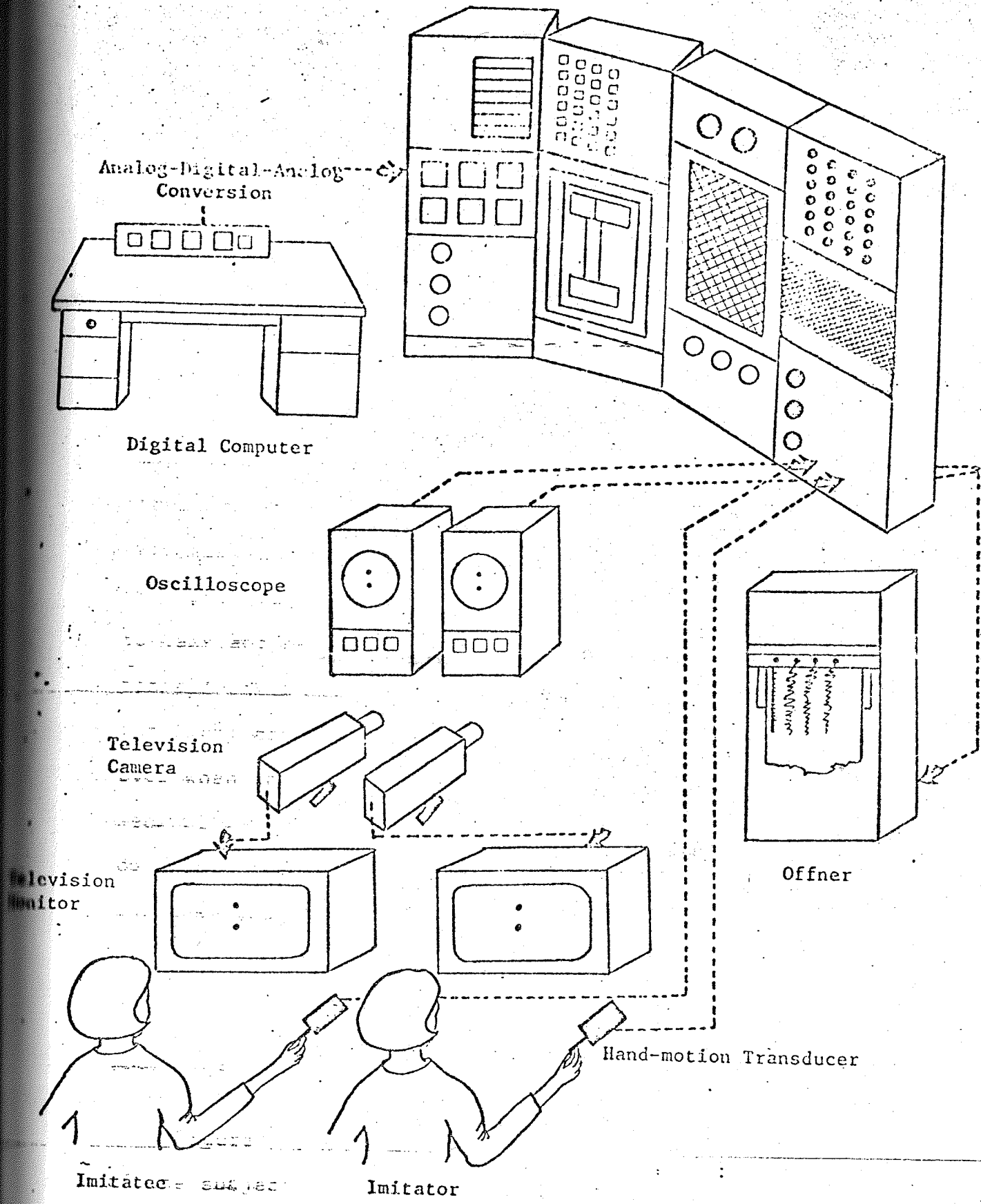


Figure 4. Schematic Systems of The Experimental Components

to closed circuit cameras. The hand transducers consisted of two 25K Ohm potentiometers, one connected to a rod that could be swung horizontally to move the individual dots on the television screens and the other was used to "center" the transducer with a voltmeter to make sure the output of voltage to the right and to the left was completely symmetrical. After the transducer was balanced the sensitivity was set to allow the participants to move their wand a distance equivalent to an electrical signal of 5 volts in either direction.

Besides being able to move his transducer wand to output a maximum voltage of five volts in either direction, the subject also could control all levels of gradual movement in between these voltage limits. Each subject sat directly in front of his own television display with his own transducer in front of him. Figure (4) shows how subjects were seated at their stations. They were seated approximately six inches from their transducer and about three feet from the television screen.

The voltage signals representing movement of the transducers of the subjects were recorded on an Offner oscillograph. On the first channel appeared the record of the

movement of the imitatee, on the second channel the movement of the imitator was registered. The monitor's movements were on the fifth channel. The third channel was used to subtract the imitator's signal from that of the imitatee, thus giving the social tracking error. On the fourth channel appeared the subtraction of the monitor's signal from the social tracking error, thus giving a record of monitor error in measuring the social tracking.

Three of the signals obtained -- i.e. the error between the imitatee and imitator, the monitor's movements subtracted from the actual error, and the monitor's movements were transmitted to an analog-to-digital converter. This converter had a voltage range of plus-minus ten volts and was also connected to a sampling clock, which regulated the speed of the data as transmitted to the digital computer. This sampling clock was set a hundred samples per second.

#### Experimental Computer Programing

One of the most essential parts of the system used in this research was the program used with the digital computer. This program was used not only to calibrate and score the three channels fed into the analog-to-digital converter but also to control the display of the three error

signals on an oscilloscope. The television camera recorded this three-variable tracking and-transmitted it to the three television tracking set-ups. The program was designed especially for this research and enabled each member of the subjects group to control his own oscilloscope target. In addition to these two essential functions, the program also controlled the order of trials and other events of the experiment. It flashed a light above the television sets to warn subjects that a trial was about to begin, controlled the length of each trial at thirty seconds, controlled the length of time between trials at fifteen seconds and also controlled the number of trials at twenty at a time.

The present experiment was designed to minimize the effect of order of presentation. Because participation in one condition of the experiment might effect the participation in another condition a between group design was used. Although each group of subjects participated in both the mutual and unilateral modes, different groups of subjects were used in each condition. As far as the mutual and unilateral modes were concerned, they were presented in block randomized form.

## PRELIMINARY EXPERIMENTS

In addition to the main experiment, two preliminary experiments were run with the methods varying somewhat from those of the main experiment. One preliminary experiment compared social tracking feedback to social monitor feedback; the other compared monitor error with computer measured error in the social tracking.

### PRELIMINARY EXPERIMENT ONE: SOCIAL TRACKING FEEDBACK VERSUS MONITOR FEEDBACK

In this first study, the operation of social feedback in the three man group situation was measured in terms of the effectiveness of a human monitor in determining the magnitude and direction of error in governing accuracy of primary social tracking between an imitatee and imitator. Two conditions were utilized, one in which the imitatee and imitator received complete visual feedback of their own error feedback, the other in which they received feedback only in terms of a monitor's measurement of their relative error. This error consisted of the distance between their

movements indicated by the monitor's movement to the right or left of a zero point. The idea was to determine whether the monitor's feedback to the imitatee and imitator would facilitate or interfere with the primary social tracking.

### Method

The experimental plan involved four groups with three subjects in each group. Of the total twelve subjects, seven were female and five were male. All subjects were students in psychology classes and none had had previous experience with this particular kind of tracking task. The monitors used in this experiment were not trained, as in the main experiment, but were also students who had had no prior experience with the task.

### Apparatus

The apparatus used was the same as in the main experiment. Feedback between the members of the group was displayed on a closed circuit television system and controlled by the computer system as described in the general methods section.

### Procedure

Each of the subject teams received forty trials -- i.e. twenty trials in each of two conditions. Each trial was thirty seconds in length. The imitatee was instructed to make smooth movements with his hand transducer. The imitator's task was simply to follow or track to the best of his ability the movement of the imitatee. The monitor was instructed to watch the graphical displays of the imitatee and imitator's movements and to give an indication of the direction and magnitude of the error between them. He did this by moving his transducer a distance from the zero point that coincided both in direction and distance to the difference between the imitatee and imitator.

The two conditions in this experiment were differentiated by the amount of feedback that the imitatee and imitator received. In one condition they received feedback of their own and each others movement. Both the imitatee and the imitator saw an oscilloscope beam of light which moved directly with the movement of their hand transducers, and in this way both team members were able to see directly the error between them. We refer to these measures as computer systems feedback. In the second condition, however,

they received only the monitor's indication of their error. The two conditions were presented in block randomized form. The scoring was done, not only by comparing the subjects across the two conditions, but also by comparing the effect of the monitor's performance. The critical measures for data analysis were primary social-tracking error and monitor movement representing primary social tracking error.

### Results

The results consist of oscillograph records and measurements of mean error in social tracking under the conditions of monitor feedback and complete systems feedback (as described above). The oscillograph records in Figures (5) and (6) illustrate the experimental results. Figure (5) shows the records under the condition in which the imitator and imitatee received complete feedback of their error and each other's movements. Figure (6) shows the records under the condition in which the imitator and imitatee received only monitor feedback of the primary social tracking error. Each set of records is composed of nine trial records (Trial 1-9) arranged vertically. Figures (5) and

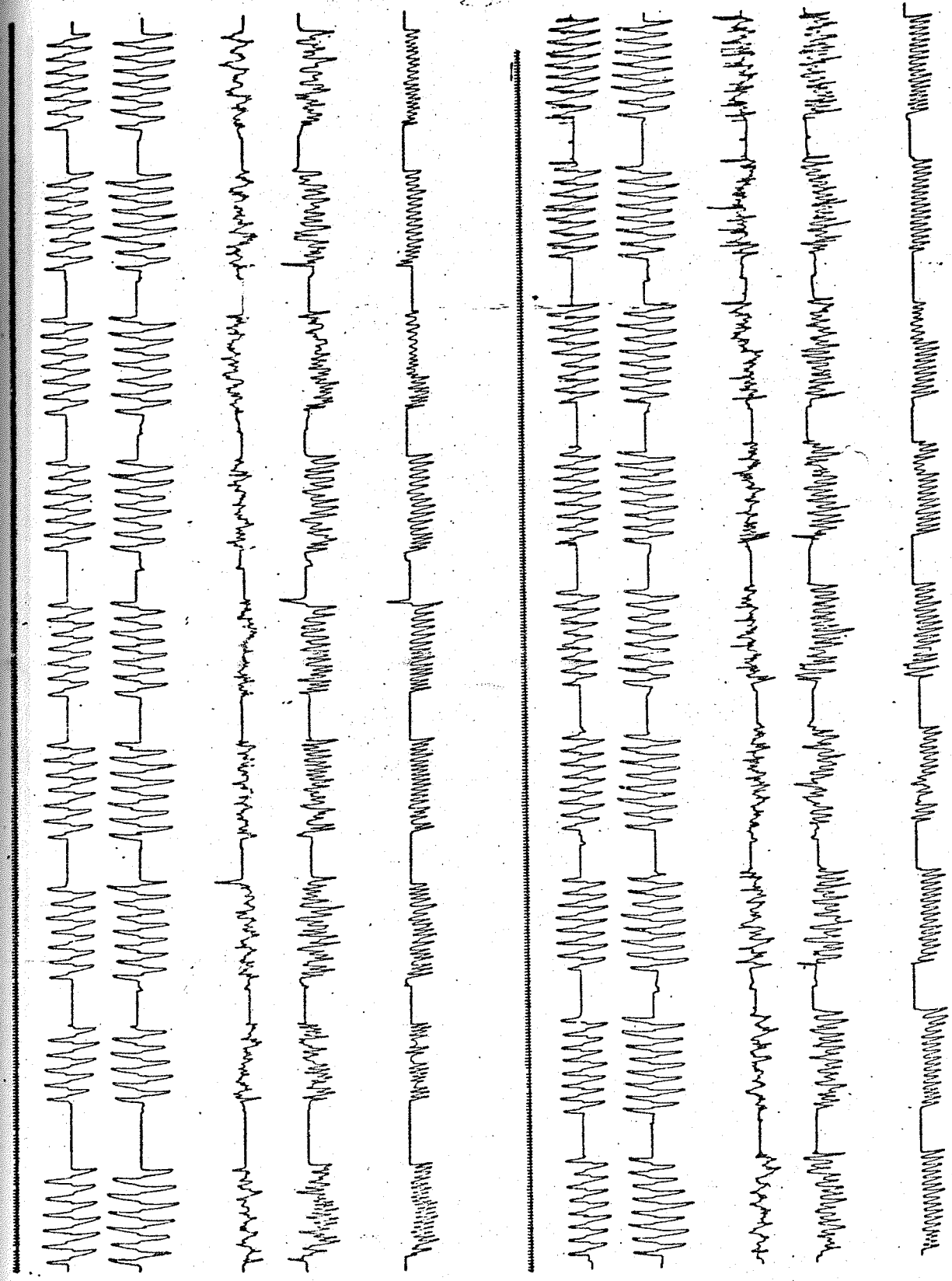


Figure 5. Oscillograph Records for subjects in Complete Feedback Condition

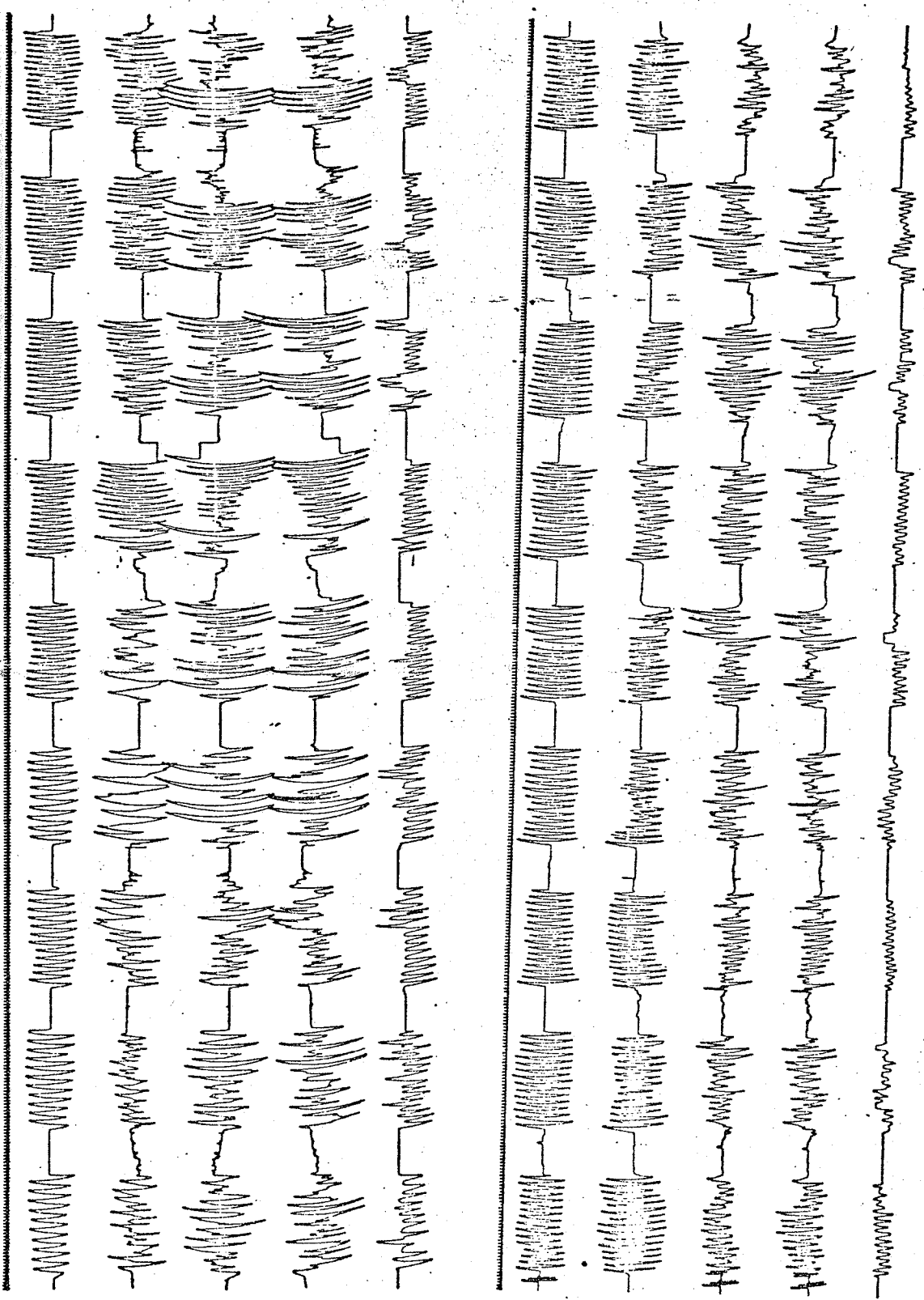


Figure 6. Oscilloscope Records for subjects in Monitor Feedback Condition

(6) are both composed of five adjacent oscillograph traces which represent from left to right (1) the imitatee's movements, (2) imitator's movements, (3) the error between the imitatee and the imitator (social-tracking error), (4) the monitor's error (monitor's movements minus the error between the imitatee and imitator) and (5) monitor's movements. Each trial record represents thirth seconds of trial time. A time line indicating the seconds appears to the left of each figure.

These records give a general indication of the results found in this study. Figure 5 in which the imitatee and imitator received complete feedback, shows the error between the two subjects to be relatively small. They were able to use the feedback of their own and each other's movements- i.e. complete systems feedback-to benefit their performance. In the conditions illustrated in Figure 6, however, in which the subjects received only monitor feedback, the error between the imitatee and imitator appears to be much larger. Judging from these records the monitor feedback added only confusion into the system, which in instances produced error in the primary tracking that was greater than the monitor's own movements on the far right trace. Each of the four

groups showed this marked increase in tracking error under the Monitor-feedback-only condition.

The bar graph of Figure (7) summarizes the result of this preliminary study. It shows the differences in the primary social tracking error level as expressed in mean relative digital voltage difference between imitatee movement and imitator tracking under the two main experimental conditions. It can be seen that the relative error level varied between the two condition, as already indicated by the oscillograph records. The error level was much lower in the primary social tracking condition.

The data of the experiment were evaluated statistically by analysis of variance. Variations in means due to the two feedback conditions were significant at the 02.5 level (See Table 1).

### Summary

From the knowledge of the importance of feedback in a closed systems from previous studies it was not surprising to find that there was statistically significant differences between the two conditions. When the imitatee and imitator had to rely only on the monitor's continuous measurements

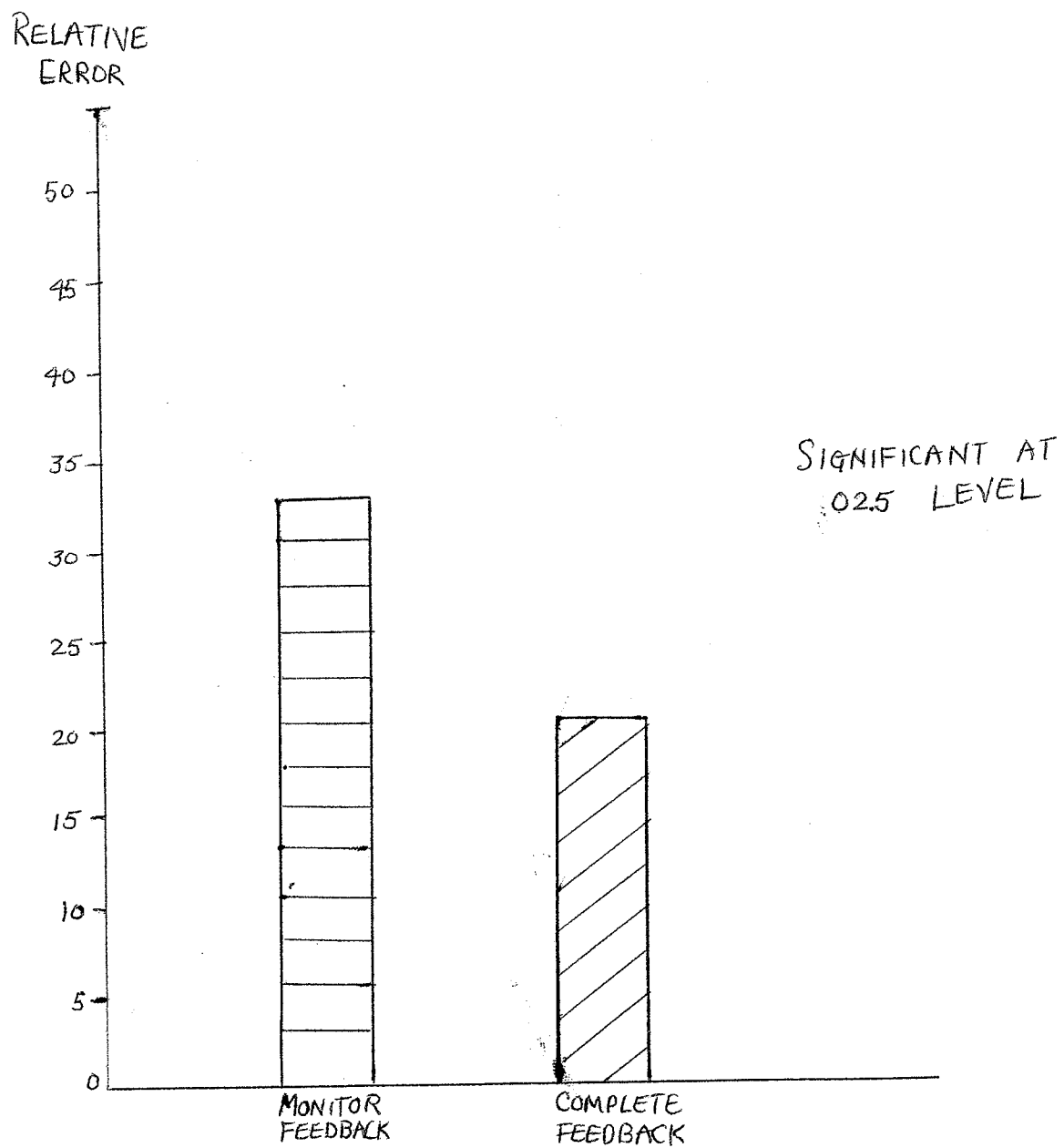


Figure 7. Mean performance errors as a function of the two conditions.

Table 1. Analysis of Variance for the comparison between complete feedback and monitor feedback.

Source of Variance	df	S.squares	variance est.	F ratio
groups	3	853	284	
conditions	1	6237	6237	22.0*
subjects X conditions	3	823	274	
trials	19	756	40	
subjects X trials	57	1611	28	
conditions X trials	19	340	18	
sub X cond X trials	57	1340	24	
totals	159	11960		

\* significant at 2.5 per cent level

of their error, their social tracking performance dropped considerable-i.e. nearly to the extent of 40%. Another aspect of this experiment that had not been anticipated fully concerned the particular task of the monitor. In the first condition the monitor's movements were not the imitator's and imitatee's source of error feedback and the monitor tracked their error quite accurately. In contrast, his performance began to slide under the second condition in which both imitatee and imitator received only monitor feedback. Thus, the error of the monitor was the most important factor in the increase of 40% error in the second condition. He acted not only as a delay in the system, but he also seemed to perpetrate error. In becoming a part of the tracking system in the second condition he not only increased the magnitude of the error but he added a source of error that was sometimes magnified and sometimes reduced in the primary tracking.

Comparison between the extent of monitor movement in the two main experimental conditions suggests very little difference in the way the monitor perceived the level of error in the second condition, although it was significantly greater. Figure (8) shows his mean movement in the first

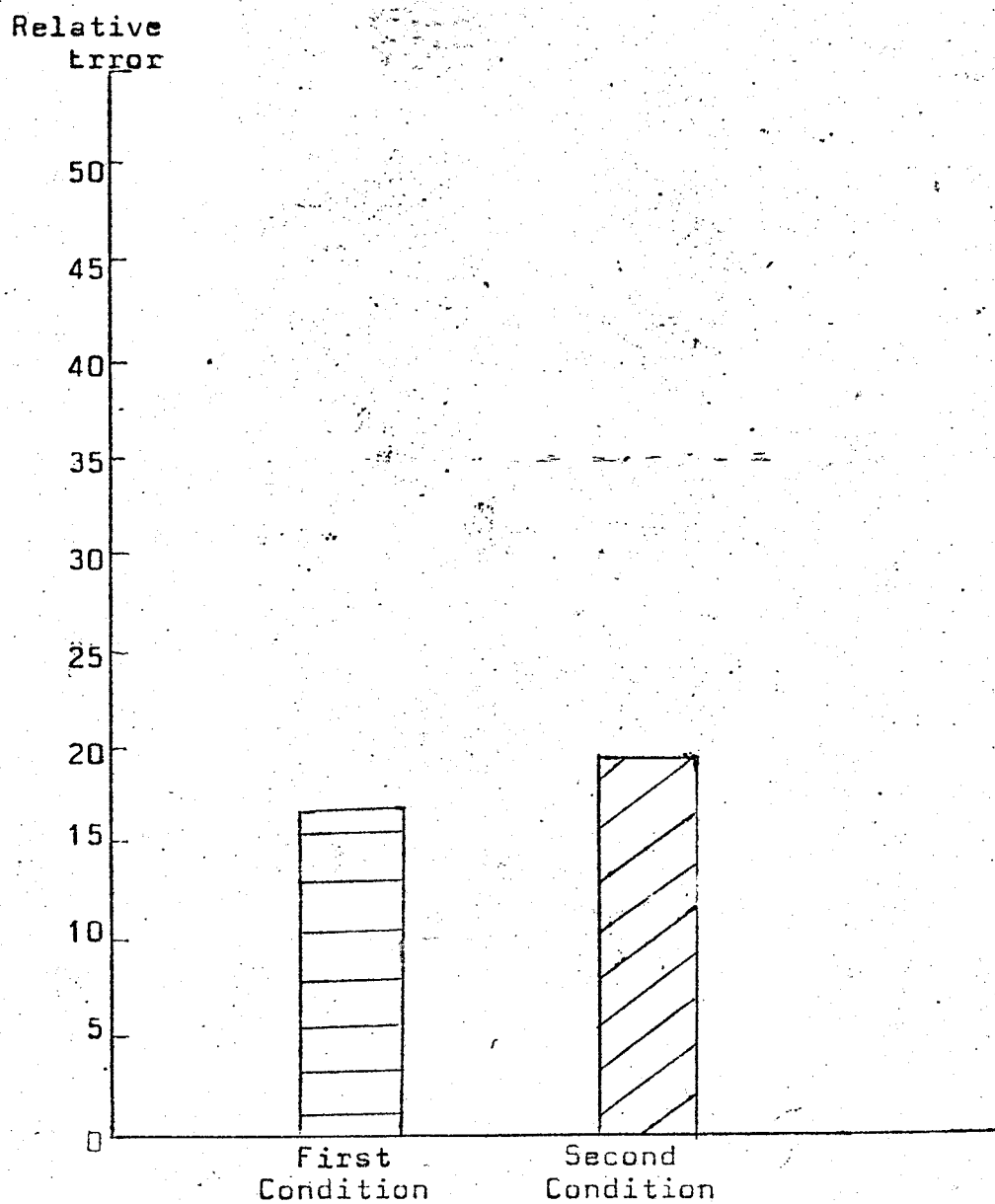


Figure 8 . Mean performance errors as a function of the monitor's performance in the two conditions.

condition was 17.02 as compared to 19.30 in the second condition.

It appears that there were both feedback and social factors operating in the system during the second condition. As the subjects' perception of the error between themselves increased, so did the monitor's perception of the error. During the second condition the monitor's movement should have been greater to give the imitatee and imitator an indication of their greater error, but instead of acting as a monitor and simply marking error, as in the first condition, the monitor became a part of the closed-looped system and became inefficient or more inaccurate as those he was trying to track.

Perhaps the most important data from this experiment is the critical Grand Error (which is the actual error minus the monitor's movement) which gives an indication of the monitor's efficiency. As shown in Figure 9, in the first condition the Grand Error was 25.72 as compared to 35.54 in the second condition. An F test revealed that this difference was statistically significant at the .50 level. This fact gives an indication of the monitor's inefficiency in indicating the error in the second condition

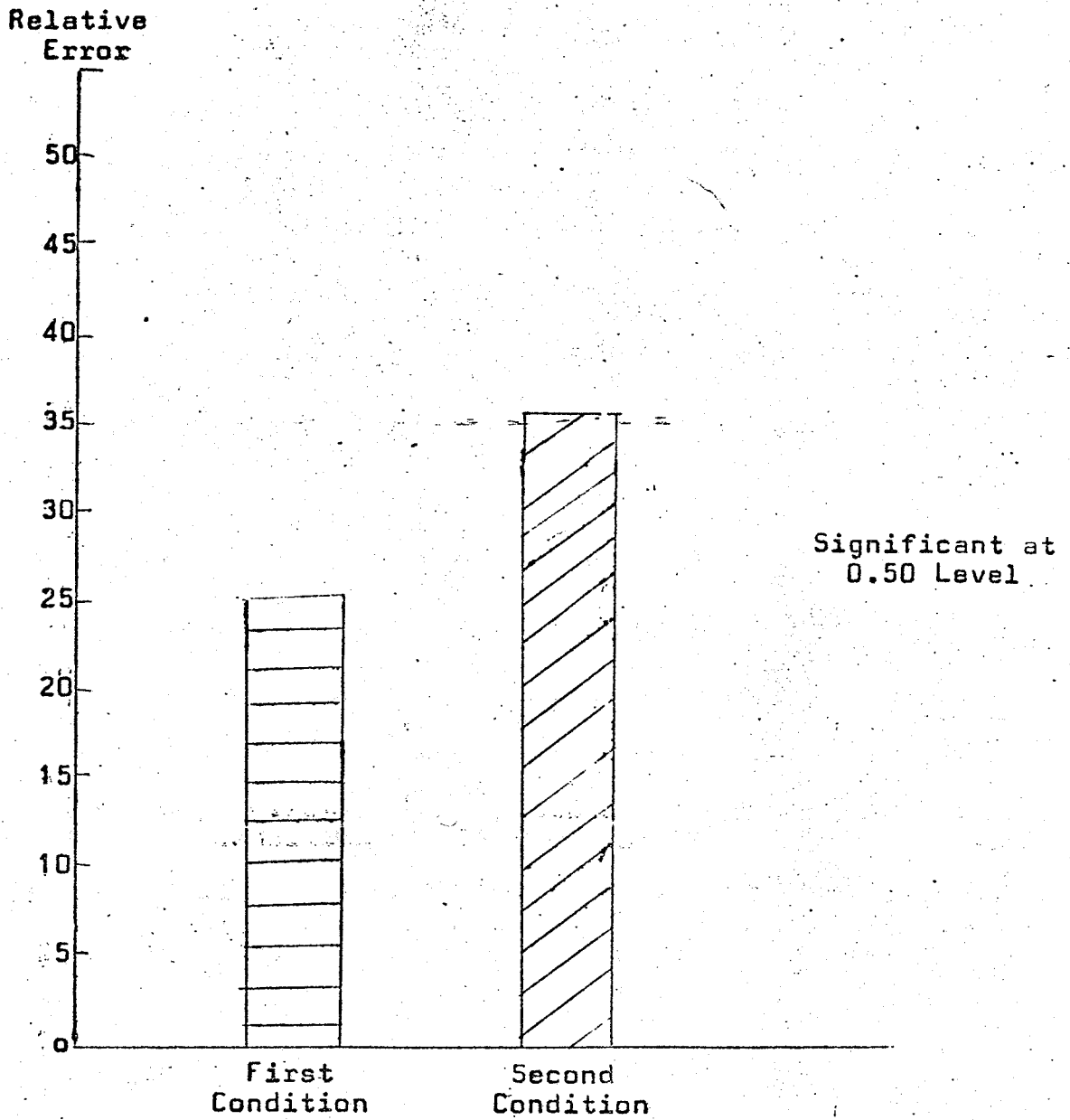


Figure 9. Grand performance errors as a function of the two conditions  
(Grand error=actual error minus monitor's movement)

where he became an integral part of the closed system.

Another interesting finding is illustrated in Figure 10, which presents oscillograph record of the two subjects participating in the complete feedback condition. There was a feeling among these subjects that their movements as monitors were of no use to the subjects who received their own and each other's movements as feedback. Notice the small tracking error as well as the Monitor Error, which is the same as the tracking error since the monitor ceased tracking. This example represents another of the social factors operating in this experiment. A final social factor operating in this experiment can be seen in oscillograph records (5) and (6) representing the two conditions. It may be seen that in the monitor-feedback condition the movements of the imitatee and imitator are much slower and the patterns different than they are in the full feedback condition. Here the imitatee and imitator attempt to synchronize their movements to enable themselves to track each other with the monitor feedback. This coincides with previous studies which have shown that the magnitude and patterns of movement change with various modes of social feedback control.

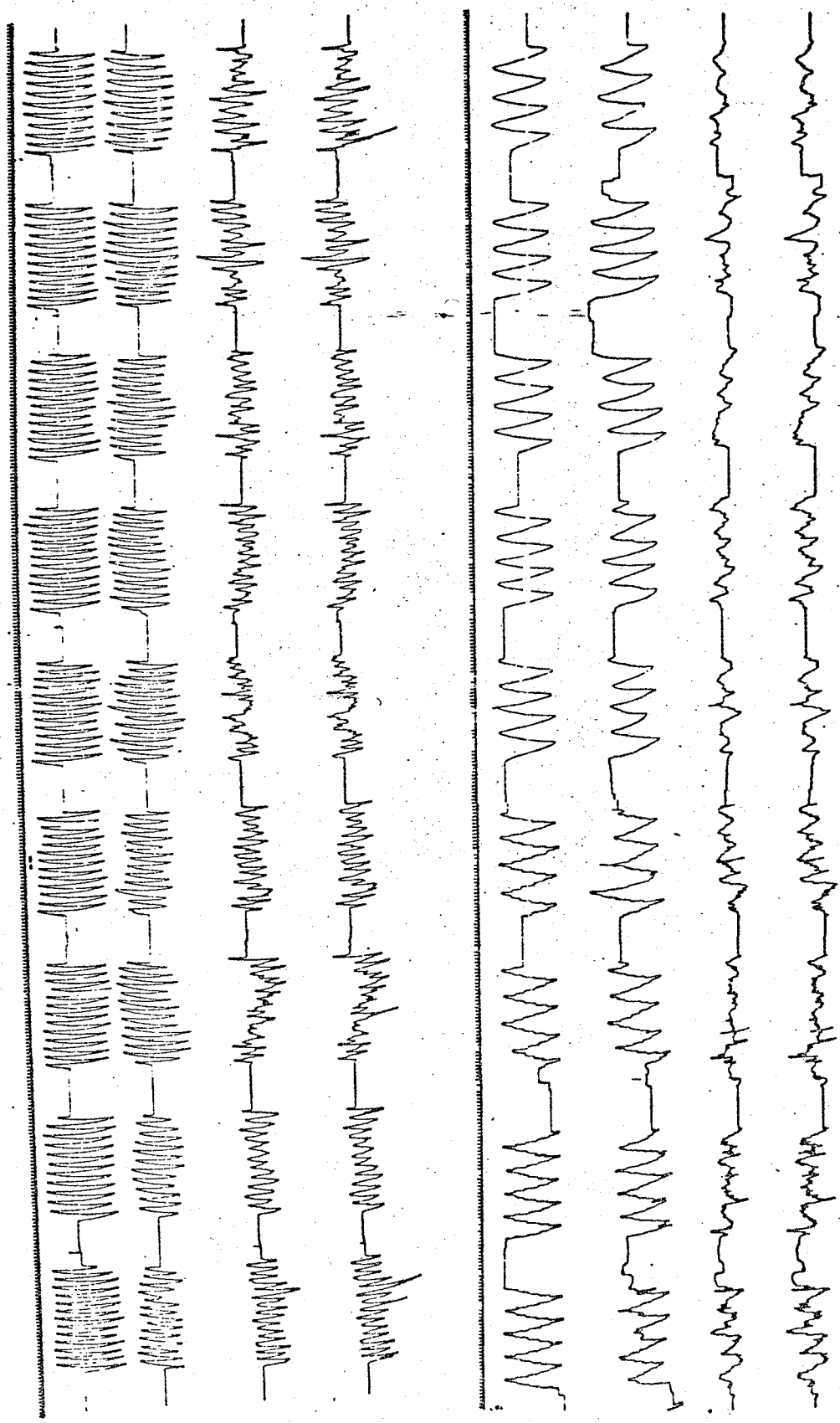


Figure 10. Oscillograph Records for two individual subjects WHO WERE MONITORS

## PRELIMINARY EXPERIMENT TWO: MONITOR ERROR VERSUS COMPUTER MEASUREMENT OF PRIMARY SOCIAL TRACKING ERROR

In the first experiment it was found that a human monitor acted to produce systems delay when his error judgments of magnitude and direction were used as feedback by team members in the primary social tracking. It thus became of interest to see if a computer-generated indication of magnitude and direction of error to the team members would be superior to the accuracy of a human monitor in measuring primary social tracking error. Results of the first study indicated that a great part of the error was caused simply by the temporal delay required for error to be interpreted by a human monitor and thereafter sent back to the team members. In the second experiment, however, the simultaneous feedback of machine-scored error was compared with the effects of the human-scored error and its inherent delays.

### Methods

The subjects consisted of six groups with three subjects in each group in which human-monitor feedback was used to guide the primary social tracking, and two subjects

in each group in which the feedback for the primary social tracking was the tracking error measured by and displayed from the computer system. Of the six groups of 18 subjects, eight were male and ten were female. All subjects were students in psychology. None had had previous experience with this particular kind of tracking task.

### Apparatus

The apparatus consisted of the real-time computer system used in the main experiment. In the case of the machine-scored error, the feedback was received simultaneously by the imitator and imitatee. Social tracking error was measured by the computer and then displayed to the imitator and imitatee. This same general procedure was used to display the error feedback as measured by the social monitor.

### Procedure

All subject groups received 40 trials, i.e. 20 in which the feedback of the team error was machine scored and 20 trials in which the team error was measured by a human monitor. These two conditions were, of course, given in block randomized form and each trial was 30 seconds in length.

Once again, the imitatee was instructed to make smooth movements with his hand transducer and the imitators' task was simply to follow or track the movements of the imitatee. The human monitor acted just as he did in the first study and watched the simulated displays of the imitatee and imitators' movements and gave them indications of the magnitude and direction of error between them. He did this by moving his transducer a distance from a zero point that coincided both in direction and distance to the actual error between the imitator and imitatee. In the machine-scored condition this error was indicated in exactly the same way but the process was entirely automated. The aim was to determine if the two types of feedback would produce differences in the primary social tracking error.

### Results

The results of this preliminary study consist of oscillograph records and measurement of mean error in social tracking under the two conditions of human monitor feedback and computer feedback. The oscillograph records in Figures 11, 12, and 13 illustrate the experimental results. All figures show a comparison of subjects performance under the two feedback conditions. Each trial record is composed of

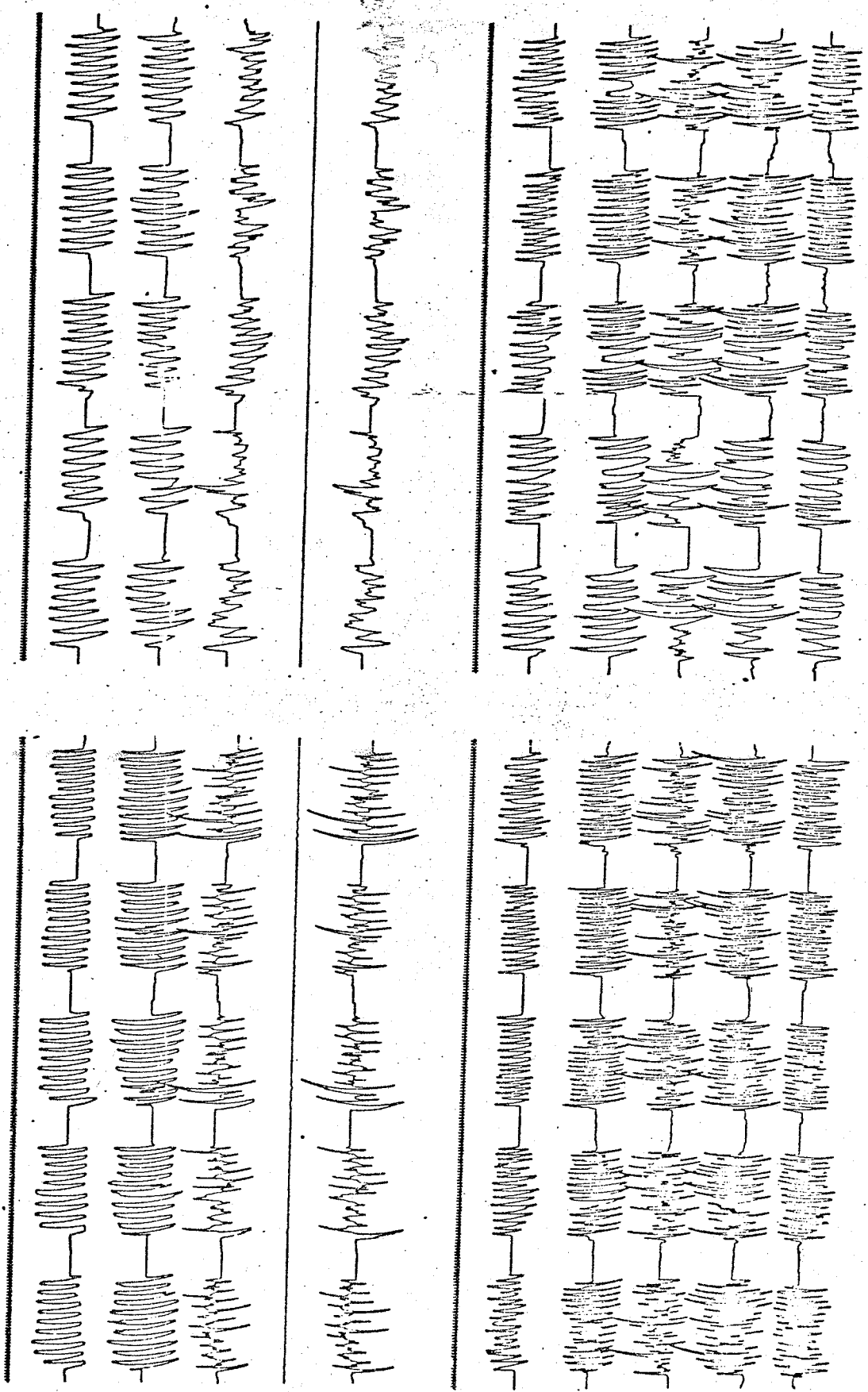


Figure 11. Oscillograph Records for the Comparison between Human Monitor Feedback and Computer Monitor Feedback

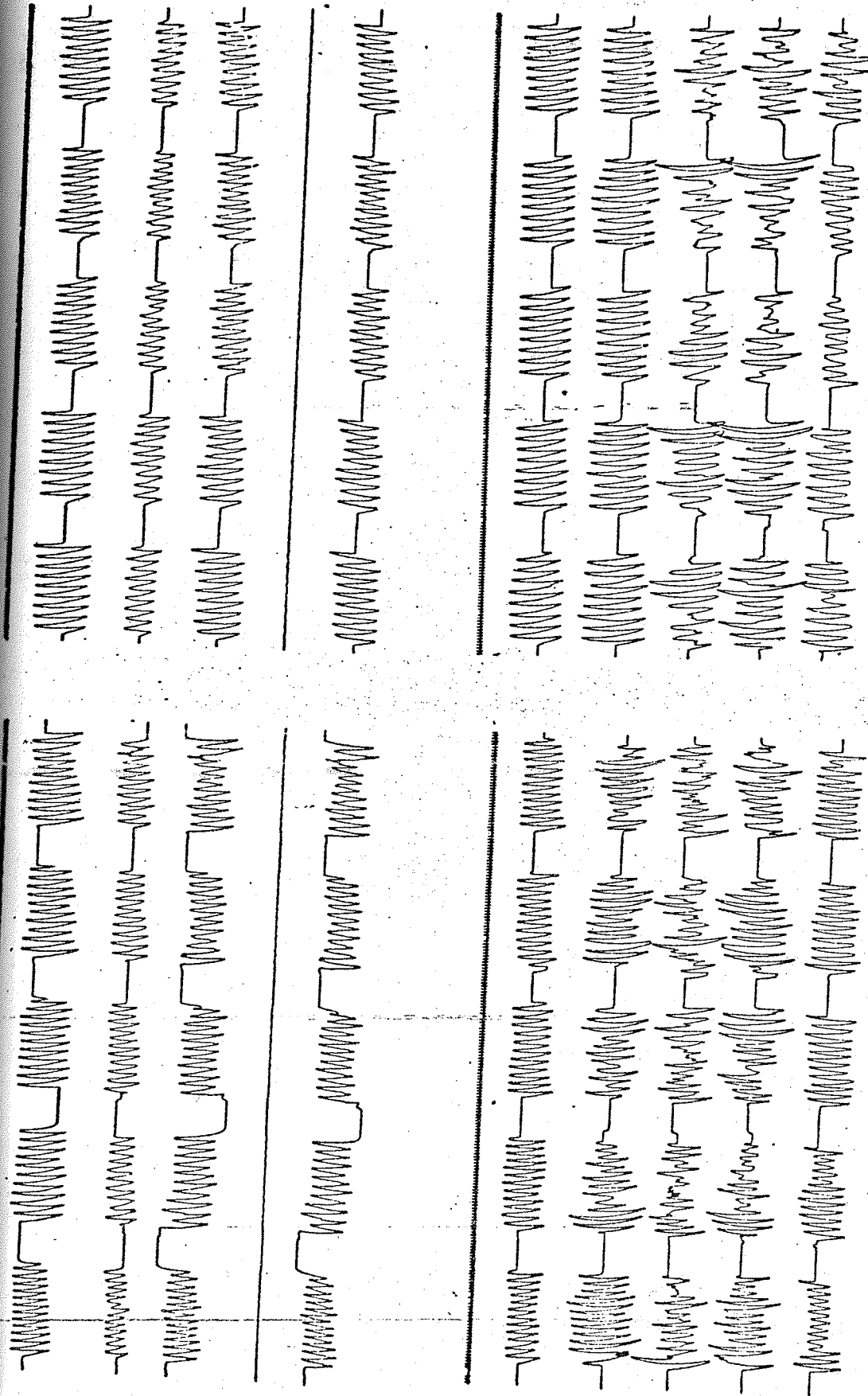


Figure 12. Oscillograph Records for the Comparison between Human Monitor Feedback and Computer Feedback

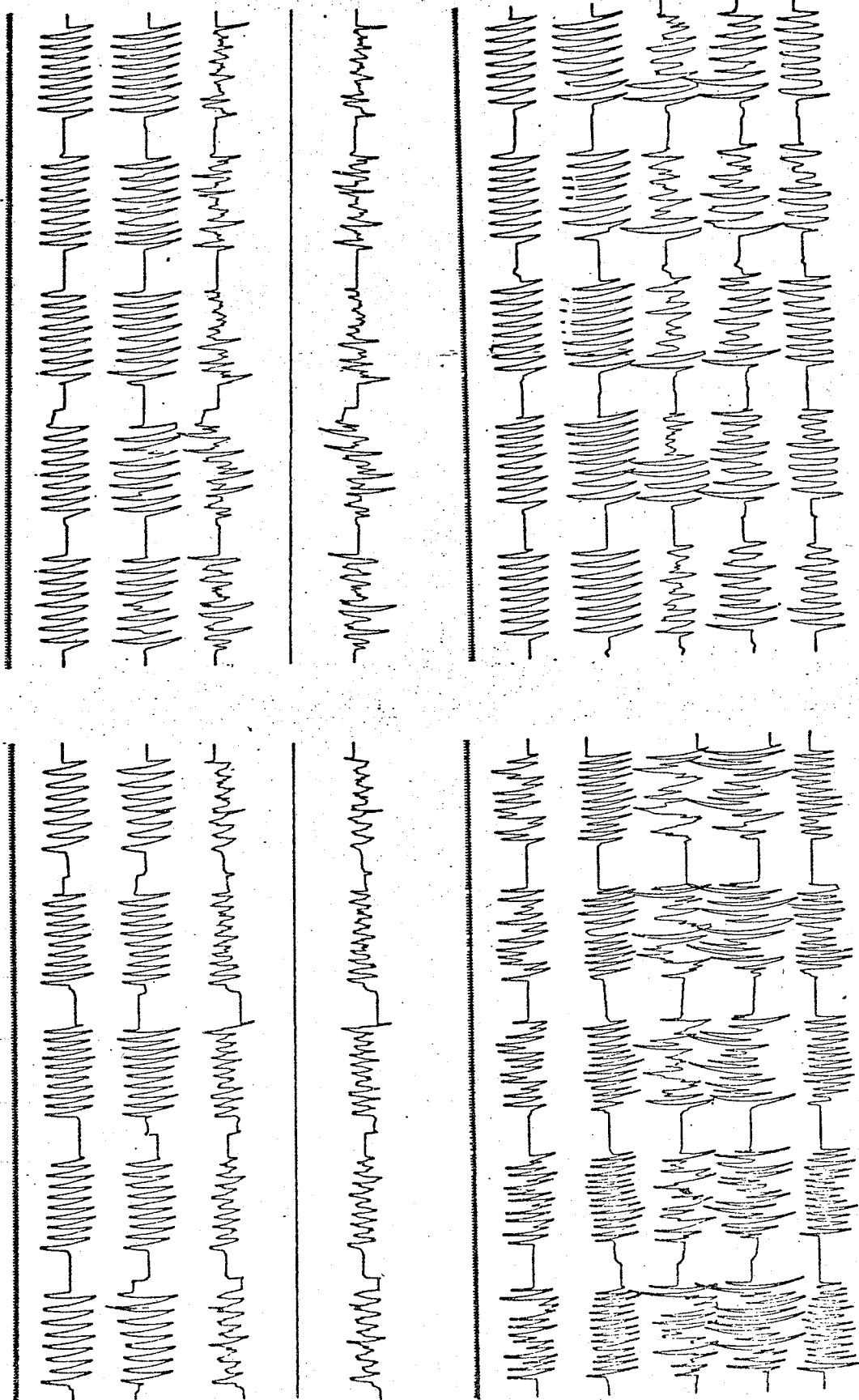


Figure 13. Oscilloscope Records for the Comparison between Human Monitor Feedback and Computer Feedback

five adjacent traces which represent the various movements and tracking errors for the subject groups. For the condition in which human monitor feedback is used these traces are read from left to right as follows: (1) imitatee movements, (2) imitators' movements, (3) error between the imitatee and imitator (social tracking error), (4) the human monitor error (the human monitors' movements subtracted from the social tracking error, and (5) the human monitors' movements. For the computer monitor feedback condition the last two traces are reversed for technical reasons. Thus, the fourth trace is always a straight line since there was no human monitor and the feedback to the imitatee and imitator was determined by the computer from the social tracking error represented by the third trace. This means the fifth trace or the monitor error is exactly the same as the third trace or the social tracking error since in this condition there is no human monitor intervention. Each trial record represents thirty seconds of time. A time line indicating seconds can be seen to the left of each figure.

These records confirmed that a computerized monitor is much more successful in reducing the social tracking

error than a human monitor. All twelve groups of subjects had reduced relative social tracking error when feedback was received from a computerized monitor. The bar graph of Figure 14 and the graph of Figure 15 summarized the results related to the two different modes of feedback. Error level, expressed as mean relative digital voltage differences between imitatee movement and imitator tracking varied systematically with both conditions of feedback. As indicated in the forementioned oscillograph records, error level was lowest in the computer-feedback condition. Thus the differences in performance were due to the mode of feedback received.

The data of this experiment were evaluated statistically by analysis of variance as indicated by Table 2. Variations due to the feedback conditions were significant beyond the 0.01 level. Variation of means related to trials or practice were not statistically significant.

### Summary

From knowledge of the effects of delay on performance in closed-looped systems it was not surprising to find that there was statistical significance between the two conditions. The realization that it takes time for a human

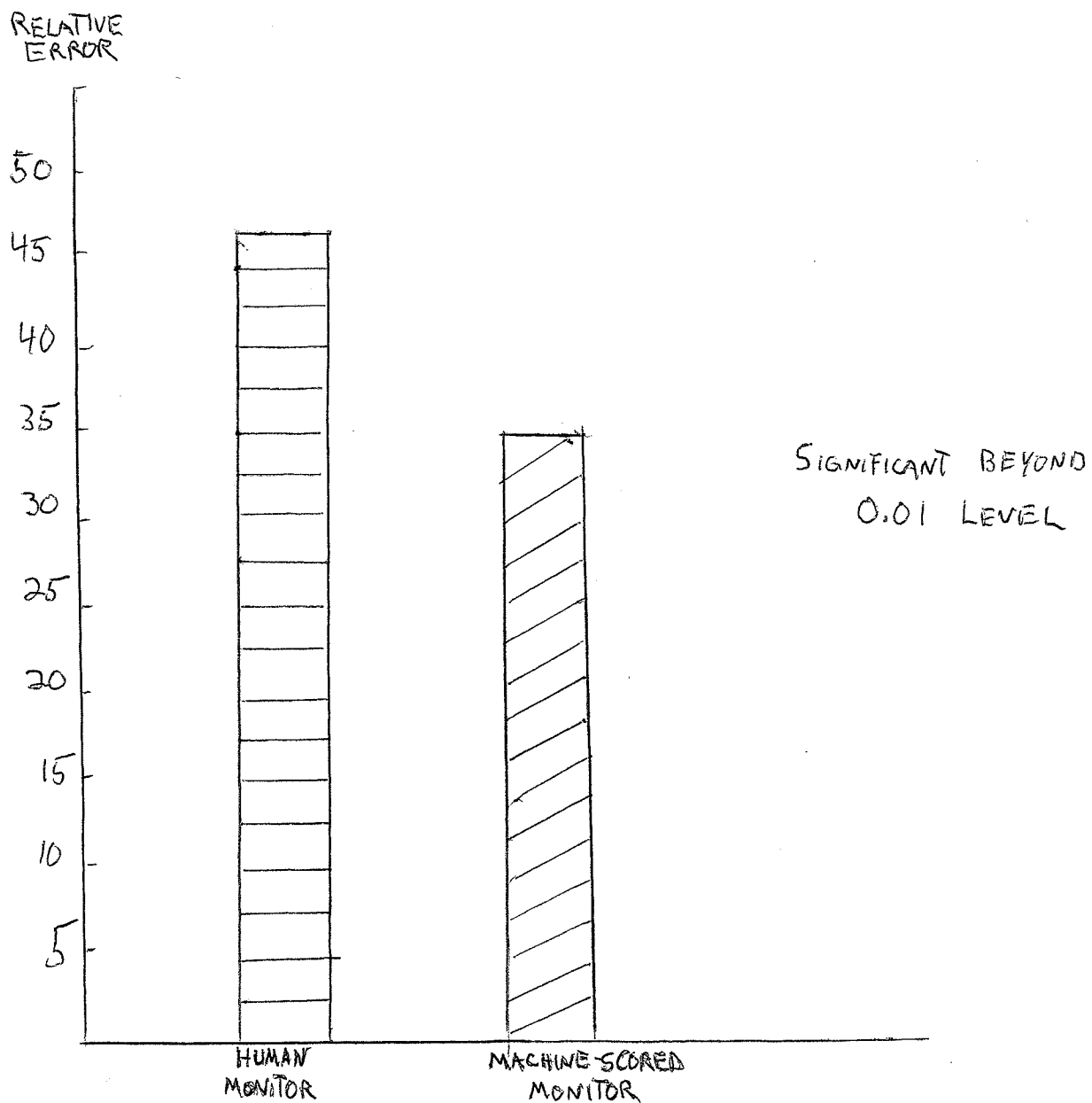


Figure 14. Mean performance errors as a function of the two conditions.

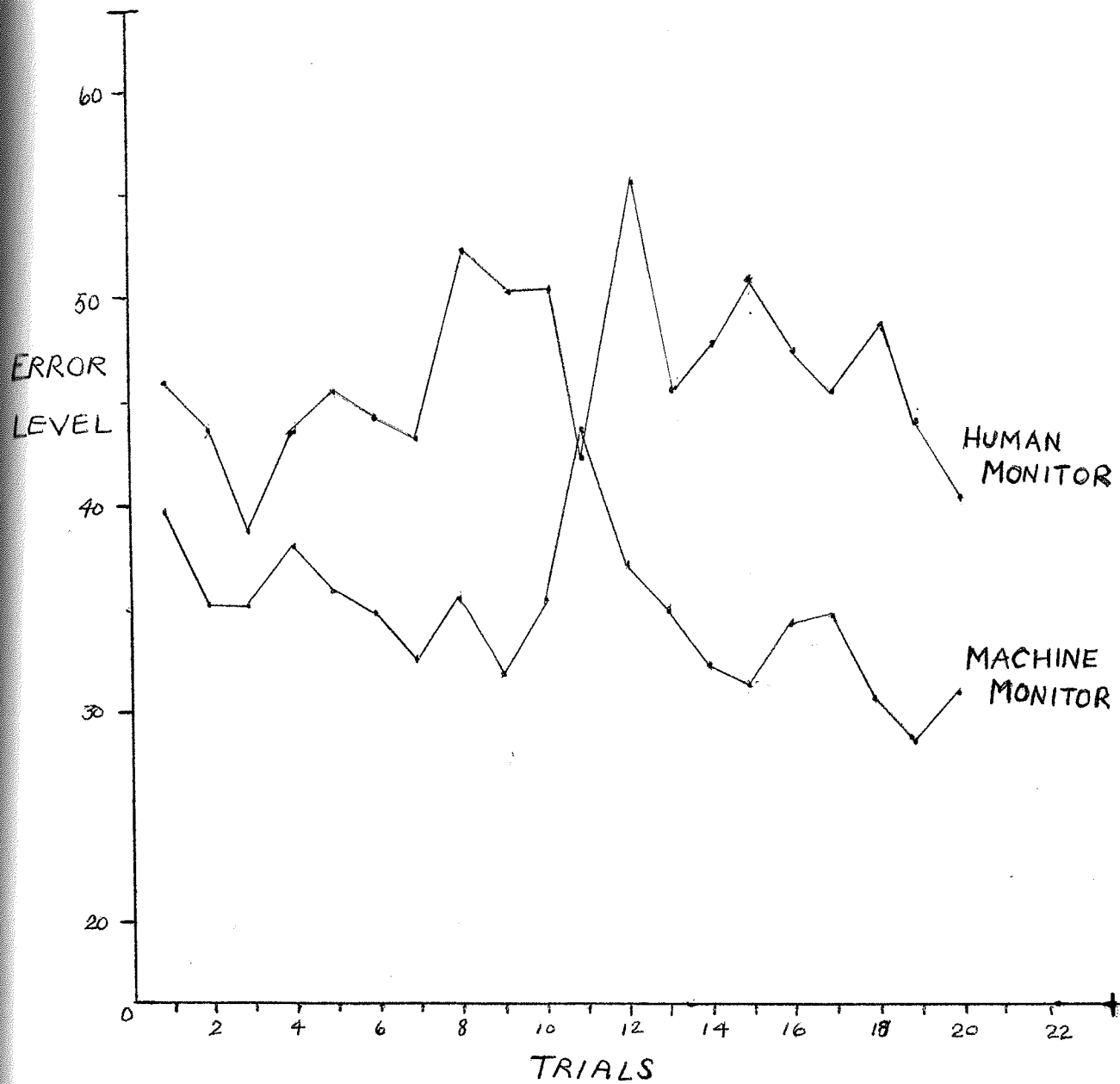


Figure 15. Mean errors over the two conditions by trials.

Table 2. Summary of Analysis of Variance of the Comparison of the Mean Performance Error Between a Human Monitor and Computer Monitor.

Source of Variance	df	S.squares	variance est.	F ratio
conditions	1	683734	683734	78*
groups	5	685549	137110	
conditions X groups	5	43718	8744	
trials	19	164731	8670	
groups X trials	95	1204376	12678	
cond X groups X trials	95	1139907	11999	
totals	239	4092806		

\* significant at .01 level

monitor to detect the error between the imitatee and imitator then to decide the magnitude and direction of that error, and finally to send compensatory information to the other members of the group, gives a good indication of what the experimental results have shown. The human monitor delays the feedback that the imitatee and imitator receive of their own movements, not to mention the inaccuracy that could occur in the monitor's judgements.

However, in the condition in which the imitatee and imitator received computer feedback compensatory information, it occurred simultaneously and with perfect accuracy. This not only eliminated the time delay it takes for a human monitor to make a judgement and transmit it, but also the human judgement errors.

MAIN EXPERIMENT:  
THE EFFECTS OF DIFFERENTIAL MONITOR FEEDBACK

As described in the methods section of this paper, this investigation aimed to determine the effect of a trained monitor and his compensatory team error information on the performance of two-man interperson teams linked in paralld yokes. The four feedback conditions under which these social monitoring and catalyzing operations were studied were: (1) no feedback condition (imitatee initiated movements and the imitator used these movements as a target for his own movement). (2) monitor feedback only (the imitatee initiated movements and both the imitatee and imitator received monitor compensatory feedback only), (3) monitor feedback only to imitatee (the imitatee initiated movements and received monitor-compensatory feedback, while the imitator saw only the target and received no feedback from his own movements or from the trained monitor), (4) monitor feedback only to imitator (the imitatee initiated movements and received no other feedback while the imitator received compensatory feedback from the trained monitor).

The experiment also tested two modes of tracking, the mutual and unilateral (aiding and non-aiding). The aiding mode involved a process in which the imitatee was instructed to aid the imitator without changing the difficulty of the task.

In the non-aiding mode no help was given. The accuracy and effectiveness of subjects teams in social tracking behavior were measured in terms of an imitator's ability to follow movements of an imitatee in the pursuit tracking situation.

The relative tracking error, as expressed in terms of the absolute arithmetic mean, were computed by averaging the inputs (the voltage discrepancy between imitatee and imitator movement) over successive five-second intervals within trials. These error scores represented relative digital voltage values, as measured by the computer system. These scores were later subjected to statistical analysis of variance. This technique of analysis of variance was used to indicate any observed differences between the experimental conditions and modes. Also, to evaluate the statistical significance of specific factors of interest, the Neuman-Keuls comparison test (Winer, 1962) was also applied. Other data consisted of oscillograph records of imitatee, imitator, monitor and the error between them.

These records provide graphical information regarding the effect of the different experimental conditions and modes on the movement patterns of the subject groups. In addition, illustrative tables and graphs are presented to point out and clarify the experimental findings.

## RESULTS

The four experimental conditions have been mentioned. For convenience these conditions shall be abbreviated. They are; NF condition (no feedback condition), MF condition (monitor feedback only) MFIE (monitor feedback to the imitatee), MFIR (monitor feedback to the imitator). The bar graph in Figure 16 describes the differences in mean performance error for the four experimental conditions. It can be seen the MFIE condition had the best tracking performance with an overall mean error of 327, with the MFIR and the NF condition following close behind with mean errors of 392 and 397 respectively. The MF (monitor feedback only) condition had the worst tracking performance with an overall mean of 501--i.e. almost 50 per cent above the MFIE condition.

Further evidence regarding the differential effect in

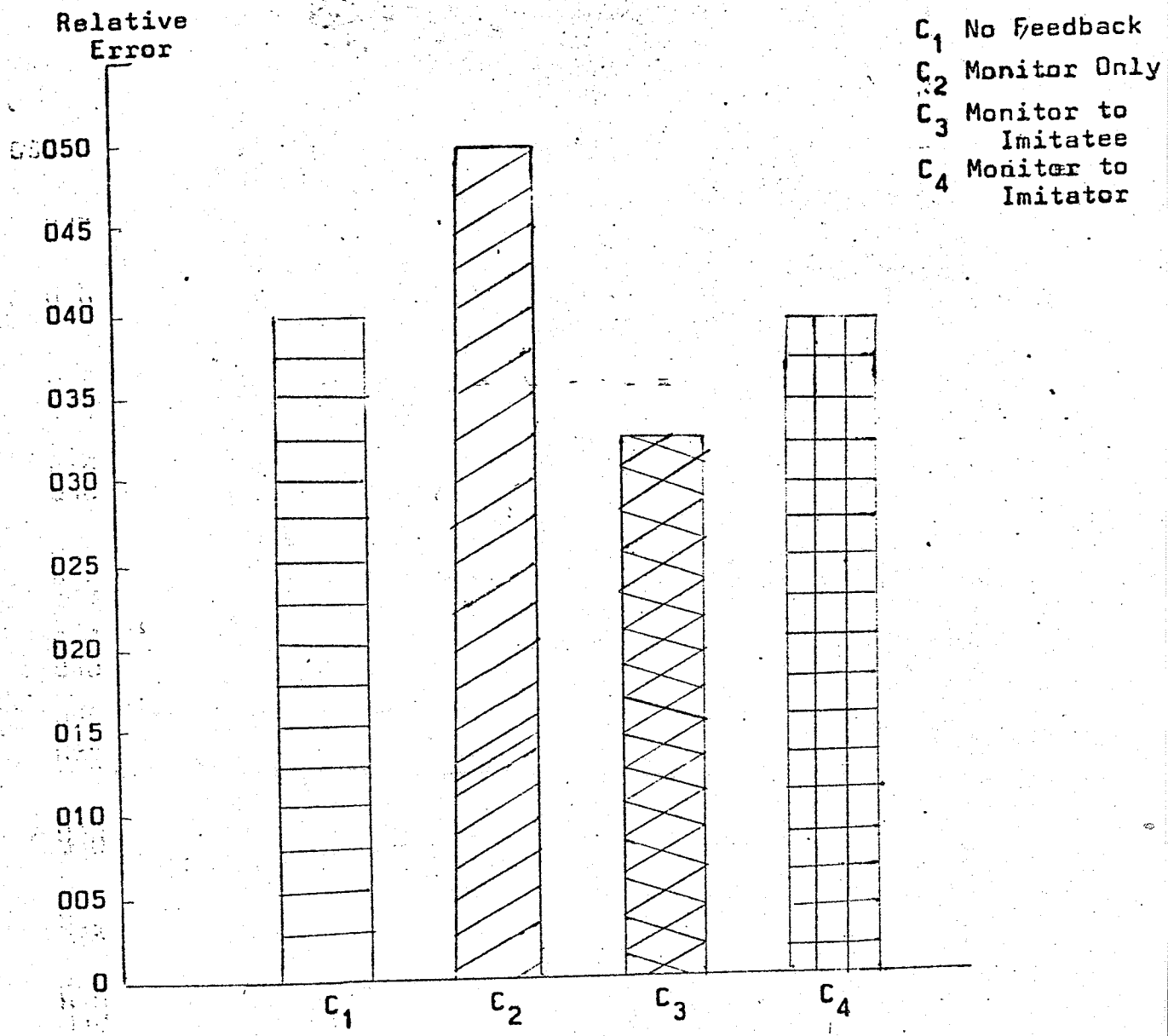


Figure 6. Mean performance errors as a function of the experimental conditions of the subject groups

tracking performance produced by the four experimental conditions is given on oscillograph records in Figures 17-20. Records for each condition appear on each page, and each page shows, under a single condition, differences in performance of the same subjects due to the aiding and non-aiding mode. Each record for each subject team shown is composed of five adjacent traces of movement patterns. From left to right they are (1) imitatee movement, (2) imitators' movement, (3) social tracking error between the imitator and imitatee, (4) Monitor error (monitor's movement subtracted from the social tracking error) and (5) the monitor's movement. Once again, the line to the left of these traces represents the time of each trial in seconds. These traces illustrate the confusion that occurs in the subject teams as monitor feedback is added into the system until it reaches a peak when monitor feedback is presented to both the imitatee and imitator. Figure 17 shows subjects oscillograph records for subjects who received no feedback of their movements these can be compared to Figure 19 in which the imitatee received monitor feedback and which was overall the best condition in terms of performance. Then Figure 20 shows an increase in error when

AIDING

NON-AIDING

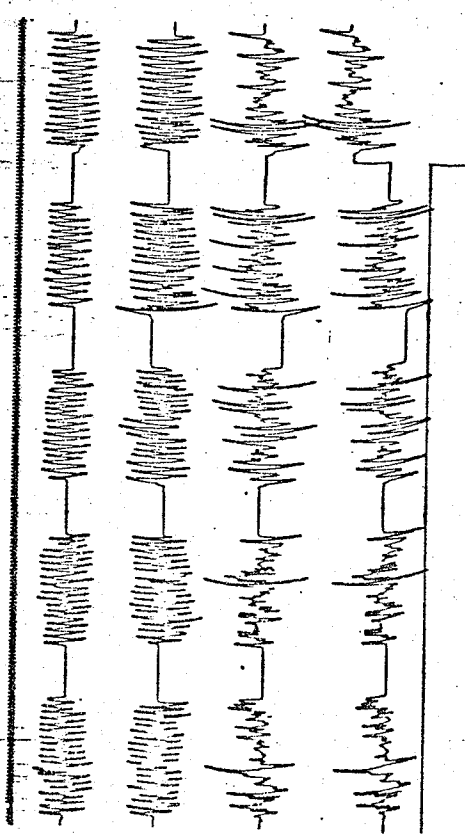
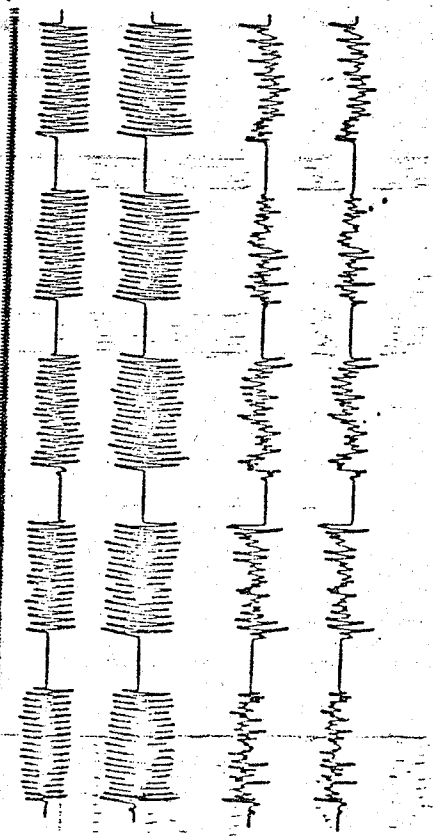
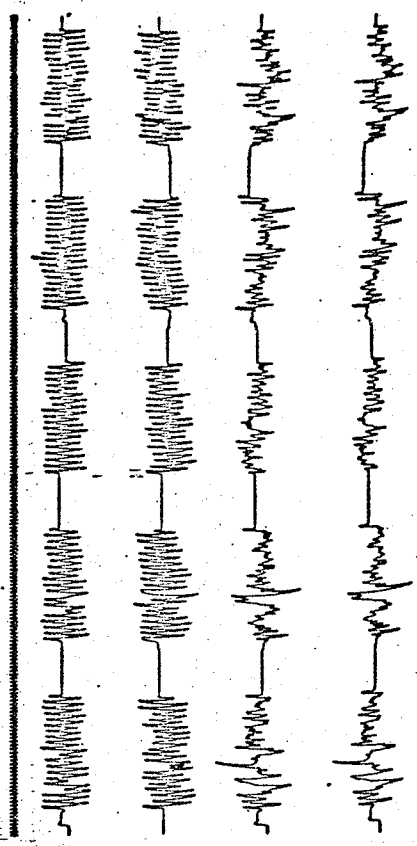
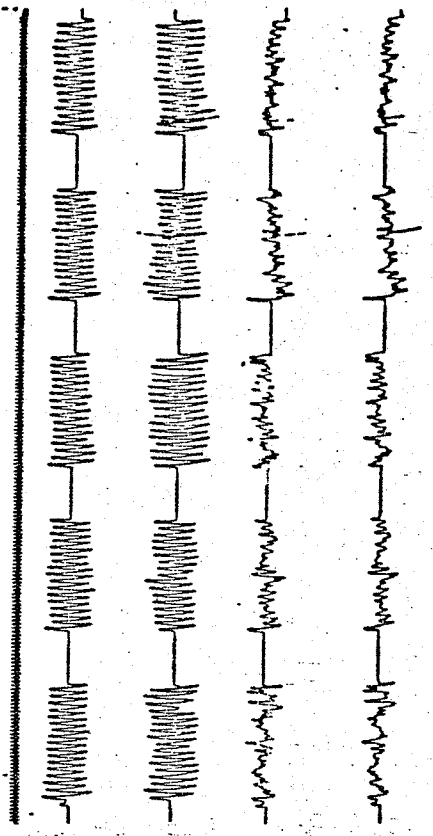


Figure 17. Oscillograph Records for subjects in NF Condition in both modes

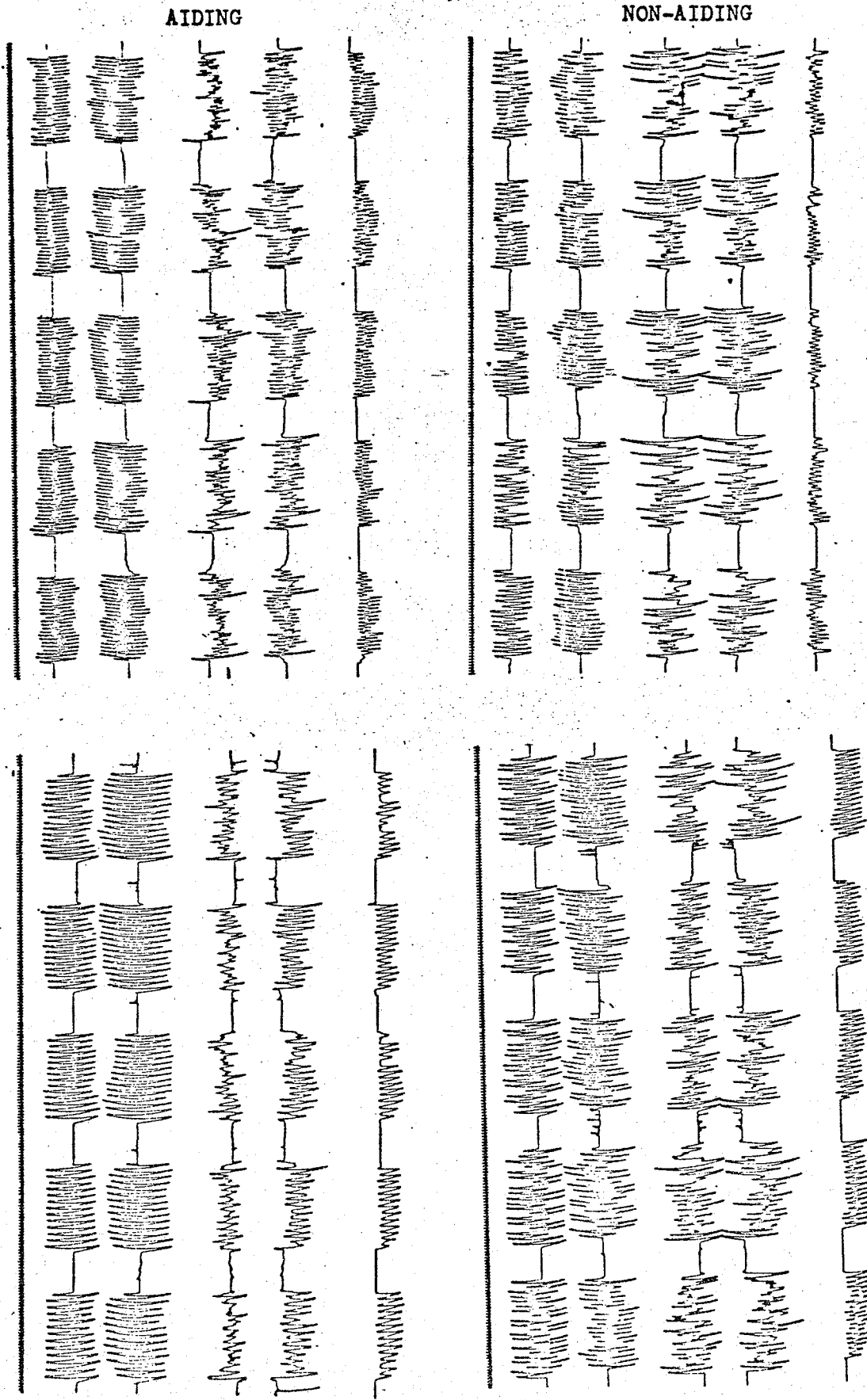


Figure 18. Oscillograph Records for subjects in ~~AF~~ Condition in both modes



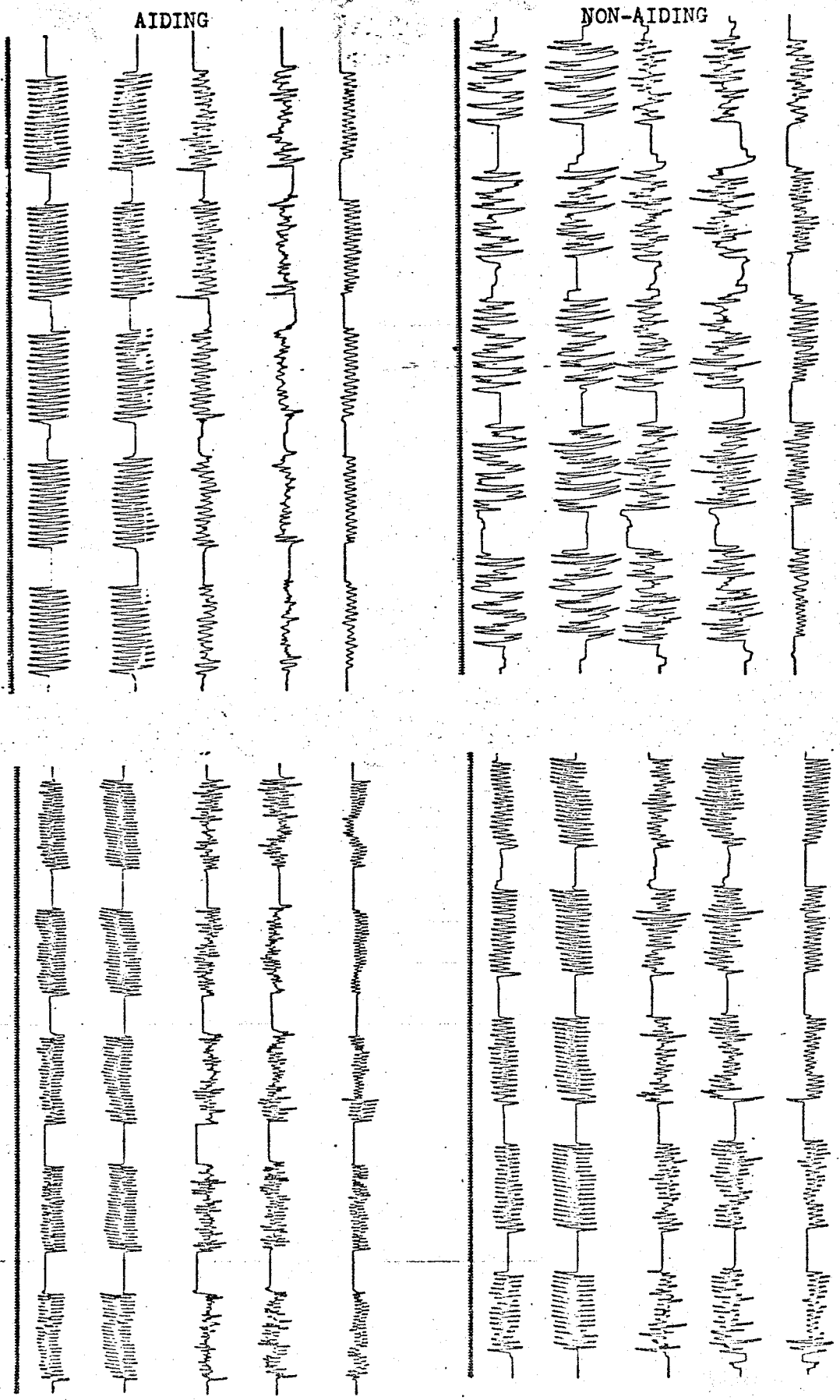


Figure 20. Oscillograph Records for subjects in the MFIR Condition in both modes

monitor feedback is introduced to only the imitator and finally Figure 18 shows the error when monitor feedback was given to both the imitatee and imitator and it is in this condition where social tracking performance was found to be at its worst.

The overall analysis of variance of the complete experimental findings is summarized in Table 3. The source of variance, the degree of freedom, the mean square, and error term, the F ratio, and the level of significance are presented.

#### Differences between non-aiding and aiding modes

The design of this experiment allowed a comparison between aiding and non-aiding modes of interaction. The social aiding consisted of the imitatee trying to synchronize generation of his movements with the pattern of error of the imitator so as to prevent the acquiescence of marded error. In the non-aiding situation the imitator did nothing along these lines.

Figure 21 shows a comparison of subject teams under these two modes for all four conditions. Also in reviewing oscillograph records 17-20, it can be seen that in each of

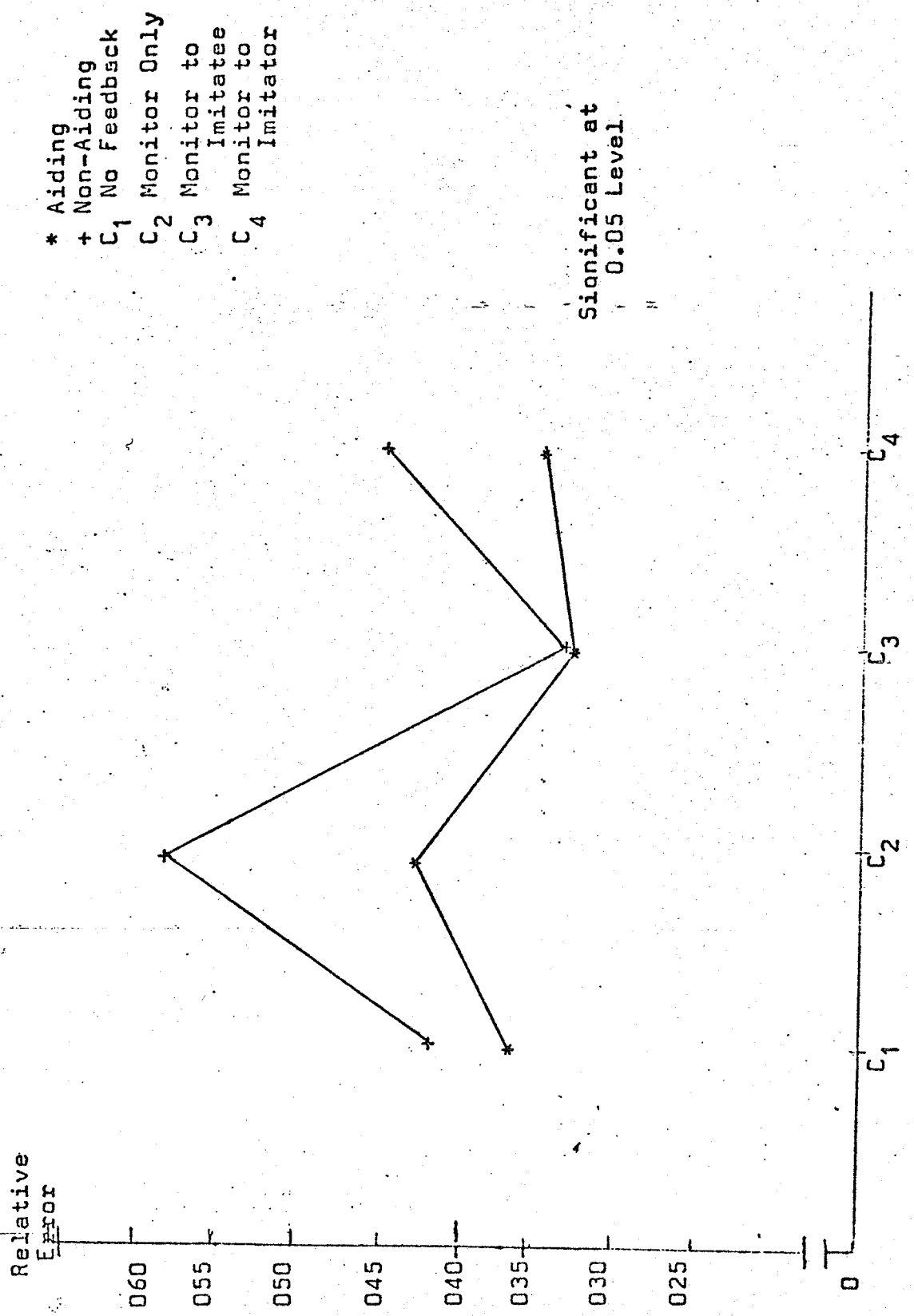
Table 3. Summary of Analysis of Variance of the  
Main Experimental results

Source of Variance	df	S.squares	variance est.	F ratio
conditions	3	3696743	1232248	2.53**
conditions X groups	20	9741567	487078	
modes	1	1730602	1730602	19.4***
conditions X modes	3	979893	326631	3.67****
cond X groups X modes	20	1782395	89120	
trials	19	137654	7245	.822
condition X trials	57	502236	8811	
cond X groups X trials	380	3658600	9628	
modes X trials	19	212394	11179	1.16
cond X modes X trials	57	365811	6418	
cond X groups X modes X trials	380	3667205	9651	
totals	959	26475100		

\*\* significant at .25 level

\*\*\* significant at .10 level

\*\*\*\* significant at .05 level



\* Aiding  
 + Non-Aiding  
 C1 No Feedback  
 C2 Monitor Only  
 C3 Monitor to Imitatee  
 C4 Monitor to Imitator

Significant at  
 0.05 Level

Figure 21. Mean performance errors across the four conditions as a function of the aiding and non-aiding modes

the experimental conditions represented by each page of records, that the magnitudes of movements of both imitatee and imitator were greater in the unilateral simultaneous condition than in the mutual simultaneous condition. Referring to Figure 22 it can be seen that the level of error in the unilateral condition was much greater than in the mutual condition. What this points out is that both the performance of the imitatee and imitator varied with the mode of social interaction.

The mean error over all groups in the unilateral mode was 446, while the mean error for the mutual mode was 362. For each of the four conditions, the scores for the mutual mode were, 369 in the NF condition, 412 in the MF condition, 324 in the MFIE condition and 344 in the MFIR condition. These scores can be compared to those in the unilateral mode which were 415, 589, 330 and 449 respectively (See Figure 19). The significance of the difference between the two modes was tested by analysis of variance. As indicated in Table 4 the F-ratio for the comparison is statistically significant at the .01 level ( $F=19.2$ ,  $df=1,20$ ). Thus the mutual mode produced much more accurate and efficient performance level than the unilateral mode.

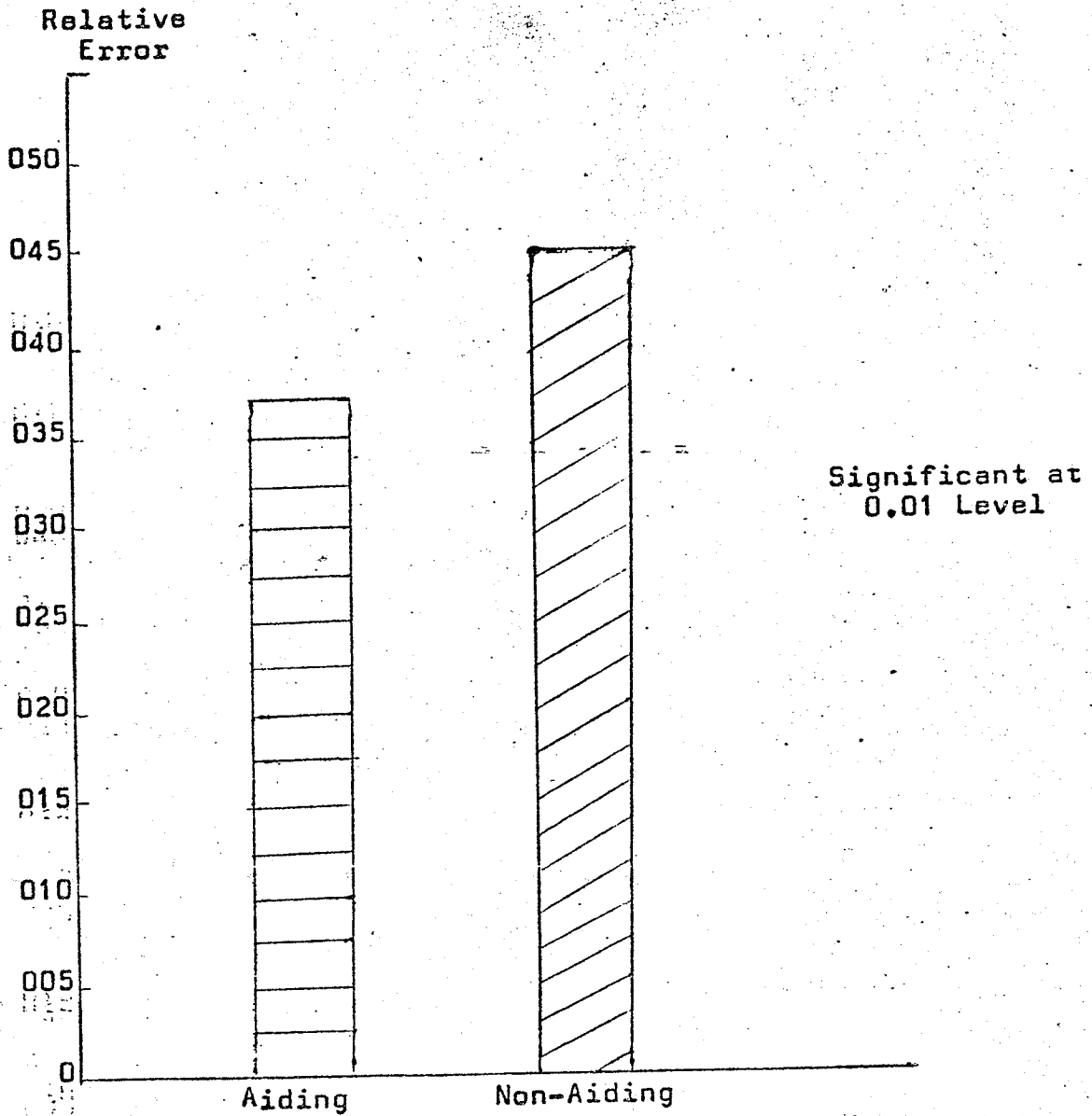


Figure 22. Mean performance errors across all conditions as a function of the two modes

Table 4. Analysis of Variance for the Comparison of the Mean performance Error between Mutual (Aiding) and Unilateral Mode (Non-aiding) of Interaction.

Source of Variance	Mean Square	df	F ratio
Mutual vs. Unilateral	1681701	1	19.2*
Error Term	87491	5	

\* significant at .01 level

Further, the difference between the mutual and unilateral modes by groups has an F-ratio of 3.65 and is significant at the .05 level.

In addition to analysis of variance a Neuman-Keuls comparison test was done on the mutual and unilateral modes across the four conditions. The results of this comparison are presented in Table 5. In this test ordered means are tested for significant difference in steps and on a studentized range. In this way several means may be compared for their relative significance to each other at the same time.

#### Effects of Practice

Error level was reduced slightly with practice in all conditions. A close look at the oscillograph records (Figures 17-20) and it can be seen that at the end of the trial period the social tracking error (third trace from the left) had decreased. It appears as if the tracking task was simple enough to be learned within the few practice trials given to each subject. The learning which did occur can be seen in Figures 23 and 24, which represent the trial means and the trial means across conditions respectively. Trials were found to be significant at only the 10 per

Table 5. Neuman-Keuls Comparison Test for  
Difference Between Representing Four  
Experimental Conditions and Two Modes

MODE 1 MUTUAL

Conditions	C2=NF	C1=NF	C4=MFIR	C3=MFIE
Mean Error	412	366	344	324

MODE 2 UNILATERAL

Conditions	C2=MF	C4=MFIR	C1=NF	C3=MFIE
Mean Error	589	449	418	330

In reading this table any means which are not connected by the chained lines are significantly different from one another at the five percent level.

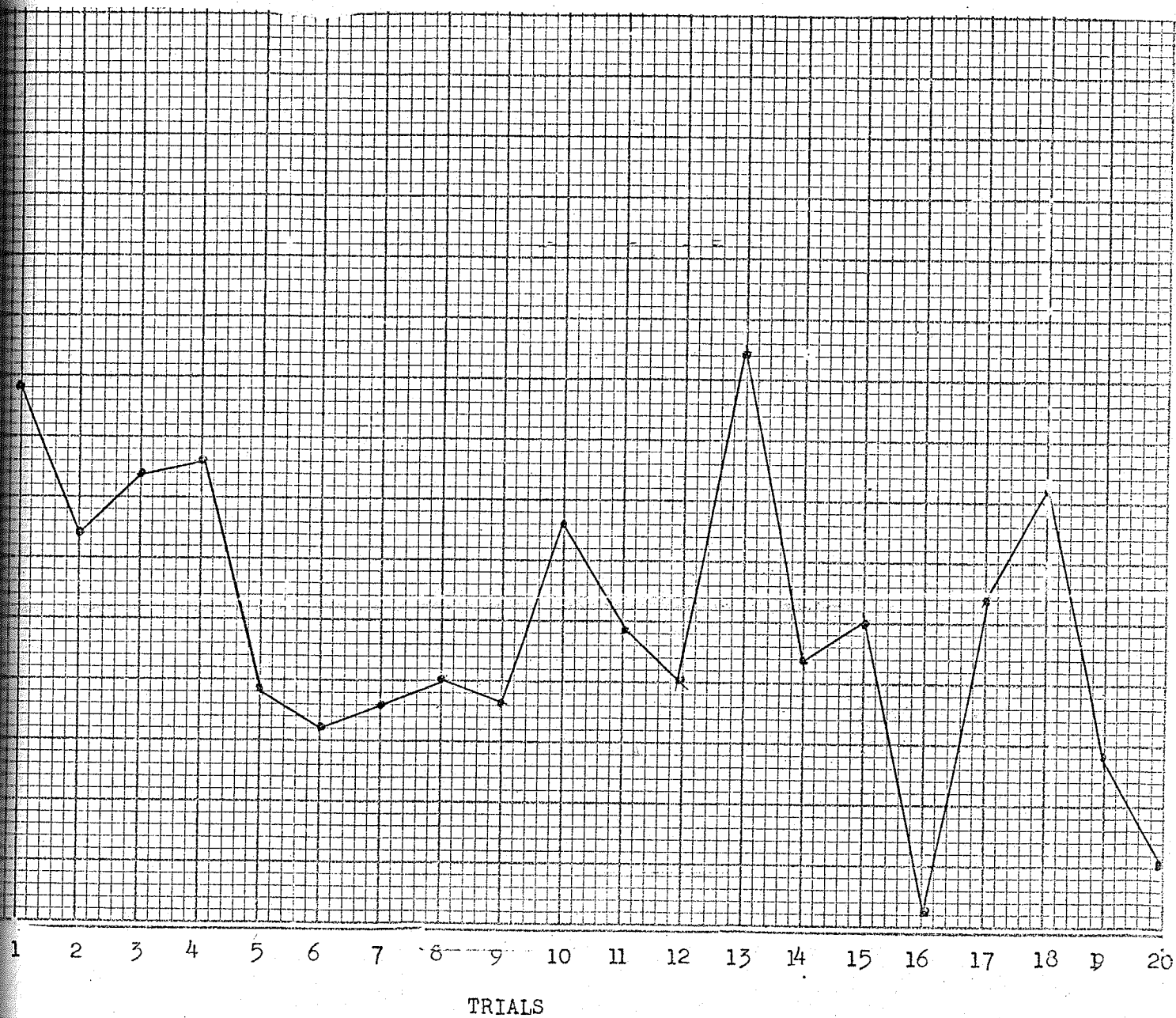


FIGURE 23. Trial means for each of the 20 trials given to each subject in all conditions

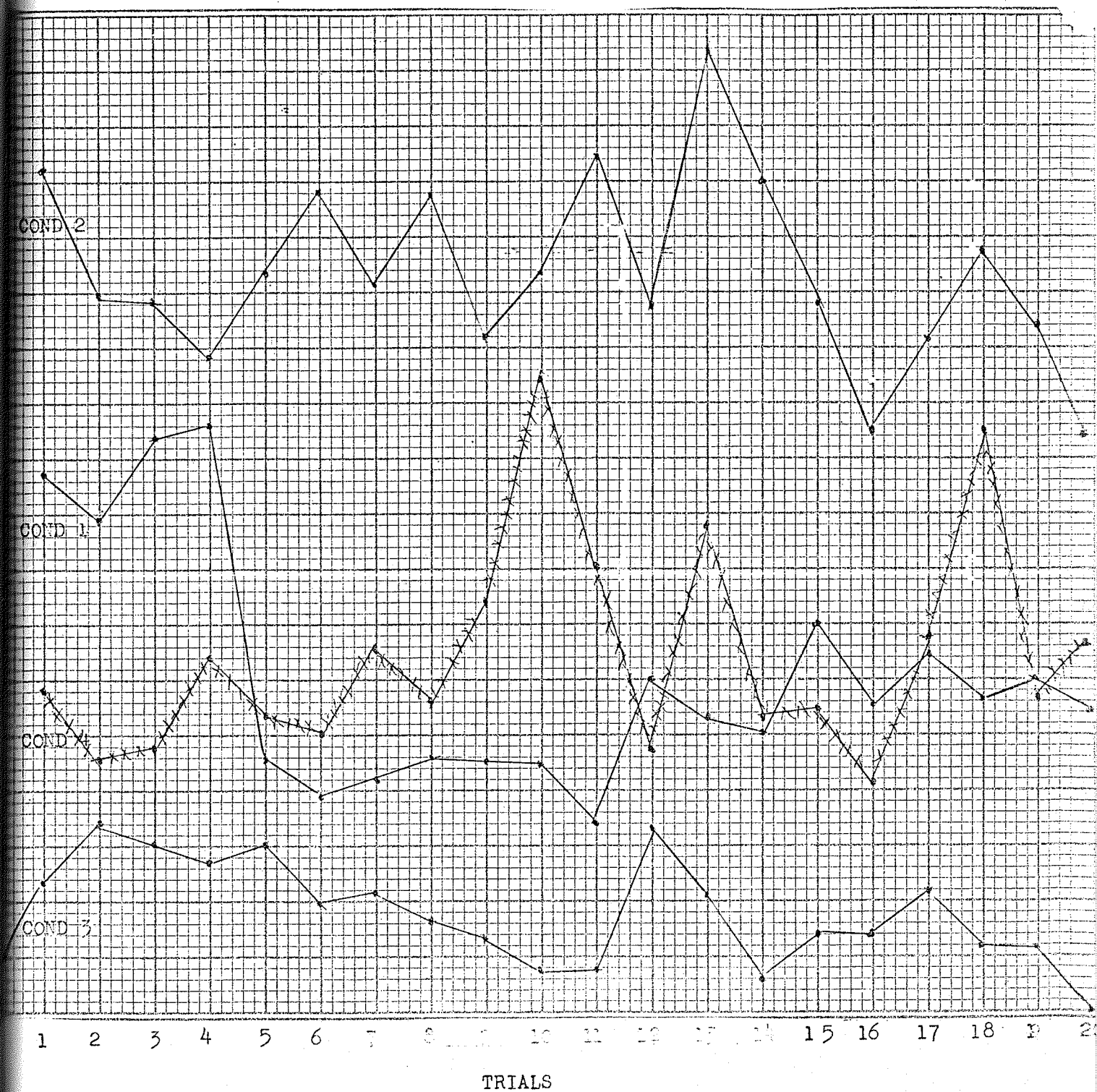


FIGURE 24. Trial means for each of the 20 trials across the four experimental conditions

cent level and although some can be seen, the learning effect must be considered limited.

## SUMMARY AND DISCUSSION

The purpose of the present experiments was to test the phenomena of social monitoring in social tracking. A social monitor is one who measures the social tracking of others and can influence this primary tracking in terms of these measurements. A first preliminary experiment compared the effectiveness of monitor feedback and primary systems feedback in determining accuracy in the social tracking. A second preliminary experiment compared the effectiveness of monitor feedback and computer measured error feedback in determining accuracy in primary social tracking. In the main experiment the relative effects of different modes of monitor feedback in determining accuracy in the primary social tracking was investigated.

The experimental findings may be summarized as follows. In the first preliminary experiment it was found that monitor feedback in the primary social tracking was inferior in reducing error and increasing accuracy to complete systems feedback where an imitator and imitatee were able to see their own as well as each others' movements.

These differences were found to be statistically significant and gave evidence that monitor feedback in social tracking can cause confusion by adding a time delay into the system while the monitor measures and transmits the error feedback information.

In the second preliminary experiment it was found that computerized monitor feedback was far superior to human monitor feedback in primary social tracking. These differences also were found to be statistically significant. It was found that if the delay in human monitoring was eliminated and the monitoring process was automated and simultaneous, primary social tracking could be greatly enhanced.

The experimental variables investigated in the main experiment were: (1) mutual and unilateral modes in interaction, (2) various conditions of monitor feedback versus no feedback. These experimental variables were arranged to minimize the effects of order of presentation. The dependent variable was measured in terms of the relative error between imitatee and imitator in the pursuit tracking situation. The research was designed and carried out by using a real-time computer to control the social feedback

factors that were to be investigated. The laboratory computer system together with peripheral subsystems, constituted a closed-loop control system that provided for precise manipulation of experimental variables, automation of experimental operations and the scoring of the social tracking performance. On the basis of feedback theory it was expected that: (1) Differences in relative error would occur as a result of the various feedback conditions, (2) Differences of relative error in social tracking would occur as a result of the mutual and unilateral modes and (3) A human monitor whose actions cause a delay or distortion of team feedback will increase the relative error in social tracking.

The different feedback conditions in the main experiment, although not statistically significant as a whole, were in certain cases significant when compared individually in the Neuman Keuls analysis (See Table 5). It was found that monitor feedback to the imitatee or imitator individually resulted in relative error scores that were no better than the condition in which they received no feedback at all. The best of the conditions was the one in which monitor feedback was given only to the imitatee,

where we could say it does the least amount of harm, since the imitatee in all conditions must make smooth movements that an imitator may follow. In comparison, the condition in which monitor feedback was given to both the IE and IR was worse by far in terms of the relative social tracking error. It can be seen in looking at Table 5 that this condition was significantly different from every other condition in the unilateral mode. In this case, not only must a monitor interpret the magnitude and direction of the social tracking error but both IE and IR must interpret the monitors movement and read just their movements. The result, as already mentioned, is delay and confusion. The time the monitor takes to make a decision and display his compensatory information acts as a systems delay and results in decreased performance accuracy in social tracking. This evidence supports our expectation that differences in relative error would occur as a result of the feedback conditions. The more feedback responsibility that was put on the monitor, the greater was the relative error. These differences are much greater in the unilateral mode than in the mutual mode because of the very nature of the mutual mode which tends to smooth down movement, the relative

error and thus the differences. This will be explained further in the summary of the mutual and unilateral modes.

In the main experiment, one of the main findings was that the mutual mode of interaction with the monitor was significantly more accurate than was the unilateral mode of giving monitor feedback. Thus, some importance was shown for mutual social interaction in group behavior. This substantiated the forementioned expectation. Across all experimental conditions performance declined under the unilateral mode of interaction. Under the mutual mode subjects tended to slow down their motion. Imitatees aided the imitators by adjusting their movements in accordance with the imitators' response patterns and performance error were greatly decreased. This aiding facilitated the mutual, reciprocal, sensorimotor linkages between the members of the social tracking teams. The imitatee was able in this way, to provide continuous guidance to the imitator in the mutual mode, resulting in more regular and compliant movements. It is interesting to note (as above) that significance between the various conditions is much greater in the unilateral mode than it is in the mutual mode. This may, of course, be due to the fact that in the mutual

mode the imitatee and imitator worked closer together in a dynamic reciprocal manner that reduced the effects of the various conditions. While in the unilateral mode this particular interaction was absent and the feedback conditions had a much greater effect on performance. It is obvious that the empirical results of this part of the experiment may be applied to actual interpersonal situations. This is especially true in industry, athletic sports or in any situation where individuals must rely on each other to supply accurate feedback information of performance to increase efficiency and productivity.

The comparison between unilateral modes and mutual modes of feedback points out the importance of social factors in any of the above activities. By means of aiding the imitator, the imitatee initiates adjustive and dynamic information which not only facilitates the imitator's response, but also compensates for the imitator's own errors. Consequently, the error level of the imitator is reduced. This finding shows the importance of adaptive, mutual-interaction between two or more persons. Thus in situations in industry, athletics or any other sort of social behavior adaptive mutual behavior must be considered

to increase efficiency of performance and reduce relative error. It is our belief that dynamic, reciprocal processes of social feedback, where an imitator not only contributes to the performance of the imitator and actively participates, but by using adjustive synchronization of movements he may improve the accuracy and efficiency of the imitator's response. We believe that this factor is critical in all human interaction situations. To recapitulate, it is just as important for a foreman to socially track workers as it is for the worker to track the foreman. It is evident from the findings of this paper that mutual social interaction can add to the effectiveness of both performance and learning.

Along with these findings, the third expectation of this experiment was conferred that indeed a human monitor whose actions caused a delay or distortion of team feedback did increase the relative error in social tracking. As mentioned in the history section, Smith, Ansel and Smith (1963) found that a delayed visual feedback had a deleterious effect on team performance and learning and here we have more evidence of the same. The combined effects of a human monitor's inaccuracy and the time it

takes for that monitor to make a judgement and transmit it to the other team members interrupts the synchrony and coordination between the primary social trackers. This fact was seen vividly when some trackers virtually gave up trying to track one another utilizing monitor feedback, while in other cases it was the monitor who became frustrated trying to keep up with his trackers. It was noticeable that these frustrations were indeed closed-looped. They tended to perpetrate one another. A monitor's error in judgement would shortly return to him as confusion of his trackers, and poor tracking would result in greater confusion for the monitor----and so on. It was evident for these reasons that groups which could gain some sort of coordination were more likely to continue at a lower relative error than groups which had more difficulty in synchronizing their movements. It is certainly for this reason that all groups improved their performance in the mutual mode. Movement as a whole was slower and coordination was greater which made the monitor's job easier and easier in the closed-looped system.

It has been shown in these experiments that a human monitor is presented with an exceedingly difficult task.

He must track movements, evaluate them, and relay compensatory information quickly and accurately. If he fails even to a small extent in any of these tasks his errors may be magnified because of the divided attention required of the monitor in this complex task. There is no doubt that a human monitor presents a systems delay which must be dealt with. A human monitor who has developed skills, however, and relates mutually and reciprocally to the primary trackers can succeed far beyond a human monitor who does not relate in this way. Everyone has had some contact with a teacher, foreman or coach who merely lectures or dictates instructions; we say that he is a poor instructor. It is our belief that an instructor must simultaneously and mutually relate to those for which he is responsible if he wants to increase performance and learning. This mutual, reciprocal and adjustive interplay on the part of a teacher or trainer is essential in any kind of instructional process.

In a very limited way a computerized or mechanized monitor such as a video-tape machine may be superior to a human monitor in making measurements of social tracking accuracy. However, where a computerized or automated monitor is not appropriate a human monitor must possess

these skills of mutual reciprocal and adjustive interplay in addition to a full understanding of the task if he is to succeed in facilitating performance and learning.

## CONCLUSIONS

For the most part the findings of this experiment are in accord with the theoretical assumptions and hypothesis. The conclusions of this study are as follows:

1. The results of the present research prove the applicability of real time computer methods to control the experimental variables and automation of laboratory operations in studying dynamic social behavior.
2. Evidence was shown by the results of the present experiment that social performance proficiency is significantly superior in modes of mutual, reciprocal feedback.
3. There was significant differences found between the unilateral and mutual mode of interaction on performance accuracy.
4. There was a differential effect among the four condition monitor feedback conditions. Human monitor feedback in all conditions was no better than no feedback at all, and when human monitor feedback was

presented to both an imitatee and imitator, performance was much worse than when there was no feedback or when monitor feedback was given to just one of the subject team members.

5. There was significant difference found between a human and a computerized monitor, with the computerized monitor being far superior.
6. Evidence was seen from the graphical records that the accuracy and synchronism of response patterns between imitatees and imitators were superior with computerized monitors which do not add delay into the system, than with human monitors. It was also seen that accuracy and synchronism were superior with human monitors acting in a mutual reciprocal manner rather than in a unilateral manner.
7. The various experimental conditions demonstrated that social behavior, as studied here, consisted of closed motor-sensory interactions between two or more individuals, and suggests that many of the phenomena of human interaction can be more effectively comprehended and illustrated in terms of the manipulation of social feedback variables.

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