SKILL DILUTION AND SKILL LEVEL REQUIREMENTS AS DETERMINANTS OF CREW PERFORMANCE

by

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CHAPTER I

INTRODUCTION

Over the past years the military and industry have become increasingly involved in the analytical evaluation of group effectiveness. While the concept of group effectiveness is not new to either type of organization, the delineation of many relevant factors has received most of its impetus in the last 25 years. A significant contributor to the new trend was the social psychologist's work in normative and other group influences on decision making, communication and group structure, and many other areas which had the common elements of human interaction and decision making.

Theory testing research that either predated or paralleled the applied research of industry and the military provided valuable adjuncts to much of the work being done in the respective fields. The now almost classical work of Newcomb (1943) and Sherif (1947) demonstrated that the interaction of group members resulted in a decrease in the variance of member behavior and, subsequently, a conforming to group norms. Another study, by Deutsch and Gerard (1955), revealed that much of the decrease in variance of member behavior could be attributed to the acquiescence of members to the superior knowledge possessed by the group. That is, in addition to certain conforming pressures, the group ostensibly provides information which influences the individual's decision.

Decision quality or group effectiveness has also been investigated by manipulating the degree of member participation in decision making. Many studies, including Brown (1965) and Kogan and Wallach (1967), found that group decisions had the quality of being "riskier" or less conservative than individual decisions. In a somewhat different vein, Bass and Leavitt (1963) found that participation in the decision process predisposes the group members toward the carrying through or implementation of decisions. Similarly, Fleishman (1965) concluded that participation in decision making has incentive or motivational consequences which go beyond the actual participating situation. That is, the incentive property may result from the perception that one possesses influence rather than from the actual participation in the decision process.

The above studies revealed that the combining of individuals into groups had two distinct implications for the final decision. First, it revealed that grouping resulted in the alteration of decision attributes of conservatism and other decision qualities. Secondly, not only were the group decisions different but the interaction of the individuals, in group decision making, culminated in the modification of the individual's dedication to or support of the decision.

An integration of these results leads to the conclusion that a task, requiring some type of group decision or integrated performance, has the potential of possessing ingredients beyond that of the simple summation of individual units or subtasks. A conclusion of this sort is simply the application of the *gestalt* notion that a whole is greater than the sum of its parts and, when fitting the conception to groups of people, one is asserting that the group's decision is greater than or different from the sum of the individual decisions. In a sense, there evolves a unique quality with the integration of individuals into a system of interacting subunits.

A method for investigating the integration of individuals and its consequences in decision making is that of examining how the individuals are integrated into a whole, via the communication linkups among the group members. By examining these communication links and, subsequently, the communication structures, one could ferret out some of the interaction variables that predispose the uniqueness of the group as a whole. As is revealed in the following review, the performance of the group as a whole does vary with the organization or communication structure of the individual units.

The study of communication structures, such as the wheel, chain, Y, and the circle, have indeed revealed that decision effectiveness varies with the different communication networks. It has been shown that, at least in the short run, centralized structures (wheels) are predisposed toward rapid organization and problem solution, while decentralized structures (circles) are slower and more cumbersome in problem solving (Morrisette, Switzer, & Crannel , 1965; and Mohanna & Argyle, 1958). These experiments confirm the hypothesis that one must consider the organization of individuals, in addition to the individual task abilities, when predicting group performance.

An additional attribute of the communication studies concerns the distribution of information to the individual group members. The particular network in use may not only contribute to decision time, quantity, or quality but, by virtue of some members having access to more information, there may be parallel degrees of satisfaction expressed by the individual members. Gilchrist, Shaw, and Walker (1954) found that the satisfaction expressed by the individual group members did, indeed, covary with the distribution of information. Thus those members with the control of more information may see themselves as being more important to the group, and therefore these central members may tend to express more satisfaction.

From the laboratory research, one may extrapolate to the applied setting where group effectiveness is more or less dependent upon information extracted from interactions with other group members and the environment. The information obtained by each member is used in decisions of a magnitude dependent upon the function of the particular member, as well as the task or function of the group. Although the decisions will vary among members and among groups, and the amount and structure of the interaction will also vary; these two elements are most common and basic to all group processes.

Having laid the groundwork for an evaluation of any group, one may move into either or both of two directions. One is the analytical manipulation of the antecedents (interaction variables), and the defining of functional relationships between the antecedents and the consequences of decision making. The alternative direction may actually be a consequence of the first. Here the tendency is to regroup group-task related variables into more molar classifications and to establish nomenclatures which consist of summary categories containing sets of functional relationships. In this instance, there is an endeavor to organize the knowledge and to build descriptive systems for prediction.

The terms of crew, team, class, gang, and committee have evolved from the organizational process. These terms are used to describe task oriented groups which one encounters in an applied setting and which have certain distinguishing characteristics. For instance, a crew refers to a group which is machine paced or dominated and which is structured with a high task demand for sequential intra-crew coordination. The crew member interacts with both the demands of the machine and other members, making the decisions or responses that are cued by the particular set of events.

The team structured group contains different interaction and decision requirements from the crew. A team is more man dominated and is structured with task demands requiring non-sequential coordination. Although the task demands may set the stage for action, the interactions of the members determine the metamorphic pattern that evolves. Each member's decision depends upon the task, in addition to the decisions made by at least some of the other members.

Gangs are structured similar to teams but differ in that there are fewer requirements for close intragang coordination. There are also lower degrees of specialization required, less need for workers to compensate for one another, and less serious consequences for mediocre performance. The decreased need for interworker compensation demonstrates that the member's decision is less dependent upon the decisions or responses of the other members.

Finally, classes or committees have little need for coordination among members even though they may share a common purpose. Activities are often competitive rather than cooperative as in the previously defined groups (George, 1966).

After one has first categorized the types of groups encountered in an applied setting, one can further classify groups as being open or closed systems. The classification may be done not only on the basis of incoming and outgoing materials that are task related, but one may also classify groups as open or closed on the basis of membership turnover. That is, an open system crew might be one that has a continuous influx and outflow of membership. The wery fact of membership turnover adds another dimension which has the potential of influencing the group's performance.

The concept of changing membership, as an independent variable, has received little attention in the literature, and yet its importance to the applied setting goes without question. Duncan (1955) was one of the first investigators to attempt to quantify the actual loss to group effectiveness attributable to changing membership. The Duncan index, skill dilution, evolved from the investigation. The index, as used in some organizations, is essentially concerned with total seniority or experience possessed by the group. In assessing the available pool of skill one might isolate a certain job or other subset of an organization and calculate the total experience of the related group of personnel. The available skill would continuously change with each successive increase in experience or with each dilution of skill caused by the replacement of a skilled member with a less skilled member.

Other investigators have taken the approach of first defining the relationships prior to building an index or model for prediction. Miles, Rogers, Ford, and Tassone (1961) were some of these investigators that examined skill dilution and group effectiveness. These investigators discovered that, in a chain structured organization, the effect of turnover in one position extended to other positions. The results would be expected since most chain structured organizations require the passing along of information from member to member. Therefore, a replacement of any one member would result in poorer performance because of the inherent dependency on the slowest group member.

Another study, (Horrocks, Heerman, & Krug, 1961), achieved converse results, in that, these experimenters found that member substitutions did not influence team effectiveness. Contrariwise, Glaser, Klaus, and Egerman (1962) obtained the predicted decrement in performance with membership replacement.

Naylor and Briggs (1965) did a followup study to the Glaser ejt_ al. (1962) and the Horrocks et^ al. (1961) studies, and obtained results intermediate to the prior studies. These experimenters concluded that the differences in results may have come about because of variance in task complexity and different feedback procedures. While Glaser ejt_ aij^. had required that all members be correct in their responses prior to receiving feedback on performance accuracy, the Naylor and Briggs study and the Horrocks ejt_ aj_. study had no similar feedback contingency. Here each man's feedback was in no way dependent upon the actions of others in the team.

As the importance of membership replacement and its effects become increasingly evident, the variable will of necessity be incorporated into the continuous operations research. The continuous or sustained operations research is currently involved in investigating human endurance, work/rest scheduling and performance, sleep deprivation and performance, alteration of the normal day/night cycle and performance, and other topics relevant to the prolonged exposure of organisms to work conditions. Since with any sustained operation one would encounter the loss of personnel, the relative effect of replacing certain central or peripheral members, at various times during an extended work period, becomes salient to the applied problem. The current study examined several of the variables which would typically evolve over an elongated work period.

Problem and Scope

The interest of the current study is membership replacement or turnover, as it dilutes the skill available to the crew and as it influences group performance. The amount of skill dilution occurring is hypothesized to be related to the task centrality of the member being replaced. That is, it is hypothesized that the replacement of members more central to the task, i.e., members responsible for increasingly larger or more complex shares of the task, should result in more skill dilution and poorer group performance. Also, since the chain-crew type organization predisposes the group's performance to be completely dependent upon the correct response of each member, this type of organization was utilized in an effort to produce maximum interdependence of the group members.

Feedback was also specifically controlled because, as mentioned earlier, the Naylor and Briggs (1965) study revealed the potential interactive influence of feedback and skill dilution procedures. Other studies have also confirmed the importance of feedback manipulations to group performance.

Among the studies concerning feedback and group performance are the pioneering works of Rosenberg and Hall (1958) and Hall (1957). These experiments demonstrated that feedback providing information directly to the individual member did not reliably differentiate that group's performance from the opposite feedback condition, where the individual was provided with team average feedback.

In another experiment, Zajonc (1962) used a group reaction time task in an investigation of direct versus confounded feedback. Contrary to the Rosenberg and Hall (1958) and the Hall (1957) experiments, the Zajonc results indicated that direct feedback is substantially superior to confounded feedback. In the Zajonc experiment, the correct response of an individual was defined independently of the response of the other crew members and mutual compensation for errors was not possible.

Due to the apparent importance of feedback contingencies, the variable was controlled in the current study. Confounded or team total feedback was provided to all crew members with no information concerning the correctness or incorrectness of the individual's performance. In this way, the individual had to gauge his performance on the basis of the crew output, and therefore the crew members were maximally interdependent.

A final hypothesis tested concerned the distribution of information among the crew members. It was hypothesized that those members with the greater task load would express greater satisfaction.

The two hypotheses together provided for tests of the turnover variable both as an independent variable, and as it is determined by job characteristic variables. The intent was to first determine if indeed turnover was detrimental to crew performance and if there were job characteristics which determined the degree of performance decrement occurring with turnover. At the same time the experiment was concerned with mood responses, hypothesized to be related to job satisfaction, and the expression of job satisfaction by means of a scale. In a sense, the question was asked, "What are some of the job characteristics which contribute to job satisfaction and do these same characteristics define the relative importance of membership replacements?"

The importance of job satisfaction to turnover has been examined on many occasions, including the early correlational study of Weitz and Nuckols (1953), with a general conclusion that employee dissatisfaction leads to turnover. Of course, there must be a multitude of variables that define satisfaction and by necessity the current experiment was limited to an examination of job characteristics and expression of satisfaction.

CHAPTER II

METHODOLOGY

Subjects

Subjects (Ss) were obtained from the pool of undergraduate students of psychology. The 80 male and female Ss were each given two credit hours for 1 1/2 hours of work. All freshmen psychology students are required to participate in four hours of experimentation. Random assignment determined placement into the various conditions.

Apparatus

The main task for the Ss consisted of problem solving and reacting to information as communicated by the other crew members and the experimenter. The Crutchfield apparatus was adapted for the purpose of controlled information flow within the crew setting.

The Crutchfield apparatus consists of a control panel for the experimenter and individual signal-response panels for the Ss. Each S's panel has a row of five mercury switches and five rows of signal lights, with each S having an assigned row of lights. The matrix of lights has the potential for a coded system of 25 different crew cues on any trial. The experimenter panel provides for the control of information going to the S^s, monitoring of S's performance, providing crew performance feedback, and the pacing of trials via reset and start switches (Sidowski , 1966).

The experiment was conducted in a room measuring 3.86 meters wide, 6.08 meters long, and 2.41 meters in height. Fluorescent lighting provided for a relatively equal dissemination of light throughout the room. Individual booths, for the crew members, were 1.83 meters high, .91 meters wide, and .91 meters deep with a table extending out .61 meters of this depth and .72 meters from the floor. The individual response panels were positioned .33 meters from the back wall of the booth. The placement of the panel enabled S's to rest their arms on the table during the entire experiment. Standard hardwood chairs, with the back .40 meters from the seat and the seat .45 meters from the floor, were used for the S^s' body support.

The mood adjective checklist was assembled from a factor analytic study, (Lorr, Daston, & Smith, 1967), and consisted of 36 adjectives loaded on factors called cheerful, energetic, anger-hostility, tense-nervous, depressed, and fatigued. The 2 embedded factors, cheerful and energetic, were of primary concern to the current experiment. There was also a job satisfaction scale.

with a possible rating from 1 through 7, included on the bottom of the mood adjective checklist. The mood adjective checklist is reproduced in Appendix A.

Procedure

The 80 Ss were randomly assigned to 30 2-man crews. Only two Ss composed the crew at any given time, and the extra one man per crew was used as a replacement member. The replacements were substituted for one of the original membership at 30 minute intervals. The three levels of the between group treatment consisted of replacing Position 1, replacing Position 2, and no replacement at all.

Each individual crew member had a unique aspect of the task to perform. The crew member in Position 1 responded to the information given by the experimenter, while the second crew member was required to respond to the light sequence of the experimenter and the first crew member. The correctness of the ultimate response was determined by the correctness of the Position 1 response as well as that of the second and final member's response.

Ss were provided with matrices individualized for the different positions in the communication structure. The matrices were before the Ss at all times and, upon receiving a signal, the Ss were required to look at the matrix and determine the correct response to be emitted. The S^ in Position 1 had two signal-response panels before him and, when receiving a cue, the S^ perused the matrix to locate the cue and associated responses. The Position 1 S^ actually made a response on each panel when receiving one cue from the experimenter, and the Position 2 S^ responded to the three cues that he received on the signal-response panel.

Although Position 1 was required to make two responses, the matrix for this position was logically arranged in alphabetical and numerical order so that the S^ in Position 1 had to simply locate the cue in the organized matrix. On the other hand, the S^ in Position 2 had only one response to emit but the matrix was randomly organized so the perusal was much more difficult. The matrix for Position 2 was organized in this manner in order to allow an opportunity for S^ learning in that position. These matrices are in Appendix A.

The cues were randomly ordered and then presented to each crew in the same standarized order. In this way each crew was exposed to the exact same task.

All crews worked for 30 minutes, and then rested for 10 minutes to give an opportunity for member replacement in the two experimental conditions. There were two 30 minute work periods with one 10 minute rest period. All S^s, including replacements, were given 5 minutes to read the instructions and study the matrices before beginning work. All three S^s, who eventually composed the diluted crews, reported to the experiment at the same time. However, the replacement S^ was allowed to read and rest while waiting to replace the planned membership turnover. There was no talking during the work sessions.

Prior to beginning work, and at the end of each work period, a mood adjective checklist was administered to the S^s. These mood scales were used to determine if there were different moods expressed by the members with different amounts of task difficulty. On the mood checklist form there was a job satisfaction scale which the S's responded to after working 30 minutes and at the termination of the second 30 minute period.

On the task itself S's were allowed one minute to respond. If a response was not made within that specified period or if an incorrect response was made within the period, an error was recorded. When the crew made an error, as evidenced by an incorrect response by the crew member in Position 2 or failure of the crew to respond in one minute, the experimenter illuminated a yellow light on all _S panels. The yellow light provided for negative confounded feedback. From the S^'s point of view, the yellow light feedback meant that either he or the other crew member had made a mistake. The S^ in Position 1 had some opportunity to determine whether he had caused the error or not, but the S^ in Position 2 had more difficulty in ascertaining error responsibility. The extra ambiguity for Position 2 was a result of the random logic of that position's matrix.

All errors were translated into one minute latencies so that both errors and speed were reflected in the one dependent variable of time to respond. This meant that determination of crew scores entailed the summing of latencies of the individual trials and then adding one minute for each error made by the crew. Since one of the primary interests was crew reaction time, the one minute time limit was used to rapidly pace the crews through the task thus eliminating extremely slow reactions to certain difficult problems.

CHAPTER III

RESULTS

There were three dependent variables examined in the present study. One of these dependent variables consisted of latency scores or crew time to respond, with each score resulting from the summation of nine test trials. The experimental design, for this particular set of scores, was a split-plot factorial analysis of variance with two levels of the between group variable and two repeated measure variables with two and three levels. The between group variable consisted of a comparison among crews which were subjected to no membership replacement, a replacement of the S^ in Position 1, and a replacement of the S^ in Position 2. The two repeated measure variables included performance scores after nine trials, repeated three times per time block; and scores for S^ before and after the break period.

The second dependent variable of interest was responses to the mood adjective checklist appearing in the appendix. In this case, the two embedded factors of cheerful and energetic were summed to give one score associated with feeling good. The other four factors were not of interest to the present study.

A split-plot factorial analysis of variance, with two levels of the between group variable and three levels of the repeated measures variable, was used to examine the mood response data. The between group variable was composed of comparisons between *S*'s occupying Position 1 and *S*'s occupying Position 2. The repeated measures variable consisted of comparisons of before work moods, middle of the work session moods, and termination of work moods.

The third dependent variable was responses to the job satisfaction scale appearing at the bottom of the mood adjective checklist. Although the *S*'s could rate their satisfaction or dissatisfaction on a scale of 1 through 7, in scoring, those responses below 4 were tallied as positive and the scores 4 and above were considered negative or an expression of dissatisfaction. A chi square test was used to analyze the job satisfaction data.

Latency Scores

The analysis of variance revealed that there were not any statistically reliable differences among the levels of the between group variable, *i.e.*, comparisons of the no replacement, replacement of Position 1, and replacement of Position 2 groups. However, there were main effects of repeated measures C (measurements taken after each nine trials) and repeated measures B (before and after break time blocks). These main effects were statistically reliable beyond the .01 level of probability. The Tukey HSD comparisons among means of the C variable revealed that level one was significantly different from levels two and three, but levels two and three were not significantly different from one another.

Although there were not any stitistically reliable interactions beyond the .05 level, there were reliable interactions beyond the .10 level of probability. One of these interactions involved the between group treatment (comparisons of diluted crews) and the repeated measure C (measurements taken after each nine time trials). The other interaction was between the two repeated measures of C and B (before and after break time blocks). These results appear in Table 1.

Mood Scores

The analysis of variance revealed that there were not any main effects from the comparison of moods for the different crew positions. In addition, there were no statistically reliable interactions. See Table 2 for a summary of these results.

Job Satisfaction Scores

The chi square analysis revealed a value of 5.12 with a tabled value of 3.84 required for statistical

TABLE 1

ANALYSIS OF VARIANCE: LATENCY SCORES

Source	df	MS	F
Crew Dilutions (A)	2	1.524	1.015
Before-After Break (B)	2	11.160	23.330***
Within Blocks (C)	2	15.806	30.148***
A X B	2	.037	.077
A X C	4	1.132	2.160*
B X C	2	1.770	2.653*
A X B X C	4	.441	.661

***p < .01

*p < .10

TABLE 2

ANALYSIS OF VARIANCE: MOOD SCORES

Source	df	MS	F[1]
Between Positions (A)	1	2.688	.052
Subjects Within (S)	58	52.068	
Periods of Work (B)	2	34.288	1.418
A X B	2	16.688	.690
B X S	116	24.172	
Total	179	33.120	

[1] No Significance Achieved

reliability at the .05 level. Examination of the chi square table below reveals that S's working in Position 1 expressed greater job satisfaction at the end of 30 minutes of work, than those working in Position 2.

TABLE 3

CHI SQUARE TABLE

	Position 1	Position 2
Positive	16	9
Negative	8	18

CHAPTER IV

DISCUSSION

Latency Scores

From the results achieved, one must conclude that the main treatment of skill dilution did not have any effect beyond that attributable to chance. These results are consistent with the Horrocks et al. (1961) experiment, in that these experimenters also reported no significant decrement in performance resulting from the operations of membership replacement.

As in the current study, the tasks performed by the Horrocks et al. S's was a very simple problem with some limitations on the amount of interaction required and permitted by the experimenters. In fact, Naylor and Briggs (1965) made the observation that the failure of Horrocks et al. to achieve a decrement may have resulted from the fact that the tasks were so simple to perform. The current study sought to manipulate task complexity but there was no result which invalidated the conclusions of Naylor and Briggs. When looking at a range of possible task complexities the tasks in the Horrocks et al. and the present study would, in all probability, fall close together at the very simple task end of the continuum.

In addition to the confirmation of the Horrocks et aj_. results, the current study added another dimension which may allow for a greater generalization of the phenomenon. The current study included a confounded feedback method in which the individual crew member was deprived of any experimenter information on his individual errors but instead received only accuracy feedback for the crew as a whole. The feedback contingencies in the Horrocks ^ aj_. experiment were somewhat more individualized because of the requirement of repeating incorrect problems. By requiring the teams to repeat the problem until solved, the individual error would become apparent because of the correction maneuvers. The present study did not provide for immediate repetition of the incorrect trial task and, therefore, there was individual confusion concerning error responsibility. Thus there is some reason to conclude that, in both an individual feedback situation and a crew confounded feedback situation, task complexity must be a primary consideration when evaluating the influence of membership replacement.

Before going ahead to examination of the other variables in the experiment, it would seem necessary to temper the above statements with reservations involving statistical theory. It is obvious that an experimenter has difficulties in asserting confirmation of hypotheses or support for other experimental results when reporting an experiment with insignificant results. The difficulty lies with the establishment of a probability level for determination of the reliability of the statistically non-significant results. Actually, an experimenter is limited to statements of null results without inferences of a no effect trend, at least until an examination of the null result experiments has revealed that the number of these experiments is beyond chance level. With this consideration, the preceding inferences concerning support for the earlier experiment are somewhat premature and should be submitted to further empirical tests.

Although the main variable of interest failed to materialize as a factor, there were statistically reliable time trend effects for both levels of repeated measurements. The main effect from the before and after break comparisons revealed that all crews performed more efficiently after the break period, even though the two experimental crews had suffered the loss of a crew member with 30 minutes of task experience. Results such as these could be construed to be in opposition to the initial conclusion that the tasks were so simple that replacement of membership had no detrimental effect on crew performance. Since all crews improved over time one might conclude that there was crew adaptation or learning taking place and, if this were the case, then at some point further in the future there would be a performance decrement resulting from membership replacement. Perhaps longer work periods would have revealed a performance asymptote which would be alterable by the introjection of system naive _S_'s into the crew setting.

The repeated measures variable within the before and after break time blocks was also statistically reliable. The Tukey _post hoc_ comparison of means revealed that the average of the first nine responses of both time blocks was reliably different from the second and third sets of nine trials. The interpretations of these results are not straight forward, however, because of the possibility that the differences resulted from procedural bias. The bias could have been a consequence of the fact that each crew was exposed to the same presentation of trials. While the presentation of trial problems was constructed in a random fashion, the presentation itself did not vary from crew to crew. It may be that by chance the first nine trial problems were simply more difficult to solve. If this were correct, then the main effect from the within blocks repeated measures is of little direct relevance to the hypotheses.

Prior to discussion of the mood checklist responses, it appears to be of pragmatic value to discuss the interactions which were statistically reliable to the .10 level. Although statistically the experimenter is restricted in inferences, the possible value for future research predisposes one to go beyond the traditional and theoretical limits set down in inferential statistics. There is an extreme paucity of research dealing with the topic and with this consideration, the marginal results become more salient as possible guides to future research.

The possible interaction between the repeated measures reveals that all crews began having greater latencies during the last nine trials before the break, but during the last nine trials after the break all crews were performing with minimum latencies. Perhaps fatigue was the determining influence before the break but the fatigue may have been over compensated for with an end spurt effect, during the last trials of the after break period. The end spurt effect is a common event in tasks of a monotonous nature. An explanation of this sort appears plausible since Ss knew how long they would be working and could anticipate the end of the work session. See Figure 1.

Finally, the near interaction involving the between group treatment and the repeated measures within time

FIGURE 1

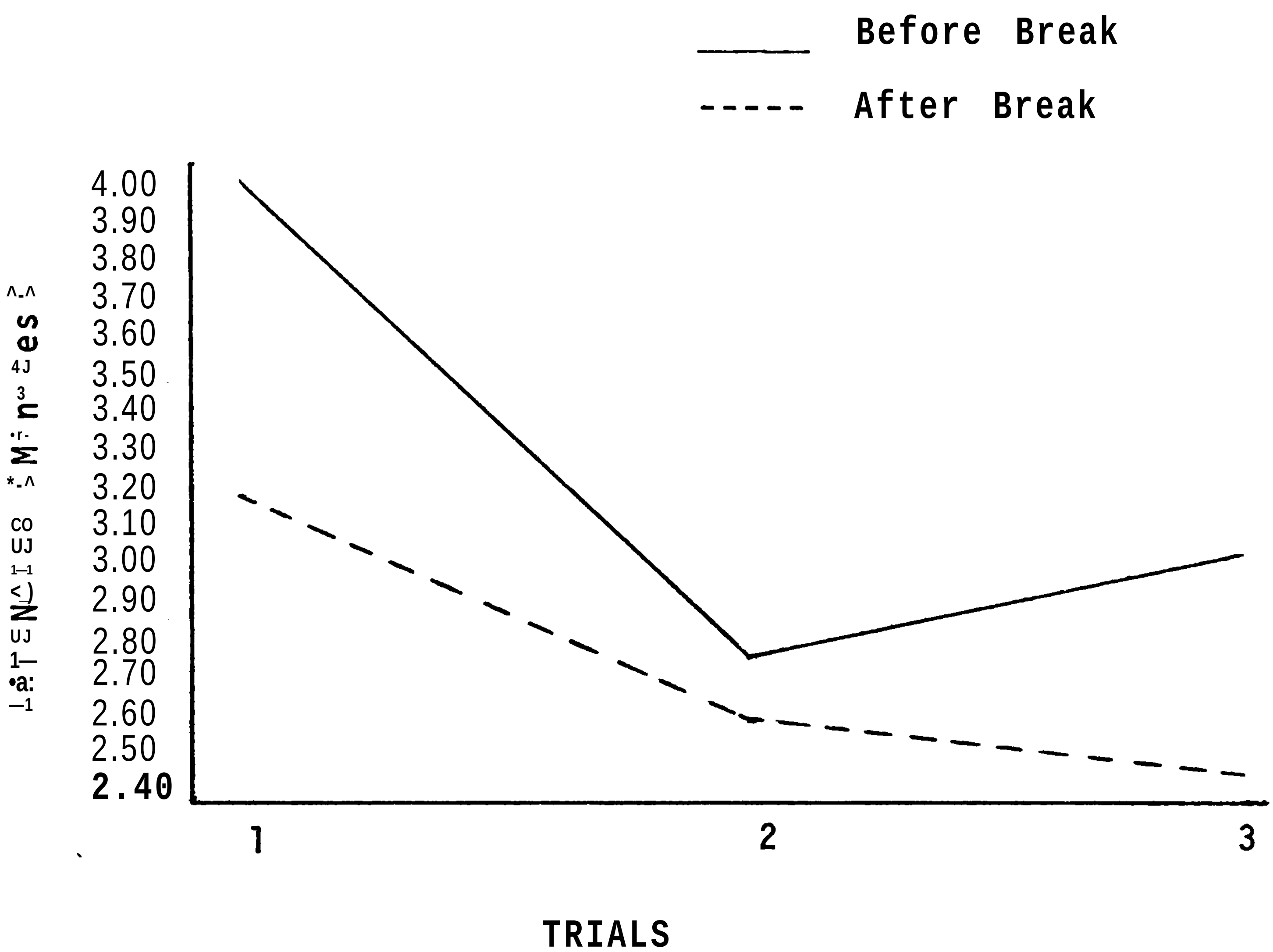

Fig. 1. The .10 interaction between the before break-after break variable and the within the blocks repeated measures variable.

blocks is essentially uninterpretable. The results appear to be an artifact of the experimental procedure because of the evidence that the no replacement crews began to respond better with first testing, and again performed better in the first nine trials after the break period. The better performance immediately after break was expected but it should have been revealed as a three way interaction. Since the no replacement crews did initially respond more rapidly, and to some extent (not statistically reliable) responded more rapidly throughout the experiment, it must be concluded that there was a chance bias in selection or treatment. There is no other apparent way to interpret these results. See Figure 2.

Mood Scores

There were not any statistically reliable differences in mood scale responses between crew positions or over the time periods. Although mood scales have been demonstrated to reflect transient affect expressions, it is obvious that in the current experiment the instrument was not sensitive to the experimental manipulations. Rather than conclude that the scale itself was insensitive, it would seem more consonant with the latency data to simply assert that the between group manipulations were ineffective. However, the failure to get repeated

FIGURE 2

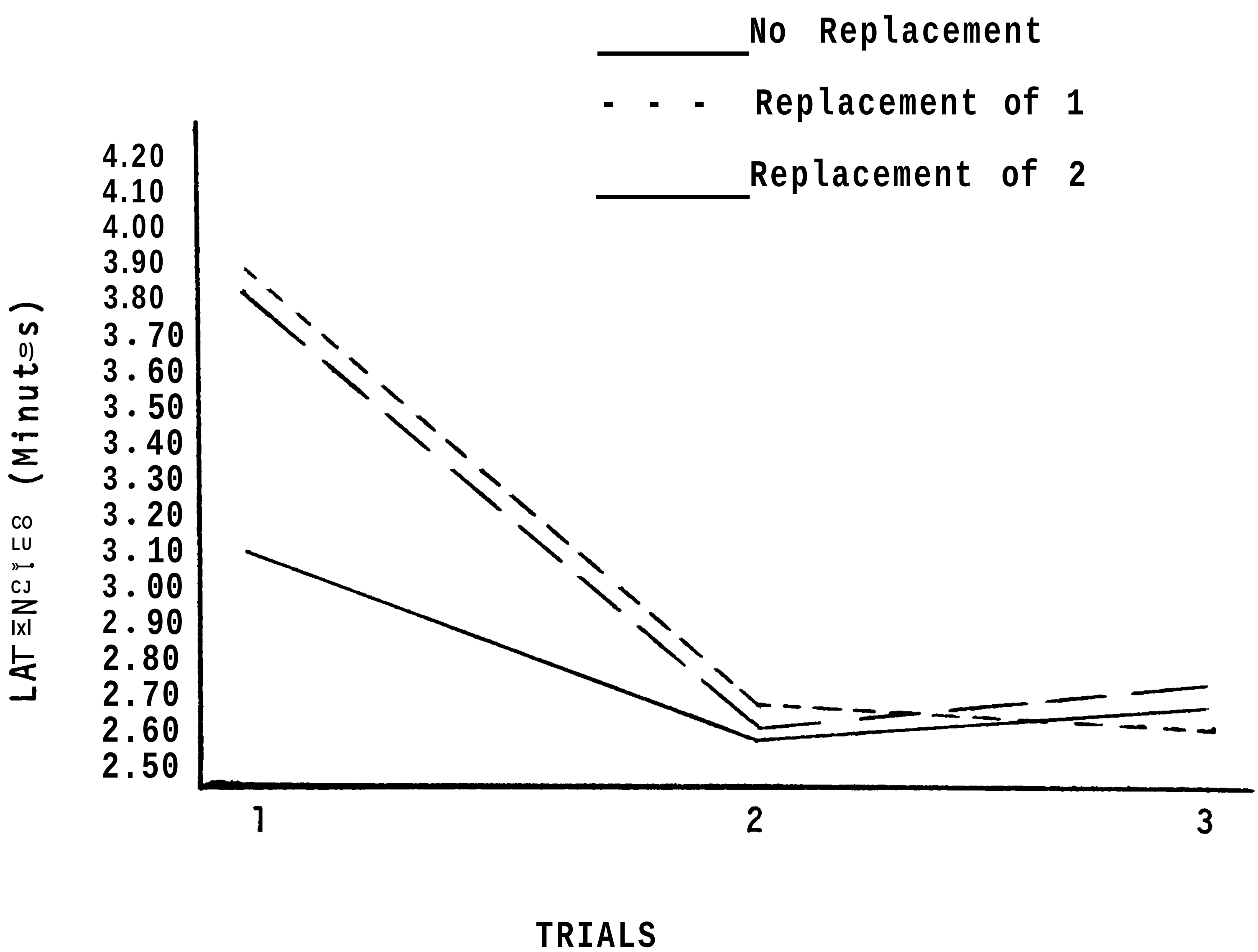

Fig. 2. The .10 interaction between the between group variable (diluted crews) and the within the blocks repeated measures variable.

measure differences could complicate the earlier end spurt effect explanation.

It would seem logical that the mood factors would be correlated with end spurt performance and, since all crews completed the final nine trials with minimum latencies, then one might expect parallel increases in mood expressions. Due to the fact that these mood expressions did not materialize, one must assume that the mood scale was insensitive to the elements that contribute to an end spurt, or else the concept of end spurt was not explanatory in this situation.

Job Satisfaction Scores

The statistically reliable chi square value revealed that those S's working in Position 1 expressed greater job satisfaction, at the end of 30 minutes of work, than those working in Position 2. The results were contradictory to the prediction that the position with the greater task demand would be more satisfying to the _^s.

A possible explanation for the discrepancy in prediction and observation might evolve from a procedural difference. Although the Position 1 matrix was the simpler of the two matrices, the ^ actually had to make two responses while the Position 2 ^ made only one response. The differences in motor responses were apparent to the crew members because the booths were adjacent to each other. However, the differences in matrices could only be determined by closer examination, and S's were prohibited from making this close examination of matrices in the alternate position.

It may be that the S^ in Position 1 perceived himself as being required to do more work and yet he was still able to perform more rapidly. If this were true, then the S^ sould probably be positively reinforced for the apparent superiority in task efficiency. The positive reinforcement could have led to the expression of more job satisfaction.

Finally, the failure to achieve mood parallels to the job satisfaction data would indicate that there was little relationship between the expressions of feeling good and the rating of job satisfaction. This is not to say that there is no relationship between moods and job satisfaction, but rather there was no apparent relationship revealed by the assessment instrument utilized In the present experiment.

Implications

The most obvious implication from the experiment is that for future research in the area. Due to the observation of the importance of task complexity to the Influences of membership replacement, there is an apparent need for programmatic research in which one locates and quantifies the threshold for effect. A programmatic endeavor would involve the selection of wery simple tasks with well defined dimensions and, successively, building on the tasks until one achieved a decrement with membership replacement. Of course, the level of group skill or system experience would, at various stages, either be manipulated or controlled.

A major problem will lie with the quantification of task complexity and skill or system experience but, at some level of analysis, these apparently correlated concepts should reveal a common dimension, allowing for their direct quantitative comparison. From the programmatic delineation of the parameters, models may be constructed for probabilistic prediction when given task requirements and human abilities and skills. Without the models, prediction will remain task specific and only y/ery limited generalization will be possible.

Implications for immediate application are limited In scope because of the wery lack of quantification in the area of task complexities. It may be safely asserted that given very simple tasks the replacement of membership has little influence on crew performance. The assertion would be particularly relevant to those systems which are not interfaced with other systems in an analogue relationship. That is, if there is a degree of flexibility which allows for compensation by other system elements, human or machine-procedural, then group members may be interchanged freely without performance decrement.

An example of the particular situation could be a typical industrial assembly line in which there is inter-human and human-procedure flexibility. In most assembly line situations, the pace of the work chain is not rigid enough to require constantly maximum performance from the five crew members. For instance, a crew member may have five minutes to do a task but as the crew member becomes maximally proficient the task could only take three minutes to perform. Therefore, there is a two minute period of flexibility in the system which provides a buffer for new membership. It is also not uncommon to observe human compensation for new membership, whereby the prior member in the chain type organization finishes that task more rapidly thus giving the new member a head start on the task. In these ways new membership is compensated for by system procedure and other crew members. If the tasks are simple and there is a built in opportunity for compensation, then membership replacement may have little influence on total performance.

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APPENDIX

A. Supplementary Materials.

   a. Matrix for crew Position 1.

   b. Matrix for crew Position 2.

   c. Instructions for crews.

   d. Mood adjective checklist.

   e. Standarized scoring sheet.

B. Raw Data.

   a. Latency scores.

   b. Mood scale data.

APPENDIX A: MATRIX FOR CREW MEMBER NUMBER 1

Cue-	Al	A2	A3	A4	A5
Respond-	CI & D2	Al & C2	Bl & E2	El & A2	Dl & B2
Cue-	ii	B2	B3	B4	B5
Respond-	Dl & E2	Bl & A2	CI & D2	Al & B2	El & C2
Cue-	C1	C2	C3.	C4	C5
Respond-	Dl & C2	El & A2	Al & D2	Bl & E2	CI & B2
Cue-	51	D2	D3	D4	D5.
Respond-	El & B2	CI & A2	Al & E2	Dl & C2	Bl & D2
Cue-	Ei	E2	E3	Ii	II
Respond-	Bl & A2	Dl & B2	Al & E2	El & D2	CI & C2

When receiving 1 cue light on your panel, respond as rapidly as possible. Note that you make 2 responses using both of the panels before you. If the cue calls for a CI and a D2 response, then you would flip the C switch on panel 1 and the D switch on panel 2. See below.

PANEL 1

	A	B	O	D	E
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
	I	I	t	I	1

-switches-

PANEL 2

	A	B	C	D	E
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
	I	I	I	I	I

APPENDIX A: MATRIX FOR CREW MEMBER NUMBER 2

Cue-	CI	A2	CI	B2	A5
Cue-	Al	Al	D2	B4	Dl
Cue-	D2	C2	B3	Al	B2
Respond-	E	B	A	C	C
Cue-	Bl	A3	A2	El	A4
Cue-	Dl	Bl	Bl	B5	El
Cue-	E2	E2	B2	C2	A2
Respond-	A	C	B	E	D
Cue-	CI	El	Bl	C2	D2
Cue-	Dl	Dl	El	El	Al
Cue-	C2	B2	A2	A2	C3
Respond-	E	A	C	D	B
Cue-	C4	C5	D2	D4	Al
Cue-	Bl	CI	CI	Dl	D3
Cue-	E2	B2	A2	C2	E2
Respond-	A	B	C	D	E
Cue-	D5	E3	Dl	E4	CI
Cue-	Bl	Al	B2	El	E5
Cue-	D2	E2	E2	D2	C2
Respond-	A	B	C	D	E

When receiving 3 cue lights in <u>any</u> order. respond as indicated above.

Example: If lights appear in row 1-column C and in row 1-column A and in row 2-column D, respond with an E switch.

	A	B	O	D	E
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
switches-	!	!	1	!	!

APPENDIX A: GENERAL INSTRUCTIONS

You will be working as part of a 2 man crew with the task of reacting as swiftly as possible to the light cues on your signal response panel. The task and layout of the crew setting represents part of what you might encounter in certain military and industrial settings.

We are interested in determining how rapidly and accurately an individual and, subsequently, the crew can react to various communication cues. Your performance will be compared to other crews working on the same task. If any crew member makes an error, the yellow light in the lower left hand corner of your panel will illuminate. REMEMBER TO WORK AS RAPIDLY AS POSSIBLE. YOUR SPEED AND ERRORS WILL BE COMPARED TO THE OTHER CREWS.

APPENDIX A: MOOD SCALE

NAME: ____

DATE: ______________________________ HOUR: __________

Instructions. The words and phrases below are used to show how people feel from time to time. If, RIGHT NOW, the term describes Very much the way you feel, put a "2" in the blank by the term; if it is somewhat the way you feel, put a "1" in the blank; otherwise, place a "0" in the blank. Fill all blanks according to how you feel RIGHT NOW.

Tense ______	On edge ______	Shaky ______
Nervous ______	Worried ______	Uptight ______
On top of the world ______	Excited ______	Light Hearted ______
Carefree ______	Gay ______	Cheerful ______
Unhappy ______	Hopeless ______	Blue ______
Worthless ______	Scared ______	Helpless ______
Annoyed ______	Furious ______	Angry ______
Bad tempered ______	Spiteful ______	Grouchy ______
Active ______	Full of pep ______	Alert ______
Lively ______	Ready to go ______	Turned on ______
Weary ______	Sleepy ______	Sluggish ______
Lazy ______	Tired ______	Worn out ______

Indicate on the scale below how satisfied you are with your job in this experiment.

well satisfied 1 2 3 4 5 6 7 totally dissatisfied

When was your last full meal ______________________

How much sleep did you get last night ______________

APPENDIX A: SCORE SHEET

Crew Type ____________ Date ________________

Time ________________ First or second work period ______

Trial	Cue	Time for Subject 1	Time for Subject 2	Error
1	Al	C1&D2 --	E3 --	
2	B3	C1&D2 --	A3 --	
3	El	B1&A2 --	C3 --	
4	A3	B1&E2 --	C3 --	
5	D3	A1&E2 --	E3 --	
6	Bl	D1&E2 --	A3 --	
7	E2	D1&B2 --	C3 --	
8	B2	B1&A2 --	B3 --	
9	A4	E1&A2 --	D3 --	
10	C3	A1&D2 --	B3 --	
11	A5	D1&B2 --	D3 --	
12	M	A1&B2 --	C3 --	
13	M	D1&C2 --	D3 --	
14	11	E1&D2 --	D3 --	
15	A2	A1&C2 --	B3 --	
16	CI	B1&E2 --	A3 --	
17	B5.	E1&C2 --	E3 --	
18	C2	E1&A2 --	D3 --	
19	D2	C1&A2 --	C3 --	
20	£5	C1&B2 --	B3 --	
21	11	A1&E2 --	B3 --	
22	Dl	E1&B2 --	A3 --	
23	E5	C1&C2 --	E3 --	
24	CI	D1&C2 --	E3 --	
25	11	B1&D2 --	A3 --	
26	11	C1&D2 --	E3 --	
27	13	C1&D2 --	A3 --	

APPENDIX B: LATENCY SCORES

		Before Break 9 Min.	18	27	After Break 9 Min.	18	27
No Reinforcement	1	3.21	5.21	4.84	4.33	3.30	3.70
	2	3.47	2.15	2.45	2.85	2.89	1 .41
	3	2.58	2.57	2.31	2.92	1 .77	2.08
	4	4.16	2.85	3.63	2.51	2.86	2.23
	5	2.60	2.52	1 .94	2.08	2.01	2.10
	6	1 .67	2.27	3.20	1.73	3.43	2.42
	7	4.65	2.55	3.29	2.87	2.26	3.16
	8	2.62	1 .81	1 .82	1.81	1.74	2.91
	9	2.72	2.14	3.39	4.32	1 .81	1 .67
	10	5.32	2.84	3.28	3.23	2.14	2.69
Reinforcement Position 1	1	5.91	3.40	2.36	3.79	2.73	2.62
	2	4.31	2.77	3.11	4.23	2.74	1 .88
	3	3.98	2.51	3.68	2.98	3.41	2.81
	4	6.02	3.24	3.71	2.24	2.80	3.17
	5	5.27	3.08	3.36	3.53	4.16	2.38
	6	2.76	2.78	2.24	3.73	2.08	2.39
	7	2.89	4.42	5.05	2.92	1 .81	2.32
	8	4.85	2.03	1 .68	3.10	3.35	2.11
	9	4.39	1 .86	1 .61	2.45	1 .53	1 .80
	10	3.69	1 .57	1 .64	3.96	1 .60	3.17
Reinforcement Position 2	1	3.66	2.04	5.44	3.23	2.53	2.12
	2	6.77	3.68	2.34	4.50	2.89	3.05
	3	4.43	2.67	1 .41	1 .62	1 .38	2.32
	4	4.39	3.04	2.83	3.46	3.14	2.45
	5	4.05	2.22	4.08	3.07	2.80	2.25
	6	3.47	2.78	2.71	3.55	2.51	1 .93
	7	4.95	2.48	2.71	3.79	3.44	3.08
	8	2.43	1 .71	3.01	3.03	2.61	2.65
	9	4.08	3.27	3.47	3.53	2.60	2.17
	10	4.11	2.34	3.38	3.58	3.06	2.58

APPENDIX B: MOOD SCALE DATA

	Before Work				Break Test				After Work			
Position 1	8	19	13	19	5	17	7	5	15	19	17	3
	0	13	19	3	5	2	2	1	2	18	2	1
	13	4	1	4	15	1	0	12	15	12	2	2
	2	5	10	2	0	13	17	3	0	4	3	1
	3	12	4	8	3	1	16	4	6	14	0	7
	18	1	15	15	14	0	11	1	10	11	13	0
	3	9	4	10	11	1	5	3	9	13	10	2
	7	2			4	3			6	5		
Position 2	2	7	19	0	2	5	13	3	1	4	10	0
	2	2	17	7	2	19	2	1	20	11	4	2
	12	9	13	9	15	9	7	6	19	0	2	3
	17	9	9	6	21	0	0	6	14	10	7	7
	2	1	8	10	8	9	13	19	3	0	7	0
	14	10	9	0	10	5	8	0	12	5	1	8
	17	7	7	12	15	5	11	11	8	1	16	3
	10	4			4	5			14	10		