Technical Report 66-10

Interaction Content and Team Effectiveness

by

Adie V. McRae

HumRRO Division No. 4 (Infantry)

AD_____

June 1966

Prepared for:

Office, Chief of
Research and Development
Department of the Army

Contract DA 44-188-ARO-2

HumRRO

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
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Technical Report 66-10
Task UNIFECT
Subtask I

The Human Resources Research Office is a nongovernmental agency of The George Washington University, operating under contract with the Department of the Army (DA 44-188-ARO-2). HumRRO's mission is to conduct research in the fields of training, motivation, and leadership.

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Published
June 1966
by
The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
300 North Washington Street
Alexandria, Virginia 22314

Distributed under the authority of the
Chief of Research and Development
Department of the Army
Washington, D.C. 20310

FOREWORD

The over-all objective of Work Unit UNIFECT is to discover and apply principles for the design of team training that will increase team cohesion and efficiency in small infantry-type units, and to test whether such training will affect the individual soldier's behavior when he is assigned to a team other than the one in which he was trained.

The work reported here was part of a series of Work Sub-Unit I experiments which required members of small groups (1) to attend both to what other members were doing and to the impact of their behavior on the group task, (2) to communicate relevant observations and suggestions to other members, and (3) to perform other members' functions when they could not carry on. These requirements are essential to the development of team effectiveness.

Research in Work Unit UNIFECT, Procedures for Increasing the Effectiveness of Small Infantry-Type Units, is being conducted at HumRRO Division No. 4 (Infantry), Fort Benning, Georgia, with Dr. Clay E. George as the Work Unit Leader. Dr. T. O. Jacobs is the present Director of Research; Dr. Carl J. Lange was Director of Research when the research was initiated.

The U. S. Army Infantry Human Research Unit provided military support. LTC Thomas E. Lawrence was Unit Chief during the period of Work Sub-Unit I. MAJ Ferdinand O. Barger, Jr. is presently Chief of the Unit.

Two Research Memoranda have been published: *Some Determinants of Small-Group Effectiveness* by Clay E. George, April 1962, and *Pilot Studies of Team Effectiveness* by Clay E. George, George R. Hoak, and John Boutwell, February 1963. A comprehensive report of all of the UNIFECT I studies is in preparation

The Human Resources Research Office conducts research under Army Contract DA 44-188-ARO-2 and Army Project 2J024701A712 01, Training, Motivation, Leadership Research.

Meredith P. Crawford
Director
Human Resources Research Office

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PROBLEM

The effectiveness of small combat teams engaged in performing tasks that require cooperation and coordination among team members is a function of the existence and strength, within individual soldiers, of the habit of coordinating his efforts with those of his fellow team members. While men differ in the extent to which they are motivated to cooperate with other team members in the resolution of a common task, there is evidence that such motivation can, in some degree, be induced in teams by appropriate task-related experience.

In previous studies, attention was directed primarily to the effects of various treatments designed to produce increments in teamwork behavior, and data were gathered after the treatments were administered. The need for observation of the events that mediated the effects of experimental treatments gave rise to the present study, whose aim was to provide information on the relationships between the interaction of a working team and its effectiveness.

METHOD

A group maze problem was used that could only be solved by verbal interaction of all team members. To quantify the content of team communications, a category set was devised that permitted an analysis into one of four organizational categories, or into one of four categories dealing directly and specifically with the task environment. Three residual categories were included to produce an exhaustive set. Correlational analyses were then conducted to relate the categories of interaction with team errors.

RESULTS

The results were analyzed in terms of team task effectiveness, volume and content of interaction, intelligence, and task contribution rank.

Despite an ascending order of difficulty over trials, the teams made fewer errors on each subsequent trial, i.e., there was an increase in team effectiveness. There was a considerable difference in the way the two major interaction categories correlated with errors. The task-specific mode of interacting was significantly correlated with errors. Such interaction contributed positively to performance and increased with successive trials. The organizational mode of interaction, however, was of low volume and varied little over trials; further, it appeared to be either unrelated to performance or related in a more complex manner. Team mean General Technical scores correlated negatively

and significantly (.05 level) with team errors, as expected. The team member who initiated more interaction than other members was credited with the highest status.

CONCLUSIONS

(1) The types of verbal interaction that mediated the coordination of individual effort appeared to be of differential effectiveness. Those oriented toward specific task aspects were associated with more effective team performance than those geared to organizational elements of team performance. A possible interpretation of the latter finding was that persistence of organizationally oriented communication resulted from the existence of unsolved problems of team organization that prevented effective team performance.

(2) As the difficulty of the task increased, the level of verbal interaction also increased, though the confounding of trials with difficulty does not allow the conclusion that this is a casual relationship.

CONTENTS

Interaction Content and Team Effectiveness

INTRODUCTION

The central purpose of this paper is to examine certain possible relationships between the interaction of a working team and its effectiveness. The study contained in this report is a part of a more extensive investigation by Work Unit UNIFECT of the parameters of teamwork as they apply to small military teams. Certain variables have been isolated in this research that have a predictable relationship with team performance. Notable among these are the team task motivation, cohesion, and coordinate response variables (*1, 2*). The present study contributes to teamwork-relevant knowledge by indicating specific ways in which coordination helps to shape team responses, and consequently, team performance.

In the previous investigation of teamwork parameters conducted in Work Unit UNIFECT, attention has been largely focused upon the effects of various treatments designed to produce increments in teamwork behavior. The data of central concern were gathered after the treatments were effected. Only tangential attention was given to the events that intervened between experimental treatments and their effects. The need for observation of these intervening processes gave rise to the present study, which was designed to provide information of use in establishing more clearly the dynamics of teamwork. Also, the controlled observation of group processes, group products, and their relationships, should increase the value of the previously obtained data.

As suggested in a previous Research Memorandum (*2*) there are a number of ways in which intrateam coordination may occur. Viewed analytically, all seem to involve taking account of other teammates' resources when adapting a response to environmental demands. These resources may be anything that is of value in resolving problems confronting the team. They may be private information, private vantage points, visual or kinesthetic cues, special abilities, knowledge, anything that can be pooled to add to the strength of the team.

The transactions that occur between members of teams are largely in the form of verbal interaction. However, other modes of communication occur frequently. Gestures utilizing the hands, face, or the entire body, are the means whereby individual resources are channeled to other team members. Through these means task-relevant information becomes common to all team members. Subsequently, each can adapt his responses more adequately in the light of his broadened understanding of the situation, with the result of more effective team performance.

Although, as was suggested above, there are modes of interaction other than verbal available to groups, they would be more difficult to handle experimentally. On the other hand, various approaches to the quantification of verbal data have been applied successfully in this area. Most of these use some variation of the Bales Category System (*3*). In the present study a category set was devised with particular reference to the experimental task. It differs from the

Bales system in that only task-oriented activity is of relevance. The set and task are described in detail later.

Justifications for this approach abound in the literature (*3, 4, 5*), and particularly in communications network studies (*6, 7, 8*). However, the relationships between verbal interaction and team task performance have not yet been clearly delineated. One of the main barriers to drawing clear inferences in this area is the acknowledged dependency of group performance upon task dimensions (*9*). One of the dimensions of obvious relevance here is task difficulty. It would seem that simple, easy tasks would require less verbal interaction to achieve relative success than would tasks that embody complex, difficult operations. The necessary addendum to this statement is, of course, "other things being held equal." The crucial "other thing" here is the existence of coordination requirements for all levels of difficulty.

METHOD

The rationale for the present study required an experimental situation that would allow mode of verbal interaction to be related to group performance on an interdependent task with varying levels of difficulty. To provide a team task that would meet the necessary requirements, an adaptation of the McCurdy and Lambert (*10*) group maze was made. In this task, the team is seated at a board of switches to be operated so as to turn on a light, the object being to turn on the light with a minimum of switch turnings. By dividing the switches equally among the various team members, a condition of forced interaction and coordination was created, which could be analyzed and related to performance. In the present use of the group maze, development of relevant group processes occurred during the solution of four separate tasks; the average time required for solving these tasks was one and one-half hours.

Subjects

A total of 48 Army enlisted men from the 197th Infantry Brigade served as subjects. Since a four-man team was used, this yielded a total of 12 teams. Post-experimental analysis of subjects' personnel files revealed that their General Technical (GT)[1] scores had a mean of 94, with a range of 69 to 141. There was no attempt to control or equate aptitudes or abilities among the teams.

Each four-man team received two days of experimentation. One day was spent in the laboratory where the subjects were utilized in four separate and distinct experiments. The following day the same subjects were used in four separate problems in the field. This paper will delineate the findings of the second of the laboratory

[1]An aptitude area score obtained from the Army General Classification Test, composed of verbal and numerical subtests.

experiments.[1] Since all subjects discussed herein were given similar treatment in the first experiment, it was assumed that no differential effects therefrom would appear in the present data.

Apparatus

The apparatus is shown in Figure 1. Also included was a control table fitted with a tape recorder and an Esterline Angus multiple-channel event recorder. On the table in easy reach of the experimenter was the master control switchboard. The team panel was connected to the control board by a cable. The panel was divided into pairs of switches numbered 1 through 8, one pair in each of four cubicles made by plywood partitions mounted on a table. The partitions were sufficiently high to visually shield each subject from his teammates.

The electric circuit, consisting of the four pairs of switches and the master control board, operated a red light mounted on the partition above the heads of the team members. In order for the light to be turned on, each of the eight switches had to be turned exactly like its duplicate on the master control panel. If any switch was otherwise positioned, the light would not turn on.

The event recorder was programed to make a record of all switch turnings and of the times the light was turned on. Since the chart rotated at a known and standard rate, it yielded a reliable measure of working time.

A tape recorder was used to record the verbal interactions of all teams. The microphone was in full view of subjects at all times.

Procedure

When the subjects entered the laboratory, they were randomly seated at the appropriate panels, names were taken per position, and the instructions were read. While reading, the experimenter slowly walked around the team's table, so that similar contact would be maintained for all.

After reading the instructions (see Appendix A) and answering questions that arose, a practice trial was run. The experimental task consisted of the learning of a given sequence of switch movements, by the subjects. At the beginning of a trial, all eight subjects' switches, and their corresponding control switches, were turned to the right. The experimenter then turned one of his switches to the left, thereby turning off the subjects' light. Their task then was to find the correct switch on their panel (panels) and turn it to match the position of the experimenter's switch, which would turn the light back on. When this was done, the experimenter turned the next switch in the series, which was then matched by the subjects, and so on to the end of the sequence. Since each switch was numbered, this, in effect, consisted of the learning of a sequence of digits by the subjects acting as a team.

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[1]The results of the remaining experiments will be reported at a later date.

MAZE APPARATUS

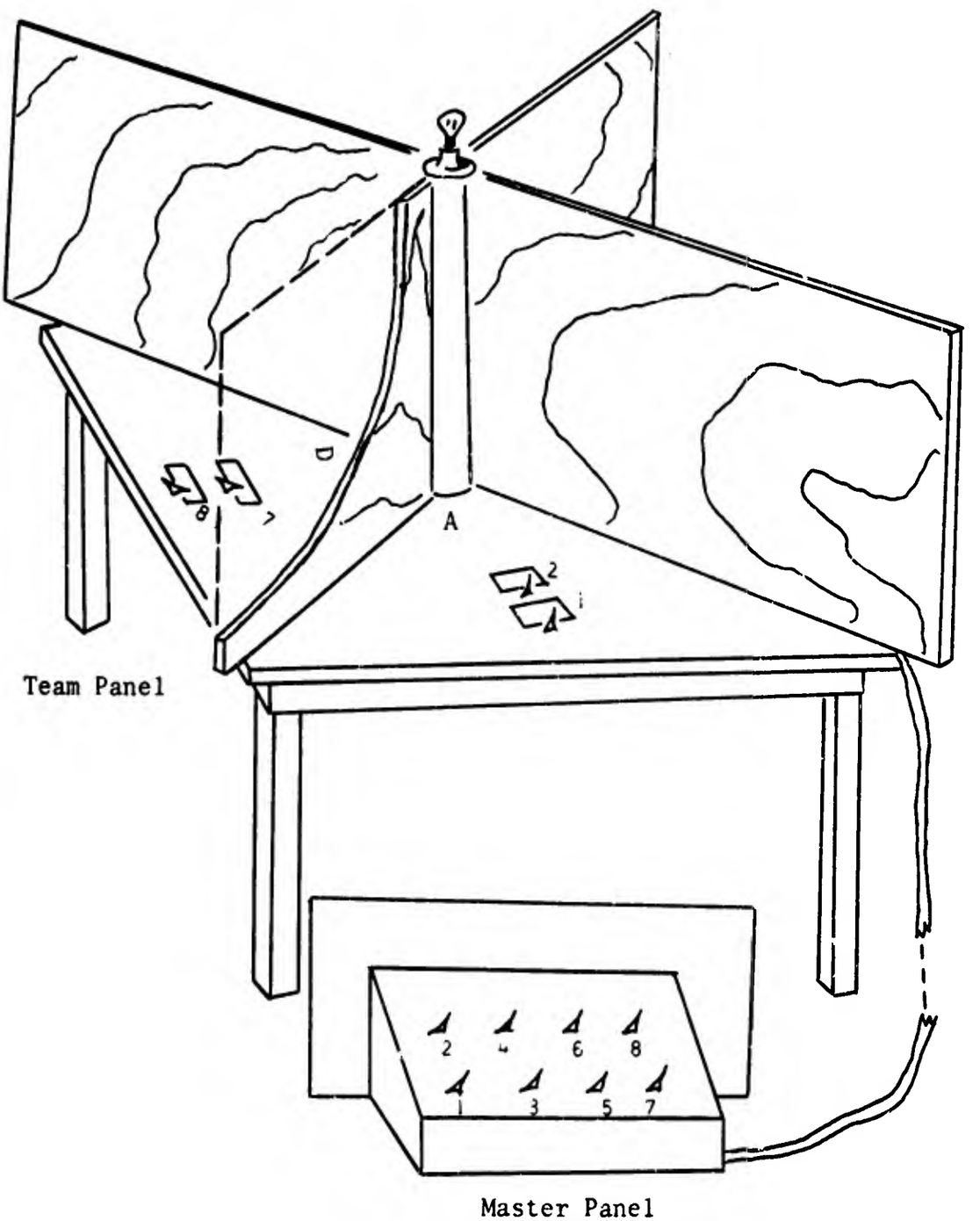

Figure 1

The interaction requirement came from the fact that the switches were divided among the team members, two per subject. Thus, the subjects were required to interact in order to coordinate their responses to minimize errors within the situation. Each of the sequences was repeated until the subjects had made one error-free sequence, or until 30 minutes had been expended, either of which terminated the trial. The order of switch movements, or digits, used throughout the experiment is presented in Table 1.

Table 1

DIGIT PROBLEMS

Trial	Switch Numbers
Practice	2, 4, 6, 8
I	8, 7, 6, 5, 4, 3, 2, 1
II	3, 8, 6, 7, 1, 7, 1, 4
III	1, 7, 5, 8, 5, 4, 6, 2, 3, 7, 4, 6

It can be seen that the digit sequences are arranged in order of increasing difficulty across trials. The four-digit problem presented on the Practice Trial should have been least difficult. The descending series in Trial I should have been next in order of difficulty. Trial II is a random series, and should have followed Trial I in order of difficulty. The most difficult, being both randomized and 12 digits long, was Trial III.

Because of time limitations, not all of the trials were given for all groups. However, all teams completed the Practice Trial and Trials I and II. Five teams had enough time to begin and complete Trial III.

Sometimes it was necessary, during the Practice Trial, to render additional guidance to subjects. When a subject appeared to be in doubt about what he should do, relevant parts of the instructions were repeated. In several cases where individuals or teams were completely confused, the experimenter tried to indicate the source of the difficulty. No aid of this type was given for trials other than the Practice Trial.

After all trials were given, the team members filled out a Task Contribution Ranking (TCR) form. They were instructed to rank all members (including themselves) in terms of how each contributed to task resolution.

RESULTS

The results were analyzed in terms of (1) team task effectiveness, (2) volume and content of interactions, (3) intelligence, and (4) task contribution rank.

Team Task Effectiveness

With the task situation as previously outlined, it is possible to define task effectiveness operationally in terms of the errors to criterion. In reaching the criterion, teams differed in the number of switches turned incorrectly. The standard deviations, listed in Table 2 below, indicate the degree of this variation. There was also a marked skewness of distribution, in all but Trial III, which occurred as a result of calling trial time for a number of poorly performing teams. The quite different record of errors in Trial III, as well as its much smaller standard deviation, probably followed from the fact that only teams that had achieved an efficient organization had sufficient time to embark on the Trial III problem. (Since the subjects were to be used on another experiment immediately following, an over-all time limit of two hours had to be imposed. More than half of the teams were eliminated at the end of Trial II by this limit.) Thus, there is no unqualified way of comparing performance on Trial III with performance on the other trials. Consequently, in the later analyses, this trial is not treated statistically.

The means of Table 2 provide a basis for making a tentative judgment on improvement across trials. The comparatively large number of errors on the Practice Trial, which was the least difficult series of digits, indicates that the teams had considerable initial difficulty with the team task. However, the mean of Trial I indicates substantial improvement. Further improvement occurs on the remaining trials.

Table 2

ERRORS--INCORRECT SWITCH TURNINGS

	Practice Trial	Trial I	Trial II	Trial III
Means	473.46	183.25	152.67	58.20
S. D.	455	263	236	19
N_{Teams}	11	12	12	5

Since the problems in the four trials represent an ascending order of difficulty, the indicated improvement is the more marked. Of course, in this design it is not possible to isolate practice effects from the effects produced by level of difficulty. This confounding was a necessary evil, required to achieve a series of problems that would continue to be challenging in the face of increased team effectiveness resulting from internal organizational changes. An ascending order of difficulty allowed the teams to make initial headway with simple problems, and then continue to develop their resources in the face of increasingly difficult problems. The data in Table 2 give some indication that this occurred.

Verbal Interaction

It was presumed that the variation in errors among teams would be significantly related to variation in volume and content of their verbal interaction. In order to assess the scope of this relationship, a means of quantifying the interaction was required. To reduce the tape recordings of the problem sessions to this form, they were analyzed in terms of a previously developed category set. The major emphasis in the development of this set was on the modes of interaction that were relevant to the solution of maze-type problems. Thus, a fairly simple category set was in order. The two dimensions having the most relevance to this research were the organizing processes of the teams (O), and activity that contributed directly to task resolution (T). In order to ensure that the set be exhaustive, a third major category dealing with residual subcategories was elaborated (R). To provide the cues for recognizing membership in these three classes, the categories were given definitions phrased in terms of the type of activity likely to occur in maze-type problem solutions. Each verbal act could then be classified into one of the following 11 subcategories:

O. ORGANIZATIONAL INTERACTION
- O_1. Procedural Innovation
- O_2. Reinforcement or Maintenance of Procedure
- O_3. Repudiation or Rejection of Procedural Innovation
- O_4. Interaction that is Motivational or Exhortative

T. TASK-SPECIFIC INTERACTION
- T_1. Specifying Action for Oneself
- T_2. Specifying Action for Another, or Others
- T_3. Request for Information
- T_4. Giving Information

R. RESIDUAL INTERACTION
- R_1. Emotional Expression not Contributory to Task Solution
- R_2. Nonrelevant Interaction
- R_3. Interaction with Experimenter

The complete definition of each category is given in Appendix B. These definitions, and instructions for scoring interaction, were designed to maximize the degree to which the various categories and subcategories were mutually exclusive, and thus to minimize problems of judgment arising from the categorizing process. It was not possible to produce a set of categories characterized by complete mutual exclusiveness, primarily because of bidimensionality in the team task itself. On the one hand, the team members were faced with organizational problems, and on the other, with the need to make specific proposals to one another for specific actions. In the

analysis of the interactions, it thus was often difficult to determine exclusive membership in a given category.

In the instructions, team members were enjoined to talk only about the problem. This, of course, reduced the variety of interaction that occurred. Identification of respondents was facilitated by assigning code names--Alfa, Bravo, Charlie, and Delta--thus further reducing the problems of decoding the taped material.

The sum of categorized acts for each team became the primary interaction data on which Table 3 was based. Some of the categories are not represented due to insufficient entries on the interaction protocols. Also presented are two derived scores, the total of O interaction and the total of T interaction.

Some of the significant relationships found in this set of correlations are the highly positive ones between errors and time to criterion. This was not surprising as the latter was previously considered as a possible measure of performance. In a task such as this one, high performing teams are characterized by low volume of errors and quick solutions.

Another set of positive associations exists between time and volume of T interaction (in most cases). Apparently the more time the teams took to reach criterion, the more time was allowed for interaction to occur. This relationship is most pronounced in Trial I.

Table 3

CORRELATION OF INTERACTION WITH ERRORS AND TIME[a]

Category	Practice Trial N = 11		Trial I N = 12		Trial II N = 11	
	Errors	Time	Errors	Time	Errors	Time
O_1	-.13	-.08	+.08	-.06	+.34	+.23
O_2	-.15	+.13	-.12	+.16	+.45	+.00
O_{tot}	-.10	+.14	+.06	+.22	+.48	+.17
T_1	-.48	-.04	-.05	+.27	-.45	+.08
T_2	-.44	-.20	+.08	+.71*	-.43	+.17
T_3	-.43	-.08	+.33	+.70*	-.04	+.51
T_4	-.41	+.04	+.15	+.70*	-.13	+.45
T_{tot}	-.49	-.09	+.13	+.71*	-.35	+.34
R_3	+.13	+.29	-.07	+.44	+.12	+.10
Time	+.78*		+.70*		+.71*	

*$p < .01$

[a]*These coefficients were evaluated by a two-tailed test.*

However, none of the correlations between errors and category scores proved significant. This was counter to expectation. However, further analysis led to consideration of the positive correlations between interaction and time, and between errors and time. Given these, it was quite possible that time, as a source of variance, could have operated to obscure the relationship between errors and interaction categories. To investigate this possibility, partial correlations were run between errors and interaction category scores, holding time constant. This yielded relationships which may be roughly considered as the correlation between verbal interaction rate, for each category, and errors per trial. The partial *r's* are shown in Table 4.

Table 4

PARTIAL CORRELATIONS OF CATEGORIES AND ERRORS WITH TIME HELD CONSTANT[a]

Category	Practice Trial	Trial I	Trial II
O_1	-.30	+.17	+.26
O_2	-.42	-.34	+.64*
O_{tot}	-.34	-.13	+.52
T_1	-.72**	-.36	-.71*
T_2	-.47	-.85***	-.79**
T_3	-.59*	-.32	-.67*
T_4	-.71*	-.68*	-.70*
T_{tot}	-.68*	-.76**	-.88***
R_3	-.16	-.60*	+.06

*$p < .05$
**$p < .01$
***$p < .001$
[a]*These coefficients were evaluated by a two-tailed test.*

Partialing out the influence of time permitted a somewhat different picture to emerge. The pattern that is most evident in Table 4 is the general negative relationship between T interaction rate and errors. This is consistent over trials with a slight tendency to increase over trials. Due to the intertrial variation of the T categories, the best estimate of their inverse relationship with errors is shown by the *r's* between T total and errors. All three of these reach significance at the .05 level or better. All of the subcategories of T relate to errors in the same manner, with varying degrees of significance. The category that gives the most consistently high correlation is T_4, "Giving Information."

The O categories apparently do not relate to effectiveness in the same manner. The correlations in the first three rows are much smaller, with only one reaching significance, that of the O_2 category in Trial II. Further, this is a positive correlation which is opposite in direction to the relationships found between errors and T interaction categories. However, in the computation of these nine $r's$, it is not unreasonable that one could have reached the .05 level of significance, purely by chance.

The main point of interest in the correlations between O categories and errors lies in the drift from negative to positive across trials. While not significant, this may be the result of a shift in balance of type of interaction that occurs as teams evolve intrateam organizations and procedures suited for handling their particular type of team task, i.e., it may well be that when teams are in the early stages of solving this kind of problem, a preponderance of organizational communication facilitates problem solution. If this were the case, the shift from negative to positive correlations over time might be indicative that some teams simply do not solve their organizational problems; a high preponderance of organizational interaction thus would be indicative not of processes which can be expected to result in increased effectiveness, but rather of organizational barriers to effective performance which result in numerous errors.

Figure 2 compares the two modes of interaction as they occur over trials. The O interaction curve is flat and low, signifying low volume and little or no variation over trials. The T interaction describes a curve of equal returns, indicating a fairly constant increase in volume over trials. A comparison of Figure 2 with Figure 3 graphically illustrates the association between improvement in team performance and increase in T interaction. This relationship seems fairly clear cut. On the average as teams go from trial to trial, their T category interaction increases steadily (Fig. 2), with a corresponding drop in the team error rate (Fig. 3). Figure 3 serves to illustrate the improvement of teams over trials.

The heavy drop in errors from the Practice Trial to Trial I is probably associated with two variables: (1) the relatively simple nature of the digit problem for Trial I, and (2) the fact that continued interaction during the Practice Trial established the team organizational requisite necessary for a more efficient resolution of the Trial I problem.

Intelligence

For a task with such an obvious cognitive element as the learning of digits, successful resolution should be related to intelligence. An estimate of the latter was available in the form of the GT score of the Army General Classification Test. For experimental teams, a Pearson product-moment correlation was run on the mean of each team GT score, and team errors, giving an r of -.60, significant at the .05 level.

COMPARISON OF INTERACTION OVER TRIALS

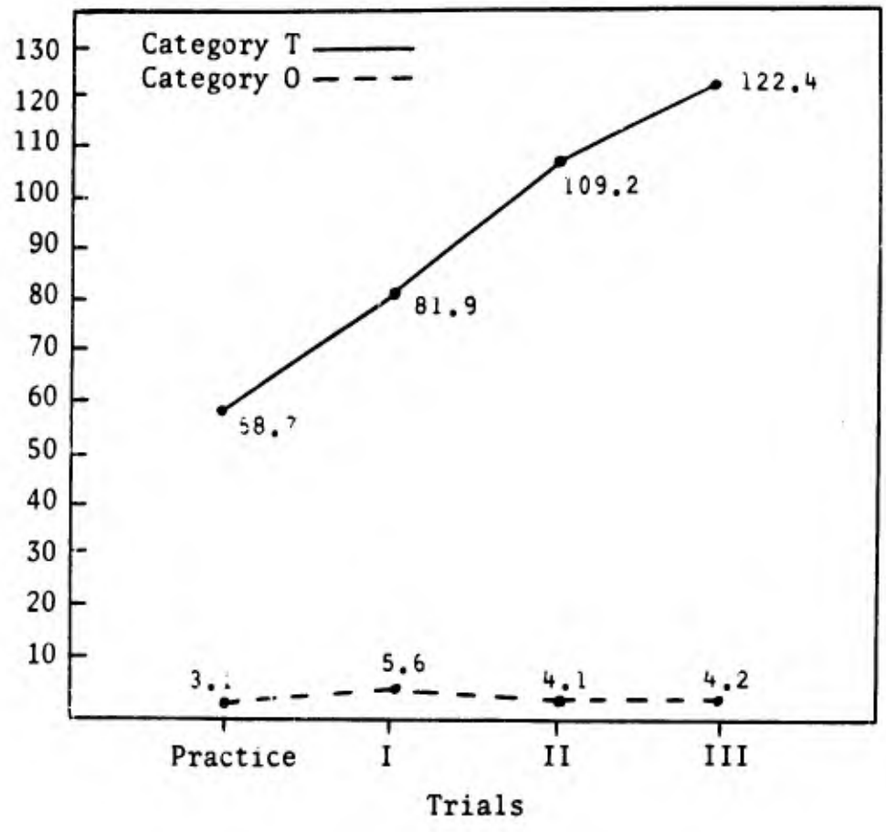

Figure 2

TEAM ERRORS

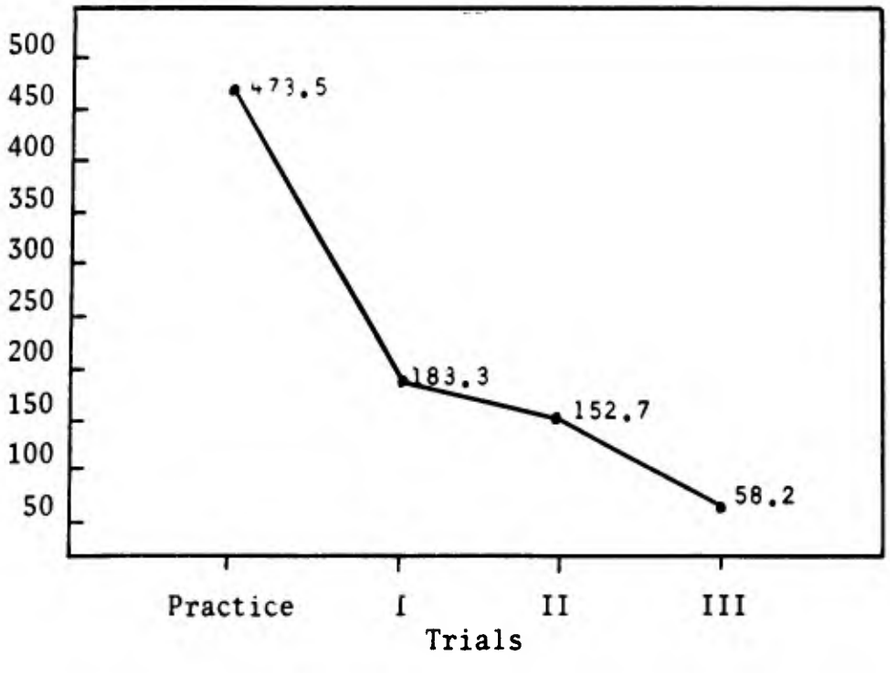

Figure 3

Task Contribution Rank

The data from the TCR form were compared with the interaction volume of each team member. After ranking the members of each team on the basis of the volume of interaction sent, and then ranking them on the ascribed status received from their teammates, a rank difference correlation was run for each team. The obtained correlations ranged from 0 to +1.00, with median *rho* of +.80. The same procedure was followed for TCR and received interaction. Here correlations ranged from -1.00 to +.95, with a median of -.32. Thus, the amount of interaction sent to teammates is significantly and positively related to the task status as ascribed by the group. However, status and interaction received seem essentially unrelated.

DISCUSSION

From the fact that the teams were less effective at the beginning of the problem sessions, it can be inferred that they were confronted with some challenging initial requirements related to internal organization. Before they could contend successfully with the task environment these internal exigencies had to be dealt with. Considering the task and the interdependency of team members, it is likely that this critical set of factors involved the adequacy of the team's procedure for the dispersion of task-relevant information. Until some procedure could be established, the team members could only emit responses independently of each other. In many, if not most, cases this involved the innumerable turning of switches by each member regardless of the setting of teammates' switches. This method of responding was noted principally in the Practice Trial. To some extent it was probably a function of inattention on the part of team subjects, since the need for coordinating responses had been stressed in the instructions.

However, as soon as interaction began to occur in volume, in later trials, there was a great reduction in these individual ventures, and a simultaneous reduction of errors. This follows from the nature of the task. In the absence of formal leadership, where one person collates information and specifies action, this function must be distributed among team members. In teams where verbal interaction does not occur freely, vital information is withheld and the probability of incorrectly turning switches is increased. The multiplication of such instances caused by a low interaction rate probably accounts for the negative correlation between volume of T interaction and errors.

The differentiation of specific categories of interaction was designed to allow specification of distinct modes of verbal behavior so that these could then be related to other dimensions of group behavior. It was expected, on the basis of the experimental work of Guetzkow and Dill (*6*), and Shure *et al.* (*8*), that the verbal behavior of groups must produce organizational structures that would allow them to solve interdependent problems. The O categories were designed to frame this mode of verbal behavior and, thus, reflect the essential organizing activity of the team.

The lack of any consistent relationship between O interaction and the criterion of team effectiveness failed to uphold this expectation. However, this study was not specifically designed to test Guetzkow and Dill's hypothesis, and thus, several alternative possibilities come to mind. First, it is possible that the category set failed to capture the organizational mode of interaction. Second, for a task with such few dimensions and such a paucity of response requirements as the group maze, the organizational requirements might be minimal, with the result that relationships would not be possible between the two variables. And third, it is possible that a structure might arise from task-specific, T interaction, by an "organization by precedent" procedure. One member, for example, might indicate through his actions (which were not categorized), or through a task-specific remark, that a certain procedure would be a feasible approach to the problem. If this action were to prove profitable, it might well be repeated by others, and so be incorporated into the organization of the group without a specific organizational proposal. However, when the drift from negative to positive correlations across trials is considered, the most attractive alternative might lie in the following: If organizational proposals and their reinforcements occur early enough in the problems, they could have contributed positively toward the integration of efforts and consequently team performance. However, this same mode of interaction continued through the subsequent trials might indicate a failure to organize or integrate. Consequently, those teams which exhibited this form of interaction in the later trials might well have been the less proficient teams. They were striving to overcome a stage of development that had already been handled successfully by the superior teams.

Interaction and Task Difficulty

In a task in which interdependent components are distributed to several team members, a condition exists where coordination is demanded. The requirement for coordinating member responses for successful performance should be increased when digit task difficulty is raised. Since, for task-oriented groups, task-specific interaction is predominantly concerned with coordination, increased difficulty should yield increased interaction of that variety. This hypothesis gains support from the data; each time a digit problem of increased difficulty was presented, the mean T interaction volume was raised. However, on the other hand, it is conceivable that the covariation of task difficulty and interaction volume reflects a relationship not yet defined. Since the development of task difficulty and the consequent coordination requirements occur over time, other possible group-dynamic factors could be emerging. To adequately test the hypothesis, an experiment would have to be designed with a group maze that included level of difficulty as a specific treatment, under full control by assigning different subjects to various levels of difficulty, rather than using the same subjects with repeated measurements and different levels, as in the present study.

Nevertheless, given the confounding of task difficulty and order of presentation, the positive relationship between team performance and the volume of task-specific intrateam interaction appears to be reasonably well established, at least for tasks of this nature. High performance teams are characterized by a high volume of interaction, mainly of the task-specific variety. Low performance is similarly linked to low interaction.

Leadership

For this type of problem, effective leadership should influence team performance, although McCurdy and Lambert (*10*) did not demonstrate any effects of leadership in their maze. They did not systematically observe interaction content. In the present study, leadership could be observed through the volume of interaction initiated. After the problem-solving sessions were over, the team members were asked to indicate their task leader (i.e., the one who contributed the most to task resolution). In most cases, the basis for making this choice appeared to be the amount of interaction initiated. Apparently, in this somewhat restricted circumstance, status was gained by providing information and feedback to fellow team members. And since the providing of task-relevant information was the vehicle of group success, then the award of status was properly given to the person most responsible for resolving the group's problem. The finding is in general agreement with the prevailing literature dealing with leadership and communication (*11*).

No clear-cut conclusions can be reached regarding the relationship between interaction received and status rank. It would not have been unreasonable to suppose that, generally, the direction of interaction should be from high status leaders to team members of generally lower, non-leader status. This rather unilateral pattern of communication would have been in keeping with the nature of the task involved. However, it was not found in the present study.

Within the limitations of the present study, the following conclusions emerge:

1. The types of verbal interaction that mediated the coordination of individual effort in the present task appeared to be of differential effectiveness. That which was geared to specific task elements was associated with more effective team performance than that which was oriented toward organizational aspects of team performance.

2. As the difficulty of the task increased, the level of verbal interaction also increased, though the confounding of trials with difficulty does not allow the conclusion that this is a casual relationship.

LITERATURE CITED
AND
APPENDICES

LITERATURE CITED

1. George, Clay E. *Some Determinants of Small-Group Effectiveness*, Research Memorandum (revised), HumRRO Division No. 4 (Infantry), Fort Benning, Ga., October 1962.
2. George, Clay E., Hoak, George R. and Boutwell, John. *Pilot Studies of Team Effectiveness*, Research Memorandum, HumRRO Division No. 4 (Infantry), Fort Benning, Ga., February 1963.
3. Bales, R. F. *Interaction Process Analysis*, Addison-Wesley Press, Cambridge, Mass., 1950.
4. Bass, B. M. *Leadership, Psychology, and Organizational Behavior*, Harper & Brothers, New York, 1960.
5. Borgatta, E. F. and Bales, R. F. "Interaction of Individuals in Reconstituted Groups," *Sociometry*, vol. 16, 1953, pp. 302-320.
6. Guetzkow, H. and Dill, W. R. "Factors in the Organizational Development of Task-Oriented Groups," *Sociometry*, vol. 20, 1957, pp. 175-204.
7. Shaw, M. E. "Some Effects of Unequal Distribution of Information upon Group Performance in Various Communication Nets," *J. Abn. Soc. Psychol.*, vol. 49, 1954, pp. 547-553.
8. Shure, G. H., Rogers, M. S., Larsen, Ida M. and Tassone, J. "Group Planning and Task Effectiveness," *Sociometry*, vol. 25, 1962, pp. 263-282.
9. Lorge, I., Fox, D., Davitz, J., and Brenner, M. "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance, 1920-1957," *Psychol. Bull.*, vol. 55, 1958, pp. 337-372.
10. McCurdy, H. G. and Lambert, W. E. "The Efficiency of Small Human Groups in the Solution of Problems Requiring Genuine Co-operation," *J. Personality*, vol. 20, 1952, pp. 478-494.
11. Sherif, Muzafer, and Sherif, Carolyn W. *An Outline of Social Psychology*, Harper & Brothers, New York, 1956.

Appendix A

TEAM INSTRUCTIONS FOR MAZE PROBLEM

Take a seat around the table.

During the problem you will work as a team.

You will notice that there are two switches in front of each of you. These are rotary switches with left and right positions. In the center of the table is a light. By turning the rotary switches to the proper setting you will be able to turn this light on. You can do this now by turning all switches to the right (PAUSE FOR THIS OPERATION). Your task during this problem will be to turn on the light whenever it goes off. This can be done by turning *only one switch* among the eight that the team has. After some practice you should learn exactly which one of the eight switches should be turned. It will not be necessary to turn more than one to get the light. You will be graded off on the number of switches you have turned unnecessarily. So try to turn the light on with the first switch that the team turns.

If you turn a switch and the light *does not* go on, you will have to turn it back to its previous position. If you don't turn it back you may never be able to get the light on.

Now remember, the object is for you to predict each time which is the proper switch to turn on the light.

Your team will have made a perfect prediction when you have turned the light on with the first throw of the switch each time it goes off. When this occurs the team can take a break.

Any questions on the task? (PAUSE AND EXPLAIN IN MORE DETAIL)

Since you will be working together as a team, it will be necessary for you to talk about the problem. You will each need to know what your teammates are doing with their switches, and you will, perhaps, want to tell what you are doing. Since you are seated with partitions between you, it will be necessary to speak loudly and distinctly so that you can be heard. You are to identify yourself before making any remarks. You are also to identify the person you are speaking to. *However*, (PAUSE), instead of using your first or last names, you are to use the phonetic version of A, B, C, or D, the letters on your cubicles. These are: ALFA, BRAVO, CHARLIE, or DELTA. Check the cards on your partitions now to see which cubicle you are in, and where each of your teammates is seated (PAUSE FOR THE TEAM TO DO THIS). Note also which switches are operated in each cubicle (PAUSE).

When you want to speak to someone around the table, identify yourself by giving your phonetic letter, tell whom you want to speak to by giving his phonetic letter (GIVE EXAMPLES OF THIS). If you want to speak to the whole team at once, identify yourself and say, "team" (GIVE EXAMPLE).

Do not speak if someone else is talking. There is plenty of time so wait for him to finish. Talk only about the problem.

As you can see (POINT TO THE MIKE), your conversation is being recorded. However, there is no need to be nervous about this. No one will hear the recordings except the experimenters.

Remember, the object is to turn on the light by selecting the one correct rotary switch and turning it. If you do not get the light by turning a switch, immediately turn it back to its previous position. If you fail to turn it back, you will be unable to get the light even with the correct switch. Admonitions:

(1) Always identify yourself when speaking by using your code name.

(2) Identify the person to whom you are speaking by his code name.

(3) Talk only about the problem.

(4) Do not talk if someone else is talking.

(5) If you turn a switch and the light does not go on, turn that switch back immediately.

Now, are there any questions about any of this (PAUSE FOR QUESTIONS)?

All right, you will now have a practice trial to familiarize yourselves with the equipment. During this practice trial you may ask any questions you wish.

Appendix B

CATEGORY SET FOR ANALYSIS OF MAZE PROBLEM VERBAL INTERACTION

0. ORGANIZATIONAL INTERACTION

Any oral interaction directly pertaining to the evolution of formation of procedural arrangements for conducting group activities. Strictly speaking, the production of the framework utilized for the guiding of interaction itself. Further, once a procedure has been suggested, anything said to promote or extend the guide line would be categorized as an organizational one. Breaking down this area or team interaction into its distinctive components produces at least four separate categories, as listed below. These can be recognized by their relatively high degree of generality. They refer to the laying out of rules that restrict behavior in a general way. They differ from the task-specific mode in that they do not require specific adjustments to task demands. The former govern only the more general organizational activities of the group members. The latter, when learned, govern the specific responses to presented cues in the task environment.

0_1. Procedural Innovation

Oral interaction that attempts to set up a pattern of task activity addressed to the group problem. These should, at the same time, take into account the interrelation of group members. This may be done by a suggestion, statement of an opinion, a downright command, that the group members act according to a prescribed procedure. The advocation of a system designed to reduce the problem or to bring the unified resources of the team to bear on it. This includes such interaction as (1) the assignment of a role or roles, (2) suggestions for accomplishing the task through modification of the communications system, (3) proposing an order of proceeding--example, "first A turns his switches, then B, and so on."

This category includes not only innovations but also any simple, verbal cognizance of a procedure that has spontaneously arisen in the course of ongoing activity.

0_2. Reinforcement or Maintenance of Procedure

This includes interaction that attempts to bring pressure on another member to conform to a previously established procedure. Any request for action that obviously attempts to instigate conformity to the established procedure. Any limitation of action, verbally applied, of another that follows from the procedure, but not following from the requirements of the task environment. For example, if a procedure specifies the turning of switches in the

order A, B, C, and D, then a direct enjoinder for C to follow B would be O_2. However, if the enjoinder for B to turn his #3 switch is obviously required because of a task-oriented judgment, then this interaction would be T_2 instead. If no mention is made of procedural requirements, the interaction would be T_2.

It includes verbal concurrence with proposed or existing procedure, agreeing to abide with the terms of a procedure. However, verbal interaction associated with overt acts that follow from acceptance of any given procedure would not necessarily be categorized thus. For example, statements like, "I'll go along with that method," will fit into this category. However, a statement like, "I am turning switch #3," by member B, albeit in accordance with a counterclockwise rotation procedure, would rather fit into a T_4 category (see below) instead. So long as the interaction is addressed to some problem of the interaction system itself, and not to task demands, it would fit in some organizational category.

O_3. Repudiation or Rejection of Procedural Innovation

Included would be any oral refusal to abide by a suggested procedure, or attempts made to set it aside. Arguments against a suggested procedure. However, a suggested alternative would be categorized in the O_1 class. An overt act that does not conform to an order, however, would not be categorized here. If accompanied by a verbal component, it would be placed in T_1 or T_2.

O_4. Motivational or Extortional to Perform Well on Task

The giving of reasons to perform well, urging on, expressions of camaraderie. Definitions of the task so that it is seen as a team goal. Specific attempts to achieve group locomotion. Example: "All right men, let's go!," "Let's try to get this one on the first try," and so on.

T. TASK SPECIFIC VERBAL INTERACTION

The interaction by which a definition of the task situation is made. Localizing and establishing the relevant environmental cues by which task-oriented activities can be undertaken. The increasing of conceptual clarity in the task area. Recognizing task requirements. Assuming some sort of interaction system, it is the bringing the resources of the group to bear on the problem so that a solution can be achieved. The recognition of an adequate solution. It is possible to conceive of four separate components that form this area of interaction.

T_1. Specifying Action for Oneself

Includes statements about what one has done or proposes to do. This also includes contingency proposals, or possible relationships between certain actions and effects. However, any response that follows a direct request for information would be categorized under T_4 (see below), e.g., "I am now turning my switch #4. This should get the light."

T_2. Specifying Action for Another

This includes direct commands, requests, suggestions that point to specific actions, e.g., "Bravo, turn your #4 switch." Any contingency proposed that includes another must be categorized thus. Influence attempts not previously categorized under O, such as a suggestion to turn some definite switch, because of a hunch or intuition about the configuration of the task itself, and whether it is or is not in conformity to accepted procedure or order.

T_3. Request for Information

This must always refer to past action and not to future acts; for example, "Which switches have you turned?" but not, "Have you turned switch #2 yet?" This latter is seen as an influence attempt and properly belongs in category T_2.

T_4. Giving Information

Detailing of past actions, or specifying future actions given as a response to a direct question, or to add to the fund of team knowledge. Any attempt to asses the problem as a whole. The recognition of an adequate solution. Summaries or over-all assessments of progress toward solution. For example, "The order of switches, so far, is as follows: 2, 7, 5, 8," or "These switches can be turned according to a definite pattern," etc.

R. RESIDUAL INTERACTION

This is the "other" category to be used if any statements do not readily fit into the preceding ones. This makes the category system an exhaustive one. Several specific types can be delineated.

R_1. Emotional Expression not Contributory to Task Solution

However, any remark prefacing or posting task-oriented interaction would be categorized with the interaction itself. Only interaction that makes no attempt to resolve task, such as pure emotional release, would be categorized here.

R_2. Non-Relevant Interaction

Extra task remarks such as, "What time do we eat?" or "Will you loan me a dime?" and so forth.

R_3. Interaction With Experimenter

Questions, remarks about the task, and the like directed to E. Also, remarks of E that further explain the purport of instructions as requested by the subject.

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Unclassified
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DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Human Resources Research Office The George Washington University Alexandria, Virginia 22314	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

INTERACTION CONTENT AND TEAM EFFECTIVENESS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Technical Report

5. AUTHOR(S) *(Last name, first name, initial)*

McRae, Adie V.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 1966	33	11

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
DA 44-188-ARO-2 b. PROJECT NO. 2J024701A712 01 c. d.	Technical Report 66-10 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. AVAILABILITY/LIMITATION NOTICES
Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Increasing Team Cohesion and Efficiency in Small Infantry-Type Units	Office, Chief of Research and Development Department of the Army Washington, D.C. 20310

13. ABSTRACT

An experiment was performed to study intrateam interaction under controlled conditions. Coordination was a prerequisite for completing a team task and verbal interaction was the sole means of coordination. All such communications were tape-recorded. Communication content was categorized into two major areas related to task demands and to organizational efforts. With time to solve held constant, number of errors correlated negatively with number of communications specifically concerned with effective response to task demands, but did not yield consistent correlations with interaction related to organizational aspects.

DD FORM 1 JAN 64 1473

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Small Groups Infantry Training Verbal Coordination Team Effectiveness COSATI Field 5						

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