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Three Models Predicting Group Productivity from Initial Individual Knowledge Certainty and Familiarity

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THREE MODELS PREDICTING GROUP PRODUCTIVITY

FROM INITIAL INDIVIDUAL KNOWLEDGE

CERTAINTY AND FAMILIARITY

by

Brother John Scileppi, F.M.S.

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VITA

Brother John A. Scileppi was born in New York City, New York, on August 30, 1946. He attended elementary school in New York City from 1952 to 1959. He attended Archbishop Molloy High School, in New York City, graduating in June, 1963. In September of the same year, he enrolled at Marist College, Poughkeepsie, New York, majoring in psychology and minoring in the natural sciences. He graduated magna cum laude in June, 1967.

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His interests lie primarily in social psychology.

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ABSTRACT

The purpose of this study was to test the effectiveness of 3 models of group productivity based on initial individual knowledge, certainty and familiarity on a vocabulary test with 2 types of test treatments, recall-recall and recall-recognition. Ss were randomly assigned to 2 experimental treatments, individual recall-pair group recall and individual recall-pair group recognition, and to 2 control treatments, individual recall-individual recall and individual recall-individual recognition. Results revealed that the rationality model in the recall-recall treatment predicted, on the average, within 2.5% of the actual group results, exactly predicting 71% of the scores of the groups, and was found to be the most effective predictor of actual group productivity. A discussion explaining the sources of error variance present in the models, and possible model modifications was included.

CHAPTER I

INTRODUCTION

From the beginnings of research on small groups, various models and theories conceptualizing and predicting group activity from prior behavior of the individual members of the group have been formulated and empirically tested.

The topics with which these models have been concerned have ranged from total over-all behavior to minute parts of group activity. For example, change in group syntality as a function of leadership has been studied by Cattell (1951), while at the same time, Bales and Strodbeck (1951) were concerned with the phases of group problem-solving as affected by the amount and type of verbal participation of the group members. The aspects or variables of individual and group behavior which have been measured in small group research have also varied greatly. Typically, in small group research, the relevant aspects of individual behavior studied have been physical attributes (age, sex, height, weight, etc.), psychomotor attributes (speed, accuracy of response quantity of response), psychological attributes (personality characteristics, introspective and observed feelings, emotions, etc.), and intellectual factors (verbal and non-verbal intelligence, aptitude and achievement). The criteria evaluating the group's activity have ranged from measurements of process to measurements of productivity; from group members' satisfaction,

cohesiveness, and participation, to the group's total output or finished product.

Various intervals along these many continua have been emphasized by groups of researchers, and many controversies, lively discussions and insightful models of group behavior have resulted. One such area of specialized research has developed in the field of small group problem-solving. Research in this field has been largely disorganized and multi-directional. Classification systems have not yet been agreed upon by all the various researchers. Most small group research therefore has been devoted to the preliminary work of determining the critical independent variables and dimensions which influence the dependent variables or criteria. While such research can be considered as preliminary attempts at formulating total theories of problem-solving, some "pockets of knowledge" have already been empirically verified, and research models have been formulated which predict or explain certain aspects of group problem-solving. The models formulated in this field have been diverse, and have emphasized different aspects of group-problem-solving. The main purpose behind most of these models was to determine the relevant and critical variables which influence group productivity.

Difficulties arose, however, as to how the various factors were to be categorized. Basically, the relevant factors include the following: nature of the task, group participation and personality factors, and initial ability.

The type of task has been categorized along such dimensions

as critical demands of the task (Roby and Lanzetta, 1958), number of stages involved in solving the task (Lorge and Solomon, 1955), difficulty of the task and the degree to which the task can be solved in many different ways (Shaw, 1963).

Steiner (1966) considered five basic types of tasks, which include most of the above dimensions. These types, based on the task demands required for completion are as follows:

1. additive tasks, or those which require each member to contribute his share to the total effort in order for the task to be completed. In such a model, productivity is equal to the summation of the individual members' efforts.

2. disjunctive tasks, or those tasks which require at least one member to contribute some knowledge, insight, or ability. In this type of task, if one member of the group discovers the method of completing the task, then the group as a whole has solved the problem. This is similar to the Rationality Model of Thomas and Fink (1961), and to Lorge and Solomon's (1955) Single-Stage Model A.

3. conjunctive tasks. In this type of task, the worst member of the group sets the production limit, and determines the rate at which the problem is solved by the group. Examples of this type of task are mountain-climbing and assembly-line tasks.

4. compensatory or pooling of resources tasks. In this type of task, usually involving some type of group judgement, each of the group members make individual judgements concerning a

particular event or course of action, and these judgements or opinions are pooled. The average judgment of the group is considered to be the group product.

5. complementary tasks. In this type of task, the problem is divided among the various group members. Each member does that part of the task which he can do best. A joint or integrative effort is needed to complete the task, in which each member contributes his complementary ability to the group. Since this type of task is composed of many steps and parts which must be completed before the group can successfully complete the task, this type of task is similar to Lorge and Solomon's Multi-Stage Model "B".

Steiner (1966) has devised an over-all model which can be applied to any of these task types. The actual productivity of the group is equal to the potential resources of the group which can be brought to bear on the problem minus the loss due to the inhibiting effects of the group interaction process, which is caused by an overlap of pertinent knowledge or a lack of group coordination or a lack of motivation of the members or other personality variables. The resources factor of productivity can be predicted mathematically from the type of task that the group is attempting to complete and from some knowledge of the ability of the individuals in the group. The loss is basically unpredictable, and adds to error variance of the experimental data. Some loss however, is due to excessive

conformity, and this can be predicted. A discussion of this situation appears in the group participation factors section. Any profit(ie. actual productivity exceeding the maximum potential resources available to the group) is also unpredictable. In these models, therefore, Steiner actually assumes that each member will contribute his full (relevant) ability to the group in its attempt to complete the task. If the group productivity is to be predicted from prior individual productivity of the members of the group, it is assumed that the contribution of any member on the group test will be equal to his contribution on the prior individual test. That is, the model assumes no change in the demonstrated ability of the group member between the two tests. Any change in ability becomes error variance. Steiner's model therefore can be restated as total productivity equals potential resources plus error variance.

Shaw (1963) applied the method of factor analysis to existing pertinent research, and found that there were basically six classes of task dimensions which were relevant to group productivity. The three strongest or most important variables were task difficulty, or the amount of effort needed to complete the task; the multiplicity of solution or the degree to which a problem can be solved in more than one way; and the cooperative requirements of the task, or the degree to which integrative joint action of all the group members is required to solve the problem. Three weaker factors mentioned by Shaw were intellectual versus manipulative requirements of the task, population famili-

arity with the task and the intrinsic interest of the problem
due to its nature or content.

Another major factor which affects group productivity and
therefore the models predicting productivity is the type of group
participation and the personality variables of the group members.
Group participation can be experimentally determined by controling
the possible channels of communication among the group members.
Shaw (1954) has set up elaborate communication networks between
the group members and he found that by varying the network, and
the information flow between group members, the productivity of
the group is significantly affected. Less elaborate methods of
experimentally varying group member interaction have been used by
many experimenters. One such method involves limiting the amount
of discussion allowed to the group. For example, Laughlin and
Doherty (1967) have found significant differences in productivity
between discussion and no-discussion groups working on a concept-
formation task. Through discussion, it is theorized, a group
member can explain his attempts at finding a solution to the
problem, and the other group members can comment on his rationale
and logic, and possibly improve upon the solution, ommitting the
errors in judgment overlooked by the originator of the solution.
Allowing for discussion however does not per-se increase group
productivity. The composition of the group in terms of the group
members' personality types is an interacting factor. If the group
members have an excessive need to conform and desire a swift

consensus of opinion, productivity can actually decrease. Thomas
and Fink (1961) have mathematized this situation in their
Consensus Model. They state that, to the extent that the group
desires an early consensus of opinion concerning the solutions to
the task, the group productivity decreases if the majority has
solved the task correctly, and will increase if the majority
opinion is correct. The probability that the majority will respond
correctly is a function of the probability that an individual will
respond correctly, the latter being empirically verifiable, given
the population from which the group members were chosen .
Therefore, the change in productivity in situations amenable to
the Consensus Model depends primarily upon the probability of
obtaining the solution to the problem. The factor of consensus
would not be present if discussion was not permitted during the
early problem-solving stages. Similarly, if discussion was forced
or demanded by the experimenter for a long time-period, desire
for early consensus would have been overcome, and its influence
on productivity would decline. Also, one's familiarity with the
task and one's certainty that his solution is correct could alter
the type and amount of discussion and consensus. Therefore, it
can be seen that there are many factors which interact with group
participation affecting productivity.

Personality factors also interact with group atmosphere and
group participation factors and influence productivity. Ghiselli
and Lodahl (1958) found that, in structured groups requiring a

supervisor, the distribution of the trait of decision-making among the group members affects group productivity, and others such as Haythorn (1953), Hoffmann and Maier (1961), and Mc Ginnies and Vaughan (1957) have found that such personality variables as heterogeneity of the group members in terms of dominance-submissiveness, socio-economic status, extroversion-introversion, and degree of adjustment have interacted with group participation and have affected group productivity on a variety of tasks and situations. Mann (1959) provided a good review of the literature in the area.

Two personality variables studied in this experiment were certainty and familiarity. Although research on these two factors is slight, some findings have been reported. Mc Ginnies and Vaughan (1957) found that high familiarity with a discussion topic correlated positively with participation rate, which influences productivity. Johnson and Torcivia (1967) found that, in two-member groups, given a complementary task, in which the partners disagreed concerning the solution to a problem, the group response came from the member who was correct and more certain of the correctness of his solution than his partner.

These variables therefore are the relevant variables affecting group productivity, and any model attempting to explain or predict group activity should take into consideration as many of these variables as possible, and all research testing these models should specify the experimental conditions of the research, in dimensions relevant to these variables, using some popular

classification system such as Shaw's (1963) or Steiner's (1966), (cf.pp3-5).

With the preceding as a background, the general purpose of this research was to test various models of problem-solving to determine the best predictor of group productivity from prior individual testing.

The test instrument used was a twenty word vocabulary test. The twenty words were chosen from different disciplines of the arts and sciences, and from the general college vocabulary. therefore, by Steiner's classification, each test item could be considered as a disjunctive task, whereas the test as a whole could be viewed as a complementary task. By Shaw's classification of major factors, the items ranged from medium to high difficulty for the population tested, and each item had only one correct meaning, to avoid solution multiplicity. The group task required cooperation on the part of the group members to the extent that the group was instructed to arrive at one solution for each word, implying a requirement of consensus. Since the groups were all two member groups, there was no majority forcing a consensus. By Lorge and Solomon's Classification system, each test item represented a single-stage task. The test words were chosen so as to provide one major task obstacle Collins and Guetzhow, 1964) for each word, which if overcome, would provide the correct solution to the item. An aspect of the test involved the recognition of a synonym or antonym of the test word by the group. Here again, the single-stage nature of

the task item was preserved by having the synonym (or antonym) be
a word of low difficulty for the population, and the relation
between the test word and its synonym (or antonym) be of low diff-
iculty if, and only if, the meaning of the test word (of high
difficulty) was known.

With respect to group participation variables, the group
members were allowed as much discussion as they desired, with the
only condition being that they did not interfere with other groups
in the experimental room. There was no set time limit, and thus
the group was not forced to arrive at an early consensus. The
general testing atmosphere was relaxed and informal.

The personality variables measured were related to the indiv-
idual group member's initial a) knowledge of each of the test
items (as demonstrated by giving a short definition of each word);
b) certainty of their knowledge of each item; and c) familiarity
with each word ("b" and "c" measured by appropriate rating scales).
Other personality variables were assumed to be normally distri-
buted with their effects cancelling out, so as not to cause the
research models to be overly unwieldy or incomprehensible.

With these experimental conditions, the research models were
as follows: a) a rationality model (Thomas and Fink, 1961), a
certainty model, and a familiarity model for recall-recall treat-
ments, and b) a modification of the preceding models in the recall-
recognition treatments to allow for guessing responses in a two-
choice recognition test.

The specific models to be tested were as follows:

Ia. Rationality model. In this model, when either or both members of the group responded correctly to a particular test item on individual prior testing, the group responds correctly to that item, in recall-recall treatments.

b. Rationality model, plus an equal chance factor (Rationality + 50/50). In the recall-recognition treatments, the group responds correctly on those items covered by the rationality model, plus one-half of the remainder of the test items.

IIa. Certainty model. In the recall-recall treatments, the group responds correctly a) on those items in which both members of the group responded correctly on individual prior testing, plus b) on those items in which one member responded incorrectly and the other scored correctly and was more certain than his partner that his response was correct (based on individual prior testing).

b. Certainty model, modified by an equal-chance factor (Certainty + 50/50). In the recall-recognition treatments, the group responds correctly on those items covered by the certainty model, plus one-half the remainder of the items on the test.

IIIa. Familiarity model. In the recall-recall treatments, the group responds correctly a) on those items in which both members of the group responded correctly on individual prior testing, plus b) on those items in which one member responded incorrectly, and the other scored correctly and was more familiar with the particular item than his partner, based

on individual prior testing.

b. Familiarity, modified by an equal chance factor (Familiarity + 50/50). In the recall-recognition treatments, the group responds correctly on those items covered by the familiarity model, plus one-half of the remainder of the items on the test.

The purpose of this experiment was to test the relative effectiveness of these models in the two different types of task situations.

CHAPTER II

METHOD

Subjects

Subjects were 160 naive students enrolled in undergraduate psychology courses at Loyola University, Chicago. Most of the subjects (141) participated in the experiment as a partial fullfillment of an experimental requirement of the course, while the remainder (19) participated in the experiment during their regular class periods.

Materials

(a sample of the test used in this study appears in the Appendix)

The tests used in this experiment were devised solely for the purpose of this study. Each test consisted of 20 words of varying difficulty which were chosen from the various fields of the arts and sciences. Following each word was a space for the definition of the word, and on the next two lines were two five point rating scales, one for certainty, and the other for familiarity. The certainty scale ran from low certainty, defined as pure guess (1) to extremely certain (5). The familiarity scale ran from low familiarity, defined as "never seen word before" (1), to very familiar, defined as "seen word very often" (5). In addition, two modified forms of this test were used in the second session of this study. Both forms consisted of the same 20 words as the basic test. The first modified form was of a recall type, listing the

20 words alphabetically, leaving a blank space for a definition
after each word. The second form was of a recognition type in
which each of the 20 original test words was followed by an
appropriate synonym or antonym. The synonym or antonym was chosen
so as to preserve the single-stage nature of the task. (For a
discussion of this aspect of the instrument, see pages 9 and 10.)
In addition, to guard against any error variance caused by Ss with
tendencies to respond more to synonyms rather than antonyms or
vice-versa when guessing, an approximately equal number of correct
synonyms and antonyms was provided. Guessing itself was factored
into the research models, based on equal-chance probabilities.
The 20 words were presented alphabetically, as in the recall
modified form.

Procedure

The experiment was divided into two treatments, each composed
of two sessions. The two treatments were recall-recall and
recall-recognition.

The first session of both treatments was identical, and
consisted of the following. The Ss were handed a three page test-
booklet, as previously described, and were instructed to read the
directions on the first page, and then to procede to the actual
test on the following two pages. The Ss were asked to give a
definition for each of the 20 words, and then rate their degree
of certainty that their definition was correct. In addition, the
Ss were required to indicate their degree of familiarity with each
word. If a S was unable to give a definition for a particular

word, he was instructed to leave the definition space blank, and to circle #1 of the certainty scale (pure guess), and #1 of the familiarity scale (never seen word before). This test was taken individually by each S. Although there were no set time limits, the test required about 25 minutes. E collected the test booklets after all the subjects were finished.

The second session began immediately after the last test booklet of the first session was collected. The Ss were instructed to "pair up" into like sex, two-member groups. They were informed that the next test they were to take was to be solved through group discussion, and the completed test was to be a group product The Ss were instructed to discuss the test as much as they desired but in a manner so as not to disturb the other groups in the room, and they were instructed to arrive at only one group answer for each word. The pair groups were then given the test form. Half of the groups were given the modified recall type, while the rest received a synonym-antonym recognition type test form.

Those Ss, who in the pairing process, were left without partners took one of the two test forms as the other Ss, but they were instructed to complete the test individually, as in Session I These subjects served as controls for the two group treatments.

Again, as in Session I, this session lasted about 25 minutes, and as before, no time limit had been set. When the last group completed the test, the forms were collected, and the Ss were de-briefed as to the purpose of the test. After all questions were answered, the Ss were requested not to divulge any information

about the experiment to other students who might later be included
in the study until all the research has been completed.

CHAPTER III
RESULTS

Recall-recall treatment

For the recall-recall treatment, the predictions of the
models were compared to the actual results obtained from the 36
groups. The mean absolute difference between the results and the
predictions of each of the models are presented in Table 1. The
absolute values of the obtained results minus the predicted
estimates were given so as to indicate the amount of deviation
between the models and the results occurring in either direction.
The standard deviations provide an indication of the amount of the
variation of the discrepancies. It was observed from Table 1 that
the rationality model was the best of the three predictors, in
that this model most closely fit the obtained data. From the in-
formation presented in Table 1, the rationality model, with a mean
absolute discrepancy of .5 items per group and a standard deviat-
ion of .5 items, can predict the actual group score within two
items in either direction, with an accuracy of 99.9%. The cert-
ainty and familiarity models were somewhat less accurate in their
predictions of group productivity.

Also, the certainty and familiarity models appeared to
consistently under-estimate the actual group results. From the
data presented in Table 2, it can be seen that neither model over-
estimated the actual results for any group, and that each model
under-estimated the obtained results in over 90% of the groups
tested.

The predictions of the rationality model, however, were more accurate. Over 60% of the scores of the groups were predicted exactly by this model, with the remainder of the total scores, equally over-and under-estimated. A discussion concerning the reasons why the certainty and familiarity models consistently under-estimated the data,while the rationality model did not, is presented in the next chapter.

The first two tables appear to present somewhat contradictory data. In Table 1, the mean (absolute) predictionsof the three models were shown to be somewhat similar in that all were within about two items per group of each other, and that the mean of the least accurate predictor, familiarity, was still within 2.5 items out of a possible 20 per group of the actual group scores.Table 2, however, shows that the trend toward a single direction of error of prediction of the familiarity and certainty models was not evident in the rationality model. A problem therefore arose as to whether these three models were identical to each other, or do they differ with respect to their actual predictions. In order to solve this problem, Table 3 was compiled. The t-test for the significance of differences between correlated means (Guilford, 1964) was used, since each of the predictions of the models were based on the same data from the same individuals, and were used to predict the same group scores. From the information presented in Table 3, the rationality model appeared to be definitely different from either the certainty or the familiarity models (p < 001) in predicting the total group scores, and also, the

prediction of the certainty model tended to differ from the familiarity model predictions, but not significantly ($\underline{df}$=35, $\underline{t}$=1.970, $\underline{p}$<.1). Therefore the three *models* were not identical in their predictions for each group score, but summed over all the 36 groups that participated in the recall-recall treatment, each model predicted, on the average, within three items per group of the group score.

Recall-recognition treatment

The results obtained from the 28 groups that served in the recall-recognition treatment paralleled to some extent, the results of the recall-recall groups. Due to the nature of the two-choice group recognition (synonym-antonym) type test, a correction factor was incorporated into the three models in order to account for guessing when neither member of the group scored correctly, on a particular item. This correction factor is based upon equal chance probability that the group will respond correctly on 50% of the items under these conditions, and the factor is therefore called a 50/50 chance factor. (cf p. 10)

Tables similar to those presented for the recall-recall treatment data were compiled. Table 4 consists of the absolute means and standard deviations of the discrepancies between the predictions of the three models and the criterion, total group scores. Table 5 shows the percentage of predictions of the models which deviated from actual results in both the under-predicted and the over-predicted directions, and the percentage of predictions which estimated the group scores exactly. Table 6 serves as an

indication of the significance of the differences between the predictions of the various models.

Table 4 shows that the mean absolute discrepancy between the predictions of all three models and the actual group scores was less than two items per group out of a possible 20. The rationality + 50/50 model was less accurate than its counterpart in the recall-recall treatment, the rationality model. The certainty + 50/50 model and the familiarity + 50/50 model were slightly more accurate than their counterparts in the recall-recall treatment.

The trend toward under-estimation of the actual group results by the models continued, but was not as pronounced as it was in the recall-recall treatment models. The rationality + 50/50 model exactly-estimated only 15% of the actual group results, approximately 46% less than the rationality model exactly-predicted. The percentage of exact-estimation of both the certainty +50/50 model and the familiarity + 50/50 model were slightly less than the models parallel to them in the recall-recall treatment.

As in former treatments, t-tests of the significance of the differences among the predictions of the three models were compiled. Only the predictions of the certainty + 50/50 model and the familiarity + 50/50 model differed significantly (df=27, t=2.055, p<.05), with the certainty model as the more accurate predictor. Possible reasons for the lack of significant differences among the remaining pairs of predictions appear in the discussion chapter.

TABLE I

The Means and Standard Deviations of the Absolute Discrepancies[A] between the Predictions of Each of the Three Models and The Observed Results[B]

	Rationality	Certainty	Familiarity
Mean	.5	2.2	2.5
SD	.5	1.4	1.5

A. Measured in number of test items per group (|observed minus predicted|)

B. Based on $N=36$ pair groups of recall-recall treatment

TABLE 2

The Percentage of the Group Total Scores Which the
Predictions of the Three Models Over-estimated,
Exactly-estimated and Under-estimated the Observed
Results

	Rationality	Certainty	Familiarity
Over-estimated	19%	---	---
Exactly-estim.	61%	6%	3%
Under-estimated	19%	94%	97%

TABLE 3

t-Ratio of the Difference Between the Predictions

of Each of the Three Models for 36 Groups in the

Recall-Recall Treatment

	t-Ratio
Rationality and Certainty	9.415
Rationality and Familiarity	12.323
Certainty and Familiarity	1.970

df=35; p=.05, t=2.030; p=.01, t=2.724; p=.001, t=3.64

TABLE 4

The Means and Standard Deviations of the Absolute

Discrepancies[A] Between the Predictions of Each of

the Three Models and the Observed Results[B]

	Rationality + 50/50	Certainty + 50/50	Familiarity + 50/50
Mean	1.6	1.4	1.6
SD	1.8	1.2	2.0

A Measured in number of test items per group

  (|Observed minus predicted|)

B Based on N=28 pair groups of recall-recognition

  treatment

TABLE 5

The Percentage of the Group Total Scores
Which the Predictions of the Three Models
Over-estimated, Exactly-estimated and
Under-estimated the Observed Results

	Rationality + 50/50	Certainty + 50/50	Familiarity + 50/50
Over-estimated	21%	21%	21%
Exactly-estimated	15%	4%	
Under-estimated	64%	75%	79%

TABLE 6

t-Ratios of the Difference Between the

Predictions of Each of the Three Models for

28 Groups in the Recall-Recognition Treatment

	t-Ratio
Rationality + 50/50 and	
Certainty + 50/50	1.123
Rationality + 50/50 and	
Familiarity + 50/50	.080
Certainty + 50/50 and	
Familiarity + 50/50	2.055

df=27; p=.1, t=1.703; p=.05, t=2.052

CHAPTER IV

DISCUSSION

The three basic models and their modifications predicted the actual group scores in both the recall-recall and recall-recognition treatments respectively with a percentage of mean absolute discrepancy ranging from 2.5% to 15% of the total group scores. The Rationality model, which was based on a model of the same name devised by Thomas and Fink, was the most accurate model. The remaining models were modifications of the basic model, and none was as good a predictor of group productivity as this model. The modified models however were more accurate predictors than the rationality model under certain conditions, peculiar to each of these models. For example, in both the certainty and familiarity models, as one member of the group became more certain or more familiar on a particular item relative to his partner, the accuracy of prediction of these models increased greatly; and in the case of the familiarity model, at a maximum difference in familiarity between the partners in a group, the accuracy of prediction reached 100%. This condition of maximum difference in familiarity (ie. on individual prior testing, a difference of four points of the familiarity scale on a particular item, or one member of the group having a familiarity of five points, his partner having a familiarity of one unit on a certain item) occurred only 13 times

out of 720 items in 36 groups, and was therefore too small a frequency to report in the results section. The certainty and familiarity models therefore predicted well, provided that the differences between group members in their certainty or familiarity on a particular item was relatively high, but this was counteracted by the finding that the larger the difference, the lower the frequency of occurrence. In future models based on the difference in certainty or familiarity of a particular word item between the group members, this factor of the degree of difference might be taken into consideration in forming a better or more accurate predictor of group productivity. A large cause of much error variance in both the certainty and the familiarity models was that in a large population of the items, there was no difference in familiarity or certainty between the two group members. This situation occurred in approximately 60% of the items in which one member of the group responded correctly and the other member responded incorrectly on individual testing. Both of these models were to predict the group outcome on the basis of the more familiar or more certain member "wins". Because of the large percentage of cases involved, it was operationally decided that in those items in which there was no difference in certainty or familiarity, the respective models would predict that the group would respond correctly in one-half of these items. This correction factor aided the prediction accuracy to some extent, yet the actual group results show that the group responded correctly in over 85% of these items, 35% greater than predicted. The rationality model

however predicted that the group would respond correctly on 100%
of these items, thus over-estimating the group response in this
instance. Most of the error variance present in the certainty and
familiarity models was therefore due to this factor, since neither
model could make accurate differential predictions in such cases.
Discounting this error factor, both models would have predicted
correctly approximately 95% of the remaining data in the recall-
recall treatment, and about 85% of the scores in the recall-
recognition treatment, which would have made both models in both
treatments about equal to the rationality model of each treatment
with respect to accuracy of prediction. The rationality model, as
noted before was not affected by this factor of no differences.

In the recall-recognition treatment, another error factor
which caused the decline in the accuracy of prediction of all the
models was the effect of guessing in cases of no expressed prior
knowledge. The correction factor of equal chance prediction incorp-
orated into each of the models in this treatment for the items in
which both members of the group responded incorrectly on individual
prior testing was only a crude estimate of the actual group res-
ponse. Of the items affected by this factor, the group responded
correctly to approximately 65% of these items, rather than the 50%
predicted. Also, neither initial individual certainty nor
familiarity was a more accurate predictor of the group scores.
This large chance factor also accounted for the lack of signifi-
cance of the differences among the predictions of the models, since
this factor was common to all three models, thus lowering the

proportion of true variance which was not common to all three
models. It was theoretically assumed that familiarity would have
been a better predictor of group productivity in such cases in
which an individual could not supply a definition of a particular
word on the initial recall test, but if he had seen the word used
before, he might recognize a synonym or antonym for that word, and
respond correctly to that item in the recognition test. Therefore
it was hoped, high familiarity coupled with low expressed
knowledge might have predicted a correct group response. From the
group results however, it appeared that if an individual could not
supply a definition for the word, he would rarely respond that he
was familiar with the word. However, on the recognition test, he
would see the synonym or antonym of the word, understand the
meaning of the word, then recognize the word as being familiar,
and finally respond correctly to it. In other words, expressed
familiarity appeared to be more a result of knowing the meaning of
the word, rather than a prediction of knowledge.

Another possible source of error variance in both the recall-
recall and the recall-recognition treatments was demonstrated by
the data compiled from the individual control groups for both
treatments. The models used in this study assumed no change in
knowledge between the first session and the second session which
immediately followed the first. It was found, however, that in the
control group which had taken both recall tests individually,
there was a 3.1% increase in correct responses which indicated a
small net change in expressed knowledge. This factor alone could

explain over 50% of the error variance found in the predictions of
the rational model in the recall-recall (group) treatment. Any
correction factor for this error variance would have to be based on
the assumption of small random increase in individual ability, an
assumption at variance with both the present models and Thomas and
Fink's models. It would seem unlikely that present-day mathematical
models could accurately predict the occurrence of this factor. A
net increase of 16% in correct responses occurred between sessions
of the recall-recognition treatment control group, which paralleled
the increase already noted in the recall-recognition (group)
treatment.

Another factor affecting the results of the study was the
degree of difficulty of the items. In the introductory chapter,
it was stated that the item difficulty varied from average to high
difficulty. This assumption was confirmed by the data in that the
least difficult word, pachyderm, was responded to correctly by 52%
of the individuals in the initial recall test, and the most diff-
icult word, impasto, was responded to correctly by approximately
1.5% of the individuals on the same test. This level of difficulty
was chosen so as to avoid any ceiling effect factor which would
have decreased the accuracy of prediction of the models. Some
of Goldman's (1965) research had previously been adversely
affected by such a factor. In the present study, the fact that no
individual received a perfect score of 20 correct items on the
recall test demonstrated that this effect was not a factor
influencing the results of this experiment.

Upon reviewing the data compiled for each test item, it was noted that two test words, pyromania and ruth, were responded to in a manner different from the rest of the words. Groups which, on individual testing, were composed of only one member responding correctly to the word, pyromania, often would respond incorrectly to the word on the group test, in both the recall-recall and recall-recognition treatments. A similar effect was noted in the word, ruth. Both of these words added a much greater than average share of error variance and therefore decreased the accuracy of prediction of all six models. One explanation of this differential response might be that both of these words are not true single-stage but two-stage tasks. In the word, pyromania, the $\underline{S}$ must first recognize that "pyro-" means fire, and "mania" means an excessive love of-. Many $\underline{S}$s would incorrectly define pyromania as a fear of fire, thereby succeeding on one stage and failing on the other stage. In cases in which one member of the group responded to pyromania as fear of fire and the other responded correctly as love of fire, the group would often adopt the wrong response. Similarly, the word, ruth, derived from its more common antonym, ruthless, means merciful. It was often the case that an individual or group would note the similarity between the words ruth and ruthless, and would define ruth as ruthless. This word also required two-stages, therefore; first to note the similarity of the two words, and then to recognize that the two words were actually opposite in meaning. Again, in cases in which only one member responded correctly and the other incorrectly, the group would

respond incorrectly to the word more often than they would respond incorrectly to other items of the test (in similar circumstances). Furthermore, an opposite trend was noted for the word, ruth, in those groups in which both members responded incorrectly and differently on individual prior testing. It appears that in such cases, discussion resulted due to a lack of consensus, and the group recognizes the relationship between ruth and ruthless, and more often than for other words (in these circumstances), the group responds correctly to this item. This word accounted for approximately 25% of the error variance of the models that occurred in these situations, for the groups involved in the recall-recall treatment. The error variance due to this factor was more pronounced in the recall-recognition treatment since the synonym-antonym recognition test listed antonyms for both of these words, namely "fear of fire" for pyromania and "merciless" for ruth. It is quite possible that in groups composed of members in which one member correctly solved both stages of the word-task, and his partner only realizing one stage and therefore responding incorrectly on individual prior testing, the discussion which ensued may have been influenced by the presence of the incorrect member's solution on the test form, and as a result, the group might have responded incorrectly. The relative degree of familiarity, and to a lesser extent, certainty, of the members of the group predicted the group outcome in a few of these cases, but the accuracy of prediction was not high due to a large number of cases in which there was no difference in degree of certainty or familiarity for this item. The test

instrument would probably have been a better means of evaluation of these models had these two items been eliminated from the otherwise homogeneous single-stage test.

It should be noted that these models were only tested in these two treatment conditions. It is quite possible that the predictions of the models may have been more accurate in other treatments, such as individual recognition-group recall and individual recognition-group recognition treatments. It would be expected that in both of these treatments, a familiarity model may predict more accurately than in the present study, since the synonym or antonym of the word item may help an individual to remember having contact with the test word before, and he might recall the meaning of the word as a result. This trend toward greater accuracy of these and other models however in such a treatment might be reversed due to a large chance factor which would have been present in the pretest from which the predictions of the models were made, thus influencing the ability of the model, since many of its predictions would be the result of guessing and response sets.

Also a possible alteration in the recognition aspect of the test might be to change from a two-choice situation to a multiple-choice situation. While this might increase the accuracy of prediction of a certainty or familiarity model, since the more certain a person is in choosing one out of many choices, the greater the probability of the group accepting his response, particularly if the other members have not been able to make a definite choice

among the alternative responses; such a situation would not be in agreement with the law of parsimony and a greater amount of error variance would result due to chance factors. In such preliminary research as model-building, it would seem best to remain with the simplest case of the model.

Finally, it should be emphasized that the models in this study did predict the group productivity very accurately, compared to random prediction models, and even other research in the field, but there were sources of error variance due to the testing apparatus and the basic underlying assumptions of the models, which, if eliminated, could increase the accuracy of prediction of the models These sources of error variance have been explained previously, and possible methods of eliminating them have been suggested.

The better treatment, based on the degree of accuracy of prediction of the set of models in that treatment, was the recall-recall treatment, since it eliminated many chance factors present in the other treatment; and the most accurate model was the rationality model in the recall-recall treatment, which predicted within 2.5% of the criterion, group productivity. This model had the greatest content and construct validity, by inspection of the test items and the compiled data, and can be expected to be the bases for much future research involving group productivity on a single-stage task. The remaining models had strong theoretical potential, and may predict group productivity more accurately, if chance factors could be reduced or eliminated.

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Initial Individual Recall Test Form, Page 1

VOCABULARY TEST

This test is designed to find out how well you know the following words. If you know the meaning of the word, please give a short definition of the word on the line provided for the definitions.

In addition, indicate how <u>certain</u> you are that your definition is correct by circling a number from 1 to 5 on the line marked <u>certainty</u> as follows:

CERTAINTY   1   2   3   4   5

            pure guess   moderately   extremely
                                    certain   certain

Also, indicate how <u>familiar</u> you are with the word (that is, how many times you have seen the exact word before) by circling a number from 1 to 5 on the line marked <u>familiarity</u>:

FAMILIARITY   1   2   3   4   5

            never seen seen word seen word seen word seen word
            word before rarely   occasionally often   very often
         (low familiarity)   (High familiarity)

For example:

Surrender
a) definition: to give up, to yield
b) certainty   1   2   3   4   ⑤
c) familiarity 1   2   3   4   ⑤

On the first line, the student gave the definition of the word. On the second line, he indicated that he was very certain that his definition was correct. Finally, on the third line, he indicated that he was very familiar with the word, and that he had seen it before very often.

Now, answer the following 20 items.

Initial individual recall test form, page 2

1. numismatics
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

9. assuage
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

2. intrepid
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

10. tonsorial
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

3. abash
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

11. prestidigitation
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

4. abscond
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

12. pyromania
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

5. adroit
definition :

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

13. perambulate
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

6. caliper
definition:

14. cryogenics

Initial individual test form, page 3

17. proliferation
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

18. embellish
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

19. pachyderm
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

20. impasto
definition:

Certainty: 1 2 3 4 5
familiarity: 1 2 3 4 5

<u>Group recall test form, recall-recall treatment</u>; also,

Individual recall test form for the second session of the control

group of same treatment. ████ TEST

Directions: This test is designed to measure group

ability. The group is to discuss each of the following

words and arrive at a single group definition of each

word.

1. abash:

2. abscond:

3. adroit:

4. anathema:

5. assuage:

6. caliper:

7. cryogenics:

8. distal:

9. embellish:

10. impasto:

11. intrepid:

12. numismatics:

13. pachyderm:

14. panacea:

15. perambulate:

16. prestidigitation:

17. proliferation:

18. pyromania:

19. ruth:

20. tonsorial:

Individual recognition test form for the second session of the control
group of the same treatment.

SYNONYMS AND ANTONYMS

Directions: This test is made up of pairs of words which have
either the same or opposite meaning. If two words mean the **same**
or nearly the same, circle the letter S . If the two words mean
the **opposite** or nearly the opposite, circle the letter O.

abash...embarrass	S	O
abscond...triumphant entry	S	O
adroit...dull	S	O
anathema...blessing	S	O
assuage...ease	S	O
caliper... measure of thick-ness	S	O
cryogenics...hot	S	O
distal...proximal	S	O
embellish...decorate	S	O
impasto...thick paint	S	O
intrepid...fearful	S	O
numismatics...coin-collecting	S	O
pachyderm...small mouse	S	O
panacea...remedy	S	O
perambulate...stroll	S	O
prestidigitation...magic	S	O
proliferation...rapid growth	S	O
pyromania...fear of fire	S	O
ruth...merciless	S	O
tonsorial...barber	S	O

APPROVAL SHEET

The thesis submitted by John A. Scileppi has been read
and approved by the director of the thesis. Furthermore, the
final copies have been examined by the director and the
signature which appears below verifies the fact that any
necessary changes have been incorporated, and that the thesis
is now given final approval with reference to content and form.

The thesis is therefore accepted in partial fulfillment of
the requirements for the degree of Master of Arts.

November 11 1968

Date

James H. Johnson Ph.D

Signature of Adviser