ABSTRACT
          The purpose was to determine the effect of group size
on both the total and the average per person fluency, flexibility,
and originality of responses to problem solving tasks. One hundred
sixty-three college juniors and seniors were assigned at random to
groups of one, three, six, or twelve members. All groups were given
identical instructions to respond aloud to three problem-solving
tasks. Results showed that as group size increased, so did the total
group fluency, flexibility, and originality; however, groups with
three members were statistically indistinguishable from groups with
six members. In terms of flexibility, six-member groups generated no
more categories of responses than did twelve-member groups. Results
also showed that as group size increased, the per-person contribution
tended to diminish, and that groups of six or of twelve members
appear to inhibit per-person contributions equally. (DT)

Fluency, Flexibility, and Originality as a Function of Group Size[1]

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Introduction.

Research in the area of creativity training has generally shown that group productivity surpasses individual productivity (Owen, Renzulli, and Callahan, 1972; Torrance, 1970, 1971; Taylor and Faust, 1952). However, there seems to be some question about the optimal size for groups who are engaged in brainstorming or creativity training sessions. Osborn (1963, p. 159) has hypothesized that "as to the size of a brainstorming group, the ideal number is about a dozen." Arnold (cited in Osborn, 1963; p. 42), on the other hand, proposed that an individual can form a brainstorming "group" with himself as an only member with the hypothe- sized advantage of the elimination of external standards. He suggested that some people simply do not need a group to encourage them to think in a highly fluent manner. Neither Osborn nor Arnold offered any empirical evidence to support these assertions.

Research dealing with group productivity has centered around two major issues. First, does the mutual stimulation which results from group interaction bring about the generation of a greater number of ideas or responses to a given problem (i.e., increased fluency)? A second issue related to group productivity studies deals with the quality or originality of responese emanating from group problem solving situations. Taylor, Berry, and Block (1958) found that while fluency increases in group situations, a larger number of unrepeated ideas were produced by

individuals when working alone than by those working in groups. These researchers concluded that group conditions may have the effect of channeling thinking in similar directions and thereby reducing the flexibility and originality of responses.

Several studies have attempted to investigate the function of group size in creative problem solving. South (1927) investigated some of the psychological aspects of committee work using groups of three and six. He found that groups of three were more efficient in dealing with abstract problems while groups of six performed more efficiently with concrete problems. South concluded that the abstract problem solving situation was more efficient in smaller groups because the resolution of abstract problems required a compromise, and that compromise was more easily reached in smaller groups. In a study dealing with the effects of group size and threat reduction on creativity in a problem solving situation, Gibb (1951) reported that as group size increased, all group members reported a feeling of threat or inhibition of their impulses to participate. Gibb's results suggested that solutions to a problem increased as a negatively accelerated function of group size. Taylor and Faust (1952) found that four-person groups correctly solved more problems than two-person groups; however, their problems appeared to be more convergent than divergent in nature. In a study dealing with the effects of large and small group participation on decision making, Fox, Lorge, Wiltz, and Herrold (1953) found that groups consisting of 12 to 13 air force officers wrote decisions that were of superior quality to those written by smaller groups that consisted of six to eight members.

In a review of the literature on the effects of group size, Thomas and Fink (1963) found that under some conditions quality of performance and group productivity were positively correlated with group size. They also reported that under no conditions were smaller groups superior. Further, Meadow, Parnes, and Reese (1959) found that persons working in groups produced seventy percent more "good ideas" than the same number of persons working individually. In contrast, Kidd (1958) employed anagram tasks, sentence completion tasks, and jig-saw tasks to measure the social influence phenomena in a task oriented group situation. His data failed to confirm the hypothesis that efficiency would increase as group size increased, and no significant differences were reported in productivity between groups of two, four, and six.

If the efficiency of the creative process is a function of group size, it would seem desirable to outline more clearly the relationship between group size and such dimensions as fluency, flexibility, and originality. Larger groups would appear to bring more minds to bear on a particular problem, however, smaller groups allow for more participation on the part of individuals. Small groups may also provide an atmosphere that is less subject to peer pressure, while larger groups may stimulate more original responses as a function of increased group fluency. The major objective of this study was to investigate the following questions with regard to group size:

1. What is the effect of group size on total fluency, flexibility, and originality of responses to problem solving tasks?

2. What is the effect of group size on average per person fluency, flexibility, and originality of responses to problem solving tasks?

Procedures.

Subjects. Subjects were 163 college juniors and seniors enrolled in an introductory educational psychology course.

Experimental Treatment. Ss were assigned at random to groups of one, three, six, or twelve members.[1] Following a short "warm-up" task, all groups were given identical instructions to respond aloud to three problem solving tasks. The tasks and instructions were as follows:

Task 1: List all of the possible uses that you can think of for a wire coat hanger. Let your mind wander and try to think of uses that no one else has ever thought of. Tell the recorder all the ideas the come to mind, even if they seem silly or impractical. You will have five (5) minutes for this task.

Task 2: List all the possible consequences that might result if the following situation occurred:

Imagine that all the people in the world were suddenly reduced to 12 inches in height.

You will be given ten (10) minutes for this exercise. Think of both realistic and fanciful responses. For example,

1. There would be no need to list peoples' heights on drivers' licenses.

2. No one would have the nickname "Shorty."

Task 3: List all of the things you can think of that come in pairs. In addition to such common things as a pair of socks, try to think of unusual pairings such as, "one half of a quartet." You will have seven (7) minutes for this exercise.

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[1] The authors acknowledge that a "group" consisting of one member is not consistent with the traditional definition of group.

Two recorders wrote down all responses generated by group members, and no evaluation of responses was made during the problem solving situation. Although the tasks were timed, the time limits were broad enough so that responses waned long before time ran out for each task.

Analysis. Responses for each group were scored according to three criteria: fluency, flexibility, and originality. The fluency criterion was established by making a simple frequency count of recorded responses, with repeated answers omitted. The responses were scored for flexibility by first grouping answers into rational categories. These categories were arrived at by a consensus of four judges, and ranged from 15 to 17 separate groupings within each of the three tasks. The flexibility score was the total number of different categories produced by any particular group. The originality score was determined by asking the judges to rate each response in terms of statistical frequency on a scale of 1 (low originality; mundane) to 3 (high originality; unique). A mean originality score was figured for each response and summed within groups. Interrater reliability for the two originality judgments was found to be .79.

Finally, fluency, flexibility, and originality scores were summed for each group across the three problem solving tasks. In addition, mean per person scores on each criterion were found by dividing the group sum by the number of group members. Thus, there were six independent variables: group scores on fluency, flexibility, and originality; and average per person scores on the same three variables. One way analyses of variance were performed on the six criteria, with the independent variable being the size of the group.

Results. Results of the analyses of variance comparing group productivity on the criteria of fluency, flexibility, and originality are shown in Tables 1, 2, and 3. Overall F ratios for each criterion were all significant at the .05 level. In other words, group size had a powerful effect on the total group output. To determine which groups were statistically different from the other groups, a posteriori comparisons were made by means of Tukey's H.S.D. (Honestly Significant Difference) technique (Kirk, 1 .6). The results of these comparisons are shown in Tables 7, 8, and 9. A distinct trend can be seen with respect to the a posteriori tests. A clear progression of scores was obvious across the group sizes; as group size increased, so did the group's fluency, flexibility, and originality. However, in each of the three criteria, groups with three members were statistically indistinguishable from groups with six members. That is, groups of three produced about the same number of responses and showed the same amount of originality and flexibility as groups of six members. In addition, it was found that in terms of flexibility, six-member groups generated no more categories of responses than did twelve-member groups.

The second research question dealt with average per person scores within the various group sizes. Again, analyses of variance produced significant overall F ratios for each of the three criteria. These results are presented in Tables 4, 5, and 6. A posteriori tests revealed results that were generally opposite from the results of total group output. It was found that as group size increased, the per person contribution tended to diminish. Exceptions to this tendency seemed to be

with respect to six- and twelve-member groups on the criteria of
fluency and originality. There were no statistical difference in
average per person productivity between these two groups. Also, the
difference in per person flexibility scores between six- and twelve-
member groups was just barely significant at the .05 level. Thus,
groups of six or twelve members appear to inhibit per person con-
tributions equally.

Discussion and Conclusions.

The results of this research are perhaps best understood if the
purposes of group problem solving are outlined. From one viewpoint,
groups are used to solve problems quickly and efficiently. If the
results of this study can be extended to practical applications, it
appears that the larger the group (up to twelve members), the greater
the total productivity in terms of the number of responses, originality
of answers, and capability of generating new categories of responses.
If the primary purpose of the group is to get problems solved, two
additional implications can be drawn. First, groups of three, six, or
twelve are generally more productive than individuals. Second, if
groups of twelve are impractical (say, within a classroom), it makes
little difference whether the group has three or six members. In fact,
if there are several problems which need to be solved under this
circumstance, it would seem judicious to use groups of three, so that
more groups could work on more problems.

On the other hand, some researchers (cf. Osborn, 1963) have asserted that one of the major functions of group problem solving or brainstorming is to stimulate ideas rather than to provide solutions to specific problems. Essentially, then, it is possible to view group activities as a procedure for training members to be more creative. From this standpoint, the results of the present study are not encouraging. It was seen that as group size increased, per person productivity generally decreased. The implication here is that the effect of increased group size may be to delimit seriously opportunities for individual productivity in solving problems.

The findings of this study must be tempered by a hard look at the nature of the problems employed. One potential criticism that must be acknowledged is the proposition that the tasks were surreal or irrelevant. It remains to be seen whether the findings hold up when "real life" problems are used. The present study is now being partially replicated with a "real life" problem. In addition, the implications for training need to be validated. For instance, does individual practice in problem solving, where per person productivity is high, facilitate group problem solving when those individuals are brought together?

While it should be stressed that the present findings depend upon how one views the purpose of problem solving activities, perhaps the most sensible approach is that a variety of experiences in groups of varied sizes will help individuals to determine under which conditions they

operate most effectively. Also, certain types of problems undoubtably lend themselves to different group conditions. For example, a complex social problem that may require input from persons representing many disciplines (psychology, sociology, economics, city planning, etc.) may very well dictate group size according to the types of representation necessary. Finally, it seems clear that the value of group problem solving sessions depends to some degree on how the sessions are conducted, the nature of the topic under consideration, and the age and educational background of the participants.

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Table 1

Analysis of Variance on Group Fluency

Source	df	SS	MS	F
Between	3	73198.74	24399.8	22.31*
Within	27	29530.22	1093.71	
Total	30	102728.96		

Table 2

Analysis of Variance on Group Flexibility

Source	df	SS	MS	F
Between	3	663.12	221.04	13.65*
Within	27	437.27	16.20	
Total	30	1100.39		

Table 3

Analysis of Variance on Group Originality

Source	df	SS	MS	F
Between	3	120587.90	40195.97	22.33*
Within	27	48595.65	1799.84	
Total	30	169183.55		

* $p < .05$.

Table 4

Analysis of			Person Fluency	
Source	df		MS	F
Between	3	2183.88	727.96	13.56*
Within	27	1448.89	53.66	
Total	30	3632.77		

Table 5

Analysis of Variance on Per Person Flexibility

Source	df	SS	MS	F
Between	3	2070.27	690.09	209.76*
Within	27	88.82	3.29	
Total	30	2159.09		

Table 6

Analysis of Variance on Per Person Originality

Source	df	SS	MS	F
Between	3	4277.17	1425.72	15.20*
Within	27	2532.32	93.79	
Total	30	6809.49		

*p $<$ .05.

Table 7

A Posteriori Tests on Group Differences: Total Fluency[1]

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	
$\bar{X}_1$	—	55.00*	81.11*	147.33*	
$\bar{X}_2$		—	26.11	92.33*	H.S.D. = 47.93
$\bar{X}_3$			—	66.22*	
$\bar{X}_4$				—	

Table 8

A Posteriori Tests on Group Differences: Total Flexibility[1]

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	
$\bar{X}_1$	—	7.98*	9.43*	13.76*	
$\bar{X}_2$		—	1.45	5.78*	H.S.D. = 5.65
$\bar{X}_3$			—	4.33	
$\bar{X}_4$				—	

Table 9

A Posteriori Tests on Group Differences: Total Originality[1]

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	
$\bar{X}_1$	—	61.38*	100.60*	187.38*	
$\bar{X}_2$		—	32.22*	126.00*	H.S.D. = 59.40
$\bar{X}_3$			—	86.78*	
$\bar{X}_4$				—	

[1]
$\bar{X}_1$ = one member group; $\bar{X}_2$ = three member group;
$\bar{X}_3$ = six member group; $\bar{X}_4$ = twelve member group

*$p < .05$.

Table 10

A Posteriori Tests on Per Person Fluency[1]

	$\bar{X}_4$	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_1$	
$\bar{X}_4$	___	4.89	15.33*	22.77*	
$\bar{X}_3$		___	10.44*	17 88*	H.S.D. = 10.26
$\bar{X}2$			___	7 34	
$\bar{X}_1$				___	

Table 11

A Posteriori Tests on Per Person Flexibility[1]

	$\bar{X}_4$	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_1$	
$\bar{X}_4$	___	2.55*	7.78*	22.24*	
$\bar{X}_3$		___	5.23*	19.69*	H.S.D. = 2.54
$\bar{X}_2$			___	14.46*	
$\bar{X}_1$				___	

Table 12

A Posteriori Tests on Per Person Originality

	$\bar{X}_4$	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_1$	
$\bar{X}_4$	___	5.66	17 88*	32.28*	
$\bar{X}_3$		___	12.22	26.62*	H.S.D. = 13.59
$\bar{X}_2$			___	14.40*	
$\bar{X}_1$				___	

[1]

$\bar{X}_1$ = one member group; $\bar{X}_2$ = three member group;

$\bar{X}_3$ = six member group; $\bar{X}_4$ = twelve member group

*p $<$ .05.