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A COMPARISON OF INDIVIDUALS AND SMALL GROUPS IN THE RATIONAL SOLUTION OF COMPLEX PROBLEMS

By MARJORIE E. SHAW, Columbia University

The work done before 1920 in the field of group activity as compared with individual activity has been summarized adequately by Allport.¹ Since then other studies have been made principally by G. B. Watson,² Bechterew and Lange,³ South,⁴ and Belaev.⁵ Many of these studies deal primarily with groups wherein individuals are interested in the same stimulus but there is little or no direct social intercourse and stimulation. The work of these individuals is contrasted with that done by isolated individuals.

The present study aimed to present individuals with an actual problematic situation which would call for real thinking to arrive at a proper solution. The problems selected (given in detail below) involve a number of steps all of which must be correct in order that the right answer may be found. The problems were to be given to single individuals and to small groups of coöperating individuals, in order that the abilities of these two might be compared. The problems were such as to make it practically impossible for one individual in the group to get a correct answer instantaneously by a sudden insight into the situation. Rather, they allow all to participate in arriving at a solution; they call for interchange of ideas and for acceptance or criticism and rejection of any idea put forth. At least some of the previous studies have dealt more with the performance of

*Accepted for publication February 4, 1931.

¹F. H. Allport, *Social Psychology*, 1924, Chap. 11.

²G. B. Watson, Do groups think more efficiently than individuals? *J. Abn. Soc. Psychol.*, 23, 1928, 328-336.

³W. Bechterew und A. Lange, Die Ergebnisse des Experiments auf dem Gebiete der kollektiven Reflexologie, *Zeit. f. angew. Psychol.*, 24, 1924, 305-344.

⁴E. B. South, Some psychological aspects of committee work, *J. App. Psychol.*, 11, 1927, 348-368, 437-464.

⁵B. V. Belaev, abstract received from the author, entitled "The Problem of the Collective and its Internal Structure." Other references are: W. A. Barton, Jr., Group activity versus individual activity in developing ability to solve problems in first year algebra, *J. Educ. Administration and Supervision*, 12, 1926, 512-518; H. E. Burt, Sex differences in the effect of discussion, *J. Exper. Psychol.*, 3, 1920, 390-395; M. P. Follett, *Creative Experience*, 1924; K. Gordon, Group judgments in the field of lifted weights, *J. Exper. Psychol.*, 7, 1924, 398-400; A study of esthetic judgments, *ibid.*, 6, 1923, 36-43; E. C. Lindeman, *Social Discovery*, 1924; A. D. Sheffield, *Creative Discussion*, 1927; T. W. Thie, Testing the efficiency of the group method, *English Journal*, 14, 1925, 134-137.

certain rather elementary tasks such as word-building, vowel cancellation, multiplication, turning fishing reels, etc., which have allowed but little constructive coöperation wherein ideas may be accepted or rejected either in whole or in part.

The problems used here are still quite far from the usual type of problematic situation met in real life. They are problems admitting of only one answer; there is only one type of best solution. They arouse none, or very little, of the emotional bias with which persons characteristically approach life situations. It can be seen at once, then, that not all of the results obtained are directly applicable to any or all group situations.

METHOD AND PROCEDURE

Subjects. The *Ss* in this experiment were the students in the class in Social Psychology at Columbia University. This group is a rather highly selected one, in view of the fact that almost all are graduate students, a large percentage of them working for advanced degrees. The experiment was divided into halves; 3 problems were used in the first half and 3 in the second half given 2 weeks later. In the first half there were 2 groups of 4 women each and 3 groups of 4 men each. There were 9 men and 12 women working on the problems individually in the same room. In the second half of the experiment there were 2 groups of 4 men each and 3 groups of 4 women each; and 10 men and 7 women worked as separate individuals in the same room. Thus data were received from an equal number of groups of men and women, *i.e.* 5 groups of each. It will be seen from the above that a group was never composed of the two sexes, but in all cases of either 4 women or 4 men. It was believed that this arrangement would, in general, make for better coöperation and more smoothly running groups. The grouping was not made for any purpose of sex comparisons; no such comparisons are made in this study.

Problems. (a) *First half of experiment.* The directions used in the first half of the experiment were as follows:

(1) Materials for this problem are in the envelope marked 'Problems I and II.' Use disks H₁, H₂, H₃, W₁, W₂, W₃. (For the present disregard the symbols on the reverse side.) Side 1 of the card. On the A-side of a river are three wives (W₁, W₂, W₃) and their husbands (H₁, H₂, H₃). All the men but none of the women can row. Get them across to the B-side of the river by means of a boat carrying only three at one time. No man will allow his wife to be in the presence of another man unless he is also there.

(2) Materials for this problem are in the envelope marked 'Problems I and II.' Use disks marked M₁, M₂, M₃, C₁, C₂, RC. (Reverse side of the disks just used.) Side 1 of the card. Three Missionaries (M₁, M₂, M₃) and three Cannibals (C₁, C₂, RC) are on the A-side of a river. Get them across to the B-side by means of a boat which holds only two at one time. All the Missionaries and one Cannibal (RC) can row. Never under any circumstances or at any time may the Missionaries be outnumbered by the Cannibals. (Except of course, when there are no Missionaries present.)

(3) Materials for this problem are in the envelope marked 'Problem III.' Side 2 of the card. In Circle A arrange the disks in order of size, that is with the largest on the bottom, etc., ending with the smallest on top. Using Circle B as a transfer station, transfer the disks to Circle C so that they will be in the same

order in Circle C that they are now in in Circle A. Never place a larger disk on a smaller one and move only one disk at a time. (Number the disks for reference if you wish.)

The card referred to in these problems contained on the one side a diagram of a river, for convenience in solving the first two problems, and on the other side a diagram of the three circles necessary to a solution of the third problem.

(b) *Second half of experiment.* The directions used in the second half of the experiment were as follows:

(1) Materials for the problem are in the envelope marked 'Problem I.' Put these words, taken from the envelope, together so that they form the last sentence (only one sentence) of the unfinished prose selection.

In New Orleans there is a tree which nobody looks at without curiosity and without wondering how it came there. It reminds one of the warm climes of Africa and Asia. Indeed, with its sharp and thin foliage, sighing mournfully under the blast of one of our November northern winds, it looks as sorrowful as an exile.

(2) Materials for this problem are in the envelope marked 'Problem II.' These words when put in the proper order form the last three and one-half lines of the unfinished sonnet below. Arrange them as nearly as possible in the proper order.

A boy named Simon sojourned in a dale;
Some said that he was simple, but I'm sure
That he was nothing less than simon pure;
They thought him so because forsooth, a whale
He tried to catch in Mother's water-pail.
Ah! little boy, timid, composed, demure—
He had imagination. Yet endure
Defeat he could, for he of course did fail.
But there are Simons of a larger growth,
Who, too, in shallow waters fish for whales,
And when they fail

(3) A consolidated school is to be built in the rural district shown in the diagram. The capital letters (A, B, C, etc.) indicate points (not towns) where pupils are to be picked up by two school buses. The mileage between each point is indicated on the diagram. The capacity of each bus is 35 pupils and the driver. Find the most desirable location for this school and give the route each bus must take. The buses may start at ANY point and need not necessarily start from the school each morning. Following are the number of pupils to be picked up at each point:

Point	No. Pupils	Point	No. Pupils	Point	No. Pupils
A	6	D	4	G	3
B	13	E	2	H	10
C	17	F	5	I	3

The diagram for problem 3 is given below. It was furnished to each individual who was working alone and was drawn to the scale of 1 in. to the mile. Only one diagram was provided in each group; it was drawn to the scale of 2 in. to the mile.

In addition to the specific instructions given above, the following general instructions appeared at the top of each set of problems given the separate individuals working in the same room.

Below are three problems. Work them as quickly and accurately as possible. There is a correct solution to each problem. Record your answer or state briefly how you solved the problem. When you have finished one problem and are ready

to go on with the second, record the time to the nearest half-minute by means of the record being kept on the front board. Then proceed with the second and then the third, and record the time when each is finished. Work the problems in the order listed.

At the top of the set of problems given to each group of 4 individuals were the following instructions:

A chairman has been appointed to manipulate the necessary materials. Work together as a coöperative group to solve the three problems given below. Work them as quickly and accurately as possible. There is a correct solution to each problem. Record your solution or state briefly how the problem was solved. Each individual, including the chairman, should make his contributions to the group solution spontaneously as they occur to him. Indicate to the note-taker when you have finished one problem and are ready to proceed to the next; the note-taker does not participate in any way as a member of the group in solving the problem.

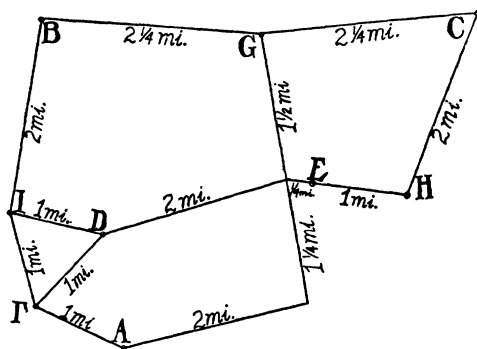


FIG. 1. DIAGRAM USED IN PROBLEM 3, SECOND HALF OF THE EXPERIMENT

Every individual in the group was provided with a separate set of the problems, but only one set of the necessary materials was given to each group; this made it more essential that all coöperate to solve the problems. The first individual in each group of 4 was appointed chairman to manipulate the materials in order to obviate the confusion and delay which might result if each attempted to carry out his own ideas. The chairman was appointed rather than being elected by the group to prevent unnecessary delay in starting to work, and because in many cases the individuals had never before met except in the more formal classroom atmosphere. It was thought that any formal or parliamentary organization of the group might tend to restrict spontaneity and coöperation and thus perhaps limit the possibilities of getting the best results.

The note-taker, referred to in the group instructions above, was for the purpose of securing more qualitative and quantitative facts concerning the group activity than the time of solving and answers to the problems would provide. In the first half of the experiment the note-taker was given the following instructions.

You are to act as note-taker and time recorder for a group of persons solving three problems. You are to take absolutely no part in the group activity. Do not indicate by any means your approval or disapproval of their activities.

Record the final solution of the group on each problem. Record the time required to solve each problem. Record as many of the detailed suggestions made by any member of the group as it is possible for you to get.

In the second half it was thought that the following plan might afford more quantitative data concerning the activity of the groups.

Tally separately every suggestion made by any member of the group so that a record can be made up of the complete number of suggestions made in any one group. Get as much as is possible of each suggestion made. Record this in your notes. If the suggestion is rejected check the tally. Note whether it is rejected by the person who proposed it or by another member of the group. If the suggestion is accepted underscore the tally.

There were 10 sets of notes taken and in only 3 cases did the note-taker have any knowledge either of the problem or of its correct solution. Thus the knowledge of whether a rejected suggestion was in reality an erroneous or a correct suggestion could have but little effect on the notes taken, and can be determined by *E* only from these same notes.

Equalization of the groups. In order to equate the groups, that is, to be reasonably sure that no one group was made up of four superior individuals and that those who worked in groups were on the whole neither inferior to nor superior to those working as separate individuals, shifts were made so that the composition of the groups differed in the two halves of the experiment. Individuals making up the first group were chosen from the class roll by placing every other man and woman in a group. Certain deviations had to be made from this general procedure in the case of absence from class, since the aim was to keep the total number of men working in groups and as separate individuals approximately equal for the total experiment; the same being true for the women. Every group was composed of 4 individuals because it was thought that a group of this size would coöperate to better advantage than a very much larger or smaller one. Also the limited number of available *Ss* made it impossible to increase the number much and still have enough single groups to make the comparisons meaningful. Limited room accommodations also limited the number of groups.

Table I below shows the accomplishments of every *S* as he worked alone in the first half of the experiment. Table II shows the accomplishment of the groups in the second half of the experiment. Group *A'* in the second half of the experiment was composed of individuals *Y*, *G*, *I*, and *R* of the first half of the experiment; Group *B'* of *K*, *U*, *W*, and an individual not before present; Group *C'* of *M*, *J*, *A*, *F*; Group *D'* of *Q*, *L*, *R*, *C*; and Group *E'* of *H*, *T*, *X*, *B*. It will be seen that each group contained only one person who had solved a problem correctly in the first half of the experiment. Since the groups in the first half were chosen at random it was necessary to check the individuals in the second half to see that no group in the first half had been superior. From Table II can be seen the accomplishments of the individual *Ss* in the second half. Group *A* was made up of individuals *A'*, *J'*, *N'*, and an *S* not used in the second half; Group *B* of *H'*, *F'*, *M'*, and *P'*; Group *C* of *B'*, *C'*, *X'*, and an *S* not used in the second half; Group *D* of *E'*, *K'*, *L'*, and *Q'*; and Group *E* of *D'*, *G'*, *I'*, and an *S* not used in the second half. Thus it seems probable that no group was composed of 4 superior individuals. In neither half of the experiment

did a group contain more than one individual who had solved a problem correctly in the other half of the experiment, and no single individual ever correctly solved more than one problem.

TABLE I

SHOWING FOR EVERY INDIVIDUAL *S* AND FOR EVERY GROUP OF *Ss* THE TIME IN MINUTES REQUIRED FOR A SOLUTION AND THE NATURE OF THE SOLUTIONS OF THE PROBLEMS OF THE FIRST HALF OF THE EXPERIMENT

		Problem 1		Problem 2		Problem 3	
		Time	Solution	Time	Solution	Time	Solution
Individuals	<i>D</i>	6.5	Incorrect	29.0	Incorrect	6.0	Incorrect
	<i>F</i>	4.5	"	17.5	"	13.5	"
	<i>G</i>	3.5	"	6.0	"	20.5	"
	<i>H</i>	1.0	"	3.5	"	10.0	"
	<i>K</i>	2.0	"	4.5	"	18.0	"
	<i>L</i>	1.5	"	2.5	"	9.5	"
	<i>N</i>	1.0	"	2.5	"	15.0	"
	<i>P</i>	7.0	"	5.5	"	15.5	"
	<i>R</i>	1.5	"	3.0	"	19.0	"
	<i>A</i>	6.0	"	15.0	"	14.5	Unsolved
	<i>C</i>	4.5	"	5.5	"	14.0	"
	<i>W</i>	6.0	"	18.0	"	14.0	"
	<i>J</i>	4.5	"	6.5	"	5.5	"
	<i>X</i>	4.0	"	12.5	"	13.0	"
	<i>Y</i>	4.5	"	10.0	"	15.5	"
	<i>T</i>	10.5	"	20.0	"	15.0	"
	<i>B</i>	3.0	"	8.5	"	60.0	Correct
	<i>I</i>	4.5	"	8.5	"	21.0	"
	<i>M</i>	5.0	Correct	8.0	"	5.0	Incorrect
	<i>Q</i>	9.5	"	9.5	"	5.5	"
	<i>U</i>	4.0	"	12.5	"	16.0	Unsolved
Av.		4.5		9.9		15.5	
S.D.		2.5		6.7		11.0	
Groups	A	5.0	Incorrect	7.5	Incorrect	4.5	Incorrect
	B	4.5	Correct	34.0	Correct	17.0	Correct
	C	5.0	"	12.0	"	37.0	Unsolved
	D	16.0	"	27.0	"	29.0	Correct
	E	2.0	Incorrect	4.0	Incorrect	4.0	Incorrect
	Av.	6.5		16.9		18.3	
	S.D.	4.97		11.6		13.1	

RESULTS

Table I summarizes the time (in minutes) required for and the nature of every solution presented by a group or by the individual *Ss* in the first half of the experiment. It will be seen that only 5

correct solutions out of a possible 63 were returned by the different *Ss*. There were 8 correct solutions out of a possible 15 for the groups. That is, 7.9% of the solutions turned in by individual *Ss* were correct, while 53% of the solutions turned in by groups were correct. It was found that the false solutions to the problems could be divided into several different types. In Problem 1 two types of false solution, handed in by 13 different individuals, made an error in the first move, 4 made an error in the third move and 1 made an error in the fifth. It took 7 single moves to solve the problem correctly. No group erred on the first move; one erred on the third and one on the fourth. Group activity would seem to insure not only a larger proportion of correct solutions, but also that even in erroneous solutions the error is not made so early in the solution.

The solution to Problem 2 shows the same. It takes 13 single moves to arrive at a correct solution. Among the individual *Ss*, 3 erred on the first move, 4 on the second, 6 on the third, 2 on the fifth, 2 on the sixth, 1 on the seventh, and 2 on the eighth. The last 3 who erred on the seventh and eighth, did not consider their solutions completed as all the cannibals and missionaries had not been transferred to the B-side of the river. It is interesting to note that no group got as near as this to a correct solution of this problem and then failed to reach it. Three groups solved the problem correctly; both of the others erred on the fifth move.

Problem 3 cannot be classified so easily on the basis of the first false move, since in all cases, except in one group, once the method of transfer was hit upon success was assured. In the case of 7 individual *Ss* no solution at all was recorded; it may be assumed that they were unable to reach one. Six individual *Ss* skipped circle B, the transfer station. Two spread the disks out in B until 4 had been transferred; then the disks were piled up and the fifth one either transferred through B to C or skipped over B to C. After this the others were again spread out and then transferred to C. Four individual *Ss* slipped the disks from underneath. One group skipped the transfer station; one spread the disks out as described above. No group slipped them from underneath; 2 groups contemplated this but abandoned it as being too simple; one group abandoned spreading them out as also being too simple. In Group C, Problem 3 has been recorded as unsolved, but this does not fairly represent the group. They had successfully transferred 4 disks into circle C and the fifth into circle B, but in manipulating to get the fifth disk into C they lost sight of their real aim and became confused. They quit work then,

although saying that they 'probably could figure it out if they stayed with it long enough.' The instructions for this problem appear not to have been sufficiently clear in the prohibition of certain procedures. It was felt that too many instructions here might make the correct solution too obvious, although the bizarre plan of spreading the disks out in the circles was never anticipated. The problem had been previously tried out both on groups and separate individuals, and neither the plan of spreading out the disks nor that of slipping them from underneath had occurred. The instructions had, therefore, been assumed to be adequate. It is to be noted that several *Ss* indicated that they were aware of not having followed the directions exactly. For example, one individual who slipped them from underneath commented, "This seems too simple but I can't see how it can be solved without moving a covered disk." Also, after the experiment, one individual *S* was overheard by *E* saying that "since the instructions did not say that the disks should not be slipped from underneath" she solved the problem that way because she "could not see how else to do it."

Table II gives the time and number of errors made by every individual *S*, and by every group of *Ss* on the three problems given in the second half of the experiment. The seventh column, which is headed "location," gives the number of miles which the proposed location is from the best location. The eighth column gives the number of excess miles which the two buses travel, the shortest possible number of miles being 12.

It will be noted that here, as in Problem 1, a greater percentage of the groups obtained a correct solution than individual *Ss*. Of the solutions reported by the different *Ss* 5.7% were correct; and by the groups, 27% were correct.

The incorrect solutions in this half of the experiment also are interesting when analyzed. Among the groups there were 4 correct solutions on the first problem, the single error being the transposition of the words "time immemorial" to read "immemorial time." Only 3 *Ss* completed the sentence to read as it had in the original. By far the greatest number of errors lay in the placing of the single word "there," which could be put in 7 different places without disturbing the smoothness of the sentence. This error was made (often together with others) in 10 cases by individual *Ss* but by no group. Five *Ss* submitted solutions wherein the structure of the sentence was poor.

TABLE II

SHOWING FOR EVERY INDIVIDUAL *S* AND FOR EVERY GROUP OF *Ss* THE TIME IN MINUTES REQUIRED FOR A SOLUTION AND THE NUMBER AND NATURE OF THE ERRORS MADE IN THE PROBLEMS OF THE SECOND HALF OF THE EXPERIMENT

	Problem 1		Problem 2		Problem 3		
	Time	Errors	Time	Solution	Time	Location	Excess
Individuals	A'	6.0	2	27.0 Unsolved	5.0	1.25	0.0
	B'	8.0	1	37.0 "	21.0	.125	.5
	C'	12.0	10	150.0 Incorrect	35.0	.25	.5
	D'	7.0	8	25.0 Unsolved	25.0	1.0	.5
	F'	8.0	1	16.0 Incorrect	16.0	1.25	.5
	G'	2.0	1	6.0 Unsolved	13.0	3.0	.5
	H'	14.0	1	20.0 "	15.0	.25	.5
	J'	6.0	1	85.0 Incorrect	30.0	6.0	1.75
	K'	9.0	2	35.0 Unsolved	12.0	4.0	1.75
	L'	7.5	1	20.0 "	24.0	6.0	1.75
	M'	11.0	7	42.0 Incorrect	18.0	1.25	1.25
	X'	12.0	3	39.0 Unsolved	14.0	4.0	2.0
	P'	8.5	9	17.0 "	12.0	1.25	.5
	Q'	5.0	1	31.0 Incorrect	10.0	4.0	2.25
	W'	6.5	0	29.0 Unsolved	18.0	Unsolved	
	I'	6.0	0	78.0 Incorrect	29.0	4.0	1.25
	N'	10.0	0	26.0 Unsolved	10.0	3.0	1.5
	Av.	8.2		40.2	18.0	2.5	1.06
	S.D.	2.9		33.8	7.9	1.9	
Groups	A'	3.0	0	28.0 Incorrect	3.0	.25	.5
	B'	12.0	0	45.0 "	10.0	4.0	2.25
	C'	6.0	1	69.0 "	00.0	Unsolved	
	D'	2.0	0	26.0 "	8.0	5.0	1.50
	E'	4.5	0	40.0 "	10.0	1.25	.75
	Av.	5.5		41.6	8.0	2.6	1.25
	S.D.	3.5		15.4	2.9		

None of the individual *Ss* solved Problem 2 correctly; 11 stated that they could not solve it and presented no solution. The 6 other individual solutions varied in their degree of imperfection. One *S* simply composed a complete sentence to finish the sonnet. Three others had either 3 or 4 of the rhyme words, but an erroneous rhyme scheme. One person had the first line in accord with the original and one had the last line correct. Others made more or less serious errors here. The second and third lines were never correctly written by any individual. All groups turned in a solution. The rhyme

scheme was correct in all cases; the first line was correct in 3 cases and the last one in 4. Group B had the two middle lines almost correct. The meaning was the same as that in the original, although several words were misplaced. In some group and some individual solutions the words had been so arranged as to convey a meaning almost opposite to that in the original.

Neither a group nor an individual arrived at a correct solution of the third problem. The average error in location and average excess number of miles traveled were about equivalent for the groups and individuals. In part, the absence of a correct solution may be due to the fact that it took a long time to solve the first and second problems. In many cases the completion of the third meant dismissal for the evening; thus perhaps any apparently suitable location was accepted. (On the other hand many persons took the problems home with them in order to complete the second and third. They kept time for themselves and returned the solutions the next week.) A comparison of Tables III and IV shows that among the groups the total number of suggestions was by far the least in the third problem.

Reference to the notes kept by the note-takers will give more definite information regarding the activities within the groups. All those in a group do not participate equally in the group activity. Such remarks or tabulations as the following are found in the notes from three groups in all. (The note-takers numbered the *Ss* to facilitate taking notes.) "*S* 1 and *S* 3 were leaders in the solution." From the tabulation of suggestions given in the solution referred to it is found that *S* 1 made 7 suggestions and *S* 3 made 14 suggestions; while *S* 2 and *S* 4 made, respectively, 2 and 3 suggestions. Later in these same notes we find, "*S* 2 not contributing much." In another set of notes: "*S* 3 and *S* 4 offered no suggestions during the solution." In the next problem solved by this same group *S* 2 made 16 suggestions, *S* 1 made 12, *S* 4 made 8, and *S* 3 made 5. From yet another set: "*S* 1 and *S* 4 did most of the suggesting, *S* 2 and *S* 3 not working much." In solving Problem 2 in the first half of the experiment the note-taker remarks that "*S* 2 and *S* 3 draw their own diagrams and become absorbed in them: do almost no suggesting." In solving Problem 3 "*S* 3 made no comments at all, *S* 2 spoke only a few words." In one of the above groups an *S* who participated a great deal in group activity very soon assumed the task of manipulating the material in the place of the less active

S who had been appointed chairman. Possibly one could get interesting, meaningful, and perhaps quite different sets of results by using in one set of cases groups with a chairman either equal or superior to the group, and in another set groups having a chairman inferior to the group in ability.

In some groups quite the reverse situation is found, and all members coöperate splendidly. Such comments as the following are found in the notes from the three groups: "All contributing beautifully," and later, "all coöperating and making check suggestions." From another, "suggestions coming from all four about equally." Another records, "the four members coöperate well," and on another page, "splendid group work."

TABLE III

SHOWING, FOR EVERY GROUP OF Ss, THE NUMBER OF CORRECT AND INCORRECT SUGGESTIONS AND REJECTIONS, AND THE NUMBER OF REJECTIONS BY THOSE MAKING THE SUGGESTIONS AND BY OTHERS OF THE GROUP
(Problem 1, Second Half of Experiment)

Groups	Suggestions			Rejections			
	No.	Correct	Incorrect	Correct	Incorrect	Maker	Others
A'	29	18	11	3	11	7	7
B'	24	18	6	1	6	1	6
C'	17	8	9	0	8	0	8
D'	20	11	9	2	9	2	9
E'	31	25	6	2	6	2	6
Totals	121	80	41	8	40	12	36

In the first half of the experiment Groups A and E solved all problems incorrectly. From notes kept there was apparently but little criticism of the work in Group E. The note-taker remarks, "All satisfied with the solution." The members of Group A, however, seemed to recognize that they were not taking all specifications of the problem into consideration, but rationalized their procedure and turned in solutions. At the end of the first problem the recorder notes that "they conclude that they have solved the problem, though perhaps not in the way the directions signify." This group is one of those referred to above in which the members do not participate equally in the group activity. In Problem 2 they finally agreed that the boat's contact with the shore would not constitute a case of outnumbering by the cannibals! In Problem 3 they failed to consider circle B always as a transfer station, but skipped it whenever it was convenient to do so.

In the other groups there is much more reference to the checking of errors and meeting the conditions of the problem. One group worked a solution through three times to be sure that they had met all specifications; in the last trial they discovered an error which would have made their solution wrong. The notes on these groups also mention numerous references to the stated problem to see that all qualifications were being taken into account.

Table III above deals with Problem 1 in the second half of the experiment. Column 2 shows the total number of suggestions made in each group. Columns 3 and 4 show respectively the number which were in reality correct and the number which were incorrect. Columns 5 and 6 indicate whether those suggestions which were rejected were respectively correct or incorrect. Columns 7 and 8 show the number of suggestions which were rejected by the individual making the suggestion or by another member of the group.

It will be noted from Table II that there was only one error (a word transposition) in any group solution. In one case, Group A', the suggestions rejected by the proposer or by another are exactly equal in number; in all other cases more were rejected by another member. Considering all groups together, three times as many suggestions were rejected by another member of the group as by the proposers of the suggestions. Five times as many incorrect as correct suggestions were rejected, whereas of the total number of suggestions made, twice as many were correct as incorrect. This fact may be considered in connection with the relative number of correct solutions among groups and among individuals. This quantitative check on rejections was not kept in the first half of the experiment, but from its results in the second half, together with the proportion of correct solutions in the first half, and the fact that notes on the groups presenting correct solutions emphasize the checking of erroneous moves, it seems as though group supremacy in the first half might have been in part due to the rejection of incorrect suggestions or the checking of errors. Also it was found that no group was composed of four superior individuals. All this would seem to indicate that one point of group supremacy is the rejection of incorrect ideas that escape the notice of the individual when working alone. Perhaps this may be the greatest point of group supremacy.

It is impossible to say with any certainty whether the rejected correct suggestions were rejected oftener by the proposer or by another member of the group. Only 8 correct suggestions were

rejected, and these were all later accepted, since the solutions were with but one exception absolutely correct. (In the solution where two words were transposed, the correct suggestion concerning their position was never made: this was a case of the acceptance and retention of an incorrect suggestion.) Five of the correct suggestions were rejected by the proposer and 3 by another, but with so small a total the difference is not significant.

TABLE IV

SHOWING, FOR EVERY GROUP OF Ss, THE NUMBER OF CORRECT AND INCORRECT SUGGESTIONS AND REJECTIONS, AND THE NUMBER OF REJECTIONS BY THOSE MAKING THE SUGGESTIONS AND BY OTHERS OF THE GROUP
(Problem 2, Second Half of Experiment)

Groups	Suggestions			Rejections			
	No.	Correct	Incorrect	Correct	Incorrect	Maker	Others
A'	71	32	39	10	35	18	27
B'	49	23	26	9	20	8	19
C'	76	35	41	9	29	7	31
D'	32	15	17	2	13	4	11
E'	37	17	20	2	14	3	13
Totals	265	122	143	32	111	40	101

TABLE V

SHOWING, FOR EVERY GROUP OF Ss, THE NUMBER OF CORRECT AND INCORRECT SUGGESTIONS AND REJECTIONS, AND THE NUMBER OF REJECTIONS BY THOSE MAKING THE SUGGESTIONS AND BY OTHERS OF THE GROUP
(Problem 3, Second Half of Experiment)

Groups	Suggestions			Rejections			
	No.	Correct	Incorrect	Correct	Incorrect	Maker	Others
A'	17	6	11	3	7	4	6
B'	10	3	7	1	6	0	7
C'			(No solution attempted)				
D'	10	2	8	0	5	0	5
E'	13	5	8	2	4	1	5
Totals	50	16	34	6	22	5	23

Tables IV and V summarize the data received on Problems 2 and 3. Since neither of these problems was correctly solved in any case, the value of the group checking does not appear so clearly. But a consideration of these results, with an analysis of individual and group work on these two problems, brings out the same fact as above. For example, only 6, or 35%, of the individual Ss presented a solution to Problem 2, as compared with 5, or 100%, of the groups. But perhaps more important than this is the fact that only one individual solution presented the idea conveyed by the part of the sonnet quoted; the other presented an opposite situation. (That is, they had *Simple Simon* railing "at

ill luck and unkind fate.") Three groups conveyed the correct idea, while only 2 reversed the conditions. That is, only $\frac{1}{6}$ of the individual *Ss*, as compared with $\frac{3}{5}$ of the groups, succeeded in grasping and presenting the proper situation. It seems not altogether improbable that this is a direct result of the rejection of incorrect ideas in the group; which, it should be noted again, is done largely by another member than the proposing one (2.52 times as many suggestions were rejected by another as by the proposer).

We find in the case of Problem 3, first, that all groups met the requirement as to the capacity of the buses, whereas 2 individual *Ss* placed more than 35 pupils in a bus (one placed 43 and the other 37 in one of the buses). Other than this, however, no superiority either of group over individual or of individual over group is shown when the two are compared as a whole.

SUMMARY

The purpose of the present study was to compare the ability of individuals and coöperating groups of 4 persons in solving complex problems. The problems involved a number of steps, all of which had to be correct before the right answer was obtained, but they are still far from the life-situations usually met. The groups were roughly equated so that no one group was composed of 4 superior individuals, but the students used were a highly selected group when compared with the population as a whole.

Upon the basis of the data and discussion presented in the foregoing pages the following conclusions seem justified:

(1) Groups seem assured of a much larger proportion of correct solutions than individuals do.

(2) This seems to be due to the rejection of incorrect suggestions and the checking of errors in the group.

(3) In groups of the size here used more incorrect suggestions are rejected by another member of the group than by the individual who proposed the suggestion.

(4) All members do not coöperate or participate equally in the solution of the problems.

(5) In erroneous solutions (where it is possible to determine the exact point at which the first error was made), groups do not err so soon as the average individual does.