COGNITIVE COMPLEXITY AND GROUP PERFORMANCE

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13 ABSTRACT

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Abstract

A study was conducted to determine if leaders with high cognitive complexity scores had better performance and manifest different behavior than leaders with low complexity scores. The results indicated that the performance of groups with high complexity leaders was significantly better than groups with low complexity leaders. No specific behavioral differences were found, but high complexity leaders seemed to show more variance in their behavior over four task settings.

COGNITIVE COMPLEXITY AND GROUP PERFORMANCE [1]

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The study of how people perceive their environments has indicated that an individual interacts with his environment by analyzing it and organizing it into meaningful patterns which are congruent with his own needs and psychological make-up. It is this relationship between the conceptual behavior of a person with respect to his environment that has been examined by psychologists interested in "cognitive complexity."

An individual's personality includes the ideas about himself and the world around him which he entertains consciously and can verbalize in more or less adequate terms. This is his "cognitive universe" (Zajonc, 1960), and we can divide this universe into "cognitive domains" or sub-areas of the individual's experience. Some of these domains are fairly similar for most people in a given culture; examples are the domains of domestic animals, or automobiles. Other domains are more idiosyncratic, depending upon the individual's unique experiences and specific objects of reference (Scott, 1967); e.g., the domains of self, family, or job. It is the way in which people have structured these domains that has been the major emphasis of psychologists studying complexity. The purpose of the present study was to determine whether the complexity of individuals in leadership positions influenced their group's performance on a variety of tasks and whether leaders with different levels of complexity utilized systematically different behaviors to obtain their respective performance levels.

Background

A variety of tests have been designed to measure "cognitive complexity" (Wallach, 1962; Gardner & Schoen, 1962; Scott, 1962; Harvey, Hunt & Schroder,

(1961). Vannoy (1965), however, found very little agreement for these various measures. More specifically, in a factor analysis of 20 complexity measures, no factors were found that controlled more than 25% of the common variance. This study pointed out, first, that different measures of complexity have been assessing different concepts; and second, that there does not appear to be a general complexity construct. One reason for this lack of agreement is that complexity varies for a single individual over several cognitive domains (Scott, 1963). This variance depends upon the amount and kind of knowledge one has about the domain and on the kind of functional demands with which that domain is confronted. Based on this information, it was decided that a measure of the complexity of a leadership domain would be used in this study.

Some research has already indicated that complex groups perform better than non-complex groups (Karlins & Lamm, 1967; Stager, 1967; Schroder, Driver, & Streufert, 1967). More specifically, groups composed of members, all of whom had high complexity scores, perform better than groups with members with low complexity scores on dimensions related to information processing, searching, integration, and tracking. The conceptual level theory of information processing (Schroder, Driver, & Streufert, 1967) which helped to generate the above studies, predicts that complex groups will perform better than non-complex groups on a variety of dimensions across a variety of situations. This theory also predicts that people with high complexity scores will be more flexible in their behavior. Their work suggests the following hypotheses:

1. Leaders with high complexity scores will have better group performance than leaders with low complexity scores on non-manipulative tasks.

2. Leaders with high complexity scores will show more variance in their behavior than leaders with low complexity scores in response to variability in the situation.

Experimental Procedure

Pretest measures. This study utilized the type of questionnaire employed by Scott (1962). Subjects are asked to arrange a list of objects (nations, groups, etc.) into categories which they think belong together, and to indicate the properties the objects have in common. For example, in a list of nations Japan and England might be grouped together as island nations, Norway, England and Sweden as monarchies. This procedure is continued until the number of categories of each subject is exhausted. Dimensional complexity is a function of the number of distinctions provided by the category system. The greater the number of different attributes ascribed to the objects, the higher the complexity score. The test-retest reliability of the measure is reported by Scott as .68 (1962).

This measure was chosen for two reasons: First, it can be reliably scored. Specifically, absolute complexity equals $H = \log_2 n - \frac{1}{n} n_1 \log_2 n_i$. Where n, is the total number of groups in the list (i.e., AMA, NAACP, bomber crews, etc.), and n_i is the number of groups placed in the same number of categories. Relative complexity equals $R = \frac{H}{\log_2 n}$. H may be treated as an appropriate measure of the dimensional complexity of the cognitive domain, and R may be interpreted as the complexity relative to the number of objects to be comprehended.

Second, this measure can be prepared for different cognitive domains. In the past, Scott (1962) has used a list of nations as the domain he wished to study. The present study used a list of 20 groups (e.g., NAACP,

construction crew, high school choir, etc.) and the subjects were asked to make as many categories as possible. Pretests indicated that the distinctions were of the following type: voluntary-mandatory; competitive-noncompetitive; service-pleasure; elected leader-appointed leader, etc. The scores obtained, therefore, reflect the subject's ability to differentiate among various aspects of group situations and the types of demands present. By using a measure directly related to the cognitive domain we wished to examine, we hopefully eliminated the problem pointed out by the Vannoy study (1965) with regard to the construct validity of the measure.

Subjects. Subjects were 48 Unitarian-Universalist church members at a leadership training conference. On the first evening of the conference each trainee completed the Scott complexity task, and a verbal fluency test (a short vocabulary test to be used as a rough indicant of intelligence). These questionnaires were scored, and the people with the eight highest and eight lowest complexity scores were chosen as leaders for the following day. Groups were organized with a leader and two members, and they worked on four tasks over a three-hour period. The members were randomly assigned to groups from the pool of 32 remaining subjects. Later tests showed no differences between groups with high complexity leaders and groups with low complexity leaders on their verbal fluency scores, and the correlation between leader complexity and verbal fluency was .01.

Tasks. Each leader worked on two structured tasks and two discussion tasks. The former tasks were variants of a task used by Fiedler (1965) where the group must find the shortest bus route. A map showing the different tours and a mileage table are provided. One of the two tasks used in this study (Ninane & Fiedler, 1967) used towns on a hypothetical map with distances

supplied and the total distance traveled as the criteria. The other task of this type required the group to cover various points with two buses to take children to a picnic. Each of the buses had a capacity of 30, and there were various numbers of children at the different points on the map. The total distance traversed by both buses was used as the criteria for this task.

The discussion tasks were concerned with two then-relevant topics in the Unitarian-Universalist church. One task required the group to prepare a short statement for the local press which explained and justified the position of their congregation in supporting the minister who counseled and actively assisted several young women to obtain an abortion.

The second discussion task required the group to prepare a short statement containing the principles which should guide the relationship of Negro members to the church. The groups had 20 minutes to work on each task, and five more minutes to record their answers.

Design. Sixteen leaders, eight with high complexity scores and eight with low complexity scores participated in the study. There were, therefore, sixteen groups composed of one leader and two members, totaling 48 subjects in all. Each group worked on all four of the tasks mentioned above with the structured and unstructured types of tasks alternated and high and low complexity leaders counter-balanced. Eight of the groups (four high and four low complexity leaders) received one task order and the other four received the other order, thus counter-balancing the design for task order effects.

There were, therefore, two levels of leader complexity and four task replications giving a 2 x 4 design for analysis of various techniques. In other words, we could examine behavior and performance ratings to see if

there were major differences between types of leaders, types of tasks or an interaction between the two.

Post-test measures. After each task, all group participants completed behavioral and Group Atmosphere ratings. The behavioral ratings asked how much influence, control and enjoyment the leader had, as well as seven other questions from the Leader Behavior Description Questionnaire (Stogdill and Coons, 1957). These latter questions were more specific (e.g., asks questions, laughs, jokes), and four dealt with interpersonal behavior and three with task-related behaviors. Stogdill and Coons (1957) report that corrected reliabilities for 15-item short forms of this questionnaire are in the .80's and .90's. Two examples are as follows:

Did the leader obtain group participation by asking questions of his members?

always:___:___:___:___:___:___:___:___:never
8 7 6 5 4 3 2 1

or, for the leader:

Did you obtain group participation by asking questions of your members?

always:___:___:___:___:___:___:___:___:never
8 7 6 5 4 3 2 1

The Group Atmosphere scale used was the standard questionnaire developed by Fiedler (1965) which is composed of ten bi-polar semantic differential type scales. The reliability of this scale is reported by Mitchell (1970) as .83. An example is shown below:

pleasant:___:___:___:___:___:___:___:___:unpleasant
7 6 5 4 3 2 1

Performance criteria. Measures for the structured task consisted of the number of miles "traveled." For the discussion task three judges rated the group products on overall acceptability. The reliability of these latter judgments (using the Spearman-Brown Formula) was .84.

Results

Leader complexity. The results show that in these four situations the complexity of the leader is positively related to task performance. Separate analyses were performed to examine task order effects, but none was found. The data were, therefore, grouped by task and leader type for all of the following analyses. Performance scores were converted to standard scores for all four tasks, and 2 x 4 analyses of variance showed that leaders with high complexity scores had significantly better performance than leaders with low complexity scores across the four tasks ($p < .025$). We mentioned earlier that neither leader nor member complexity scores were related to verbal fluency. These results could, therefore, not be attributed to the intelligence or verbal fluency of the leader. (See Table 1.)

Behavior ratings. The behavior ratings produced interesting but inconsistent results. It is important first, however, to point out that leader ratings and member ratings of the same behavior are often not highly related (Mitchell, 1970). Table 2 shows the correlations between leader and member ratings of the leader's behavior and of the group atmosphere for all four tasks. The agreement on the leader's behavior was obviously very low in some instances, with the estimate of group atmosphere being perhaps the most reliable. With these limitations in mind we will discuss the results in more detail.

Analyses of variance similar to the one mentioned above on performance scores (2 x 4) were computed for the three general ratings, the seven behavioral ratings, and group atmosphere. These analyses were done for both leaders and members. One result indicated that leaders with low complexity scores saw themselves as having significantly more influence ($p < .025$) as

TABLE 1

Analyses of Variance on Performance Scores

for High and Low Complexity Leaders

Task Performance ($\bar{X}$)

Complexity	Bus	Ninane	Negro	Abortion
high	+.56	+.52	+.22	+.19
low	-.56	-.52	-.22	-.19

Source	Nesting	Denominator	Degrees of Freedom	MS	F
Leaders		Subjects	1	9.01	7.69*
Subjects	B		14	1.17	
Tasks		Subjects by tasks	3	.00	n.s.
Leaders X tasks		Subjects by tasks	3	.60	n.s.
Subjects X tasks	B		42	.78	

*$p < .025$

TABLE 2

Correlations of leader and member judgments of the same behavior for each task

Judgments of	Correlations for: Bus Routing Task	Abortion Discussion Task	Picnic Routing Task	Negro Discussion Task
1. Leader's influence	.32*	.15	.48*	.70*
2. Leader's control	.38*	.36*	.04	-.12
3. Leader's enjoyment	.23	.22	.27	.38*
4. Leader obtaining group participation by asking questions	-.04	.12	.65*	.63*
5. Leader relieving tension by laughing, joking	.43*	.52*	.31*	.05
6. Leader using his own ideas	.41*	.54*	.74*	.18
7. Leader keeping discussion centered on the task	.53*	.32*	.30*	-.04
8. Leader inquiring about opinions and feelings of members	.16	.36*	.72*	.41*
9. Leader attempting to give everyone's ideas equal consideration	.23	.31*	.67*	.49*
10. Leader making sure everyone got along well.	.08	.42*	.39*	.51*
11. Group atmosphere	.43*	.74*	.69*	.80*

*$p < .05$

well as more control ($p < .10$). These results are intriguing in light of the fact that these leaders had poorer performance than leaders with high complexity scores and that the members of these less effective leaders perceived the exact opposite (i.e., that leaders with high complexity scores had more control and influence).

The ratings of more specific behaviors did not produce any significant main effects for leader or member ratings. There was, however, significant main effect for the two different types of tasks (structured vs. discussion). In the two discussion tasks the leader was seen by either the leaders or the members as asking more questions and asking more for opinions and feelings than in the two routine tasks. These results support the work of Hackman (1966) which indicated that the specific behaviors of leaders and members tend to be more a function of the group task than of the leader. The analyses and the F ratios are presented in Tables 3 and 4.

Variance in behavior. The final set of analyses examined the variance in complex leaders' behavior compared to non-complex leaders. We had hypothesized that leaders with high complexity scores would show more variance in behavior than leaders with low complexity scores. F tests were run on the variance of the 11 leader ratings and 11 (summed) member ratings across all four tasks. Of these 22 tests, four were significant ($p < .05$) in the expected direction, none in the opposite direction. Both the leaders and members perceived the high complexity leaders as having greater variation in the group atmosphere. These leaders were also perceived by the members as varying more in their laughing or joking behaviors and in their enjoyment of the various task settings.

TABLE 3

Analyses of variance for behavior ratings of leaders and performance: Two levels of leader (high and low complexity) and four tasks

Question	F Ratio B = Leaders	C = Task	B x C
1. Leader's influence	6.50*	1.07	1.04
2. Leader's control	3.33	.70	1.47
3. Leader's enjoyment	1.25	.93	.07
4. Leader obtaining group participation by asking questions	.48	1.34	.99
5. Leader relieving tension by laughing, joking	1.02	.32	.42
6. Leader using his own ideas	.07	.13	2.54
7. Leader keeping discussion centered on the task	.59	.89	.61
8. Leader inquiring about opinions and feelings of members	1.54	5.35*	.59
9. Leader attempting to give everyone's ideas equal consideration	.12	.66	1.13
10. Leader making sure everyone got along well	.51	.84	.35
11. Group atmosphere	.00	.79	1.07
12. Performance	7.69*	.00	.78

*$p < .025$

TABLE 4

Analyses of variance for behavior ratings of members:
Two levels of leader (high and low complexity) and four tasks

Question	B = Leaders	C = Task	B x C
1. Leader's influence	.70	1.11	.41
2. Leader's control	.23	.67	.40
3. Leader's enjoyment	.01	3.26*	1.17
4. Leader obtaining group participation by asking questions	1.29	3.76*	.76
5. Leader relieving tension by laughing, joking	.12	1.62	1.04
6. Leader using his own ideas	.34	.96	1.23
7. Leader keeping discussion centered on the task	1.65	2.39	1.06
8. Leader inquiring about opinions and feelings of members	2.91	2.73	.69
9. Leader attempting to give everyone's ideas equal consideration	.00	1.26	.29
10. Leader making sure everyone got along well	.87	1.04	1.09
11. Group atmosphere	1.99	.13	1.27

$p < .05$

Further support for this hypothesis was provided by the correlations of the first ten ratings for the high and low complexity leaders with the group atmosphere score. The correlations of these ratings with the group atmosphere ratings were examined in order to see if the leaders were perceived as changing their behavior as the situation was perceived as being more or less favorable. These correlations indicated that high complexity leaders as perceived by themselves and by their members had more variables systematically related to their perception of the group atmosphere than did low complexity leaders. In other words, as the group atmosphere was perceived as changing, the behavior of the complex leaders was perceived as changing. For the leader ratings, these coefficients ranged from -.29 to +.69 (six out of ten significant, $p < .05$) for high complexity leaders and from -.11 to +.41 (one out of ten significant, $p < .05$) for the low complexity leaders. For the member ratings the coefficients varied from -.01 to +.80 (seven out of ten significant, $p < .05$) for the high complexity leaders and from +.26 to +.58 (six out of ten significant, $p < .05$) for the low complexity leaders. (See Table 5.)

In summary then, the behavior of the leaders with high complexity scores does seem to be perceived as varying more than that of the leaders with low complexity scores. We will elaborate further on this point in the final discussion.

Summary and Conclusions

The results of this study indicate that leaders with high cognitive complexity scores tended to have better performance and more variable behavior than leaders with low cognitive complexity scores. A few words of caution, however, seem appropriate.

Table 5

Correlations or ratings with Group Atmosphere

Variable	High Complexity Leaders Leader Rating	High Complexity Leaders Member Rating	Low Complexity leaders Leader Rating	Low Complexity leaders Member Rating
1. Leader's influence	.08	.43*	-.08	.26
2. Leader's control	-.17	.23	.04	.34
3. Leader's enjoyment	.62*	.73*	.27	.47*
4. Leader obtaining group participation by asking questions	.56*	.62*	-.00	.57*
5. Leader relieving tension by laughing, joking	.26	.68*	.10	.49*
6. Leader using his own ideas	-.29	-.02	-.12	.31
7. Leader keeping discussion centered on task	.51*	..20	.07	.57*
8. Leader inquiring about opinions and feelings of members	.64*	.75*	.09	.49*
9. Leader attempting to give everyone's ideas equal consideration	.69*	.77*	.41*	.31
10. Leader making sure everyone got along well	.69*	.80*	.30	.51*

*$p < .05$ for $N = 32$

Numerous reviews have indicated that leadership traits rarely give consistent results over a variety of settings (Mann, 1959; Stogdill, 1948; Gibb, 1954). It seems likely, therefore, that in certain situations, complex information processing skills might be harmful rather than helpful. For example, in settings which are relatively simple or extremely stressful, the ability to make fine differentiations might lead to irrelevant behavior on the part of the leader. It is also true that we have sampled only a very small number of intellective tasks. Different types of tasks (motor skill or assembly line, etc.) must also be sampled to ascertain the generalizability of these findings.

Finally, although leaders with high complexity scores did not differ in the types of behaviors they used from leaders with low complexity scores, it appeared that they varied their behavior more than low complexity leaders. These data suggest that it is not necessarily what the leader does that is important (being considerate, initiating structure, etc.), but rather his flexibility or ability to change set. Further work is, therefore, required to determine the conditions under which cognitive complexity contributes to group performance and how this complexity manifests itself in specific leader behaviors.

References

Fiedler, F. E. Engineer the job to fit the manager. Harvard Business Review, 1965, 43, 115-122.

Fiedler, F. E. A theory of leadership effectiveness. New York: McGraw-Hill, 1967.

Gardner, R. W., & Schoen, R. A. Differentiation and abstraction in concept formation. Psychological Monographs, 76, No. 560, 1962.

Gibb, C. A. Leadership. In G. Lindzey (Ed.), Handbook of social psychology, Vol. II, Cambridge, Mass.: Addison-Wesley, 1954.

Hackman, J. R. Effects of task characteristics on group products. Urbana, Ill.: Department of Psychology, University of Illinois, 1966. (Mimeograph)

Harvey, O. J., Hunt, D. E., & Schroder, H. M. Conceptual systems and personality organization. New York: Wiley, 1961.

Karlins, M., & Lamm, H. Information search as a function of conceptual structure in a complex problem-solving task. Journal of Personality and Social Psychology, 1967, 5, 456-459.

Mann, R. D. A review of the relationships between personality and performance in small groups. Psychological Bulletin, 1959, 56, 241-270.

Mitchell, T. R. The construct validity of three dimensions of leadership research. Journal of Social Psychology, 1970, 80, 89-94.

Ninane, P., & Fiedler, F. E. Member reactions to success and failure of task groups. Human Relations, 1970, 23(1), 1970, 3-13.

Schroder, H. M., Driver, N. J., & Streufert, S. Human information processing. New York: Holt, Rinehart, & Winston, 1967

Scott, W. A. Cognitive complexity and cognitive flexibility. Sociometry, 1962, 25, 405-414.

Scott, W. A. Conceptualizing and measuring structural properties of cognition. In O. J. Harvey (Ed.), Motivation and social interaction: cognitive determinants. New York: Ronald, 1963, 266-288.

Scott, W. A. Measuring individual differences in cognitive balance. Boulder: University of Colorado, 1967.

Stager, P. Conceptual level as a composition variable in small-group decision making. Journal of Personality and Social Psychology, 1967, 5, 152-161.

Stogdill, R. M. Personal factors associated with leadership: A survey of the literature. Journal of Psychology, 1948, 25, 35-71.

Stogdill, R. M., & Coons, A. E. Leader behavior: Its description and measurement. Research Monograph No. 88, Ohio State University, Columbus, Ohio, 1957.

Vannoy, J. S. Generality of cognitive complexity-simplicity as a personality construct. Journal of Personality and Social Psychology, 1965, 2, 385-396.

Wallach, M. Commentary: Active-analytical vs. passive-global cognitive functioning. In S. Messick, & J. Ross (Eds.), Measurement in personality and cognition. New York: Wiley, 1962, 199-215.

Zajonc, R. B. The process of cognitive tuning in communication. Journal of Abnormal and Social Psychology, 1960, 61, 159-167.

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