Some Social Factors Related to Performance in a Research Organization

Relations between the social environment provided by the organization and the performance of medical researchers are reported in this article. The study was conducted in a large governmental organization devoted to medical research. Results indicate that scientists tend to perform more acceptably when they are closely associated with colleagues having a variety of values, experiences, and disciplines and when supervisors provide frequent stimulation combined with autonomy of action.

The author is study director at the Institute for Social Research, University of Michigan.

THIS report will summarize some of the highlights from a study conducted in a large government organization for medical research.¹ The organization employs some three hundred investigators who conduct laboratory research on the frontiers of medical knowledge. The organization is regarded by its employees as having an atmosphere similar to that of a large university.

¹The study was financed by the National Institutes of Health, U.S. Public Health Service, and the Department of Health, Education, and Welfare. Additional analysis and writing were made possible by a grant from the Foundation for Research on Human Behavior, Ann Arbor, Michigan. Assisting in the study were Glen Mellinger, Robert C. Davis, and Howard Baumgartel.
The research is generally of a fundamental rather than applied character, and considerable freedom is allowed the individual investigator.

As part of the study, judgments of individuals' scientific performance were made by panels of investigators. The latter were experienced scientists, nonsupervisory as well as supervisory, who were familiar with the work of the others. Where possible, each scientist was evaluated twice, once in comparison with others in his own laboratory or division, and again in comparison with others in the same scientific discipline. A particular individual might be judged by as many as fourteen other scientists, only one or two of whom would have supervisory authority over him. Essentially, this was an evaluation by one's peers. The assessors' judgments were assigned numerical scores from 1 to 9, the scores from different judges were averaged, and where a scientist received both a laboratory and a discipline score the two results were combined.

In our analyses we wanted to study the effects of the social environment on the individual's performance. For this purpose we wanted to reduce variations in performance caused by individual factors such as basic ability, quality of training, or type of experience. It seemed reasonable to assume that such factors would be reflected in the scientist's amount of education and in his job grade. The data showed that with increase in grade, there was a definite increase in average performance; and non-Ph.D.'s scored lower than Ph.D.'s of equal rank. By adding or subtracting an appropriate constant, an "adjusted" score for each individual was obtained such that the residual variation still associated with grade or doctoral degree was no greater than 0.4 per cent. In this adjusted measure it seems likely that differences owing to individual factors have been reduced.

SCIENCE VERSUS INSTITUTIONAL VALUES

If social factors can influence a person's scientific achievement, they may do so in part by affecting his motivation toward the work. To study such effects it was first important to determine whether motivational factors have any association with performance.
In a previous study of a government organization administering research grants, Dwaine Marvick\textsuperscript{2} demonstrated the significance of certain general motivations or values. He isolated two syndromes labeled the “specialist” and “institutional” orientations. The specialist seeks the approval of a larger circle of peers wherever they may be found; the institutionalist seeks rewards within a localized institution. We wanted to know whether such orientations would relate to scientific performance.

In the present study each scientist filled out a questionnaire, one part of which listed nine factors that might be important in a job. Each person indicated how much personal importance he attached to each factor. A correlational analysis located three items which seemed to represent the specialist or (as we named it) the science orientation. Another cluster of items seemed to indicate the institutional orientation.\textsuperscript{3}

In an analysis of these data, R. C. Davis\textsuperscript{4} found that the index of science orientation was significantly related to scientific performance, whereas the index of institutional orientation was not. Furthermore, it appeared that a strong science orientation went with high performance mainly when the institutional orientation was weak; strength of science orientation was not significantly related to performance when the institutional orientation was strong.

Similar results were obtained with data from another study conducted at the Institute for Social Research by S. Lieberman


\textsuperscript{3}The three science-oriented items were: stress on using present abilities or knowledge, freedom to carry out original ideas, and chance to contribute to basic scientific knowledge. The three institutional-oriented items were: stress on having an important job, association with high-level persons having important responsibilities, and sense of belonging to an organization with prestige in the lay community. The latter cluster might also be labeled a “prestige” orientation. The two indexes were neither positively nor negatively correlated; a person high on one might be either high or low on the other.

and L. Meltzer as part of the Survey of Physiological Sciences sponsored by the American Physiological Society. In a questionnaire sent to a nation-wide population of physiologists, similar questions about the personal importance of various job factors were asked. Scientific performance was measured in this instance by the number of times each person had been cited in the *Annual Review of Physiology* for the preceding three years. When a parallel index of science orientation was formed, a significant relationship was again found with performance. No relationship was found between the number of citations and the scientist's motivation toward prestige items such as advancement in his profession.

These results raise some provocative questions for research administrators grappling with knotty problems of salaries, titles, and promotion policies. The point to be stressed here, though, is that the index of science orientation does relate to actual performance and thus points toward a way in which performance might be increased. Some results to be given later suggest that science motivations may be affected by the type of leadership in the organization. It may also be possible to raise the level of science motivation through the selection of new personnel or through the kinds of recognition given.

**CONTACT WITH SCIENTIFIC COLLEAGUES**

A second series of analyses approached the question of whether the style of communication with one's colleagues can raise or depress the level of performance. If so, what is the optimal pattern of such contact? Should a scientist rub elbows daily with his peers, or should he be assigned a cubbyhole where he can work without distraction? If frequent contact proves worth while, should it be mainly with others of similar background, with whom he can talk the same language, or would he benefit more by the stimulation of ideas from persons of different backgrounds?

To study these questions G. Mellinger used nonsupervisory scientists at a senior level who were mature investigators at civil

---


6G. Mellinger, manuscript prepared for *Interpersonal Factors in Research, Part II* (in process; Ann Arbor: Institute for Social Research, University of Michigan, 1956).
service grades of GS–12 and higher, with several years of experience. On their questionnaires scientists named up to fifteen people in the organization with whom "some contact is of greatest significance to you in your work," and indicated the frequency of contact with each.

For each respondent we selected the five scientific colleagues he named as most significant, excluding supervisors above him, technical assistants, and administrative personnel. For each colleague we computed a measure of similarity on the science and institutional orientations described above; we averaged these for the five colleagues, and also computed the mean frequency of contact. Figure 1 shows the results when these measures are jointly related to scientific performance.

Among the four possible combinations of frequency and similarity to five colleagues in prior employment and to frequency of contact (at senior level).

\footnote{In the following data a distinction will be made between senior- and junior-level scientists. They differ in experience and in autonomy and may require different kinds of social environment for high performance.}
larity, highest performance is found when scientists have frequent contact (more than several times weekly) with colleagues who are on the average dissimilar from themselves in values.

Increase in contact is significantly related to performance only if colleagues are on the whole dissimilar from themselves. When colleagues have similar values, more frequent contact is not accompanied by higher performance; there is, in fact, a slight decline.8

These findings suggest that scientists benefit by frequent opportunities to exchange ideas with persons having different values. Since the institutionally oriented persons in our study tend to lay stress on improving the nation's health, the results might mean that those who emphasize basic research can benefit from contact with those who stress applied research, and vice versa. The interpretation suggested here is that frequent contact with dissimilar colleagues stimulates higher performance. It might also be argued that abler scientists seek out those of different values. The second interpretation seems to be preferred by some scientists who do not feel that social factors can influence level of performance. The facts are, however (from data not shown here), that the colleagues of abler scientists are on the average just as similar to these scientists as the colleagues of less able scientists are to the less able scientists. It does not look as though the more competent investigators deliberately seek contacts with colleagues of dissimilar values.

Another result in a parallel vein was obtained with a different measure of similarity. On the questionnaire scientists were asked about the kinds of situations in which they had previously worked; most frequently named were government, university, and hospital (including private practice). Depending on the number of such situations that they shared in common, each pair received a high to a low similarity score; and the average similarity between a scientist and his five main colleagues was computed.

The results are shown in Figure 2. We note that highest performance occurs when the senior scientist has frequent contact with five colleagues who are markedly dissimilar from himself in type of previous employment.

8This does not mean that among this group "the fewer contacts the better." Most scientists report average contacts weekly or more often with their colleagues. Among the few isolates who report less than weekly contacts, performance tends to be low.
Frequency of contact is associated with significantly higher performance only for those scientists whose colleagues are dissimilar from themselves. When colleagues come from similar backgrounds, increase in contact from weekly to daily tends to go with slightly lower performance.

On the other hand, among moderately isolated scientists (who see their colleagues weekly) dissimilarity in previous employment seems to be a handicap; performance is significantly lower in comparison to those having similar colleagues.

It is likely that those who have worked previously in government, university, and hospital situations will develop different views as to the best way of approaching a research problem.
Whatever the nature of these differences, it appears that they can encourage high scientific performance, provided there is ample interchange among the individuals. But diverse viewpoints may be a hindrance if they constitute the only contacts of a relatively isolated individual.

Is the similarity illustrated in Figures 1 and 2 the same thing or two different things? The correlation between the two similarity measures is in fact slightly negative (−.15) and not statistically significant. It appears that we are dealing with two independent kinds of similarity. What their precise nature is remains a question for future research.

Such results raise the question of scientific discipline. Will scientists benefit from close contact with others in different disciplines? Does organization of laboratories along interdisciplinary “project team” lines give better results than organization into single-discipline groups?

In our study we classified each scientist according to the major and minor disciplines he was currently using in his work. These classifications were based in part on the disciplines he named on his questionnaire and in part on the groupings established to assess performance. Similarity scores were assigned, depending on whether scientists had major fields in common, minor fields in common, or no fields in common.

The results of this analysis are not as clear-cut as the previous ones, but they point in a similar direction. In general, senior scientists whose five main colleagues differ from themselves in field of work tend to perform somewhat better; and this tendency is more marked with frequent contact.

The tendencies (according to data not shown here) are also sharper when the colleagues are not equally dissimilar, but vary in their degree of dissimilarity. Thus it appears that for high performance the scientist requires variety in his daily fare. Additional support of this idea will be given below.

CONTACTS WITH SINGLE INDIVIDUALS

The foregoing analyses raised further questions. We have studied contacts with five colleagues; will similar results obtain with the scientist's one most important colleague? And what about his
chief—should the scientist work under a supervisor who is in a different field? To explore such questions we again used frequency of contact and several measures of similarity. The present analysis was extended to junior-level scientists (in civil service grades GS–9 and GS–11, most of whom have doctoral degrees but limited experience) as well as the senior level used previously.

One particularly surprising result emerged, as shown in Figure 3. The measures used are similar to those in Figure 1 except that they refer to the one most significant colleague rather than to an average for five colleagues. The figure demonstrates that high scientific performance is associated with daily contact provided that the scientist's major colleague has similar values. By contrast, Figure 1 showed that high performance goes with frequent contact provided that contact is mainly with five colleagues who have dissimilar values.

How to reconcile these results? The following view seems

![Figure 3](image-url)
plausible: For maximum performance it is helpful to have at least one close colleague with a similar orientation—someone who "talks the same language," with whom the scientist can air his problems and get a sympathetic hearing. But one or two such individuals are enough. To provide the stimulation of new ideas, it is important that the remaining contacts be with people of dissimilar orientation. In short, one kind of environment for high performance is frequent contact with a variety of viewpoints, a few similar, but most of them different.

Other conditions for achieving variety are possible. Consider the relatively isolated scientist who sees his colleagues only once or twice a week. The data from Figures 1 and 3 suggest that in this case his major colleagues should possess different values and the remaining colleagues similar ones. Again the principle of variety is indicated.

The same principle emerges when we examine the relationships of the scientist to both his chief and his major colleague in terms of scientific field. The data in Figure 4 show that scien-

![Figure 4](image-url)

*Figure 4. Scientific performance related to similarity of field to that of chief and main colleague.*
scientific performance tends to be higher if the scientist's chief and major colleague are heterogeneous in scientific field—one similar and the other dissimilar. Lower performance occurs when the two are homogeneous—both dissimilar to the scientist or (for senior investigators) both similar.

It does not seem to matter whether the chief plays the role of "confidant" and the colleague that of "stimulator," or vice versa. The important thing is that both roles be provided, especially for senior scientists. The key lies in variety.

LEADERSHIP METHODS OF THE IMMEDIATE CHIEF

What sort of supervision do scientific personnel require for maximum performance? One view commonly held is that the scientific supervisor should do little except keep out of the way of his subordinates. The soundest way to encourage high achievement, according to this philosophy, is to secure good people, give them good equipment and assistants, and then leave them alone. This view arises in part as a protest against the continental tradition of the Herr Geheimrat, the professor directing his students, the master his disciples.

Many scientists conceive of leadership in this either/or manner, and do not recognize the existence of a middle ground between domination and isolation. Does such a middle ground of scientific leadership exist, and, if so, how does it affect performance as compared with the extremes?

In the following analyses, measures of supervisory behavior were obtained from the average reports of two or more subordinates. This procedure helps to guard against the possibility that the supervisor is simply adjusting his methods of leadership to the abilities of a particular subordinate.

In this section we shall deal with "small working groups"—two or more investigators who name the same person as their immediate chief. (In terms of the administrative structure, such a group might consist of a unit, a section, or even a small laboratory.)

A major supervisory variable we attempted to measure may be called independence or autonomy from the chief. Two items were used: (1) the percentage of scientists in each group who report that in selecting work problems or in interpreting results they
make their own decisions; (2) the extent to which they feel the chief's activities and decisions can influence their work. With these two items, four patterns of leadership were defined, ranging from "dependence" (subordinates make few decisions, and the chief has considerable influence) to "independence" (subordinates make many decisions on their own, and the chief has little influence). The intermediate categories were "mutual influence" (both subordinates and the chief have much to say) and "separation" (neither subordinates nor the chief have much to say—apparently decisions depend on the nature of the task or on higher chiefs).

The results (not illustrated here) show that performance is slightly higher under an intermediate degree of independence, rather than under full dependence or full independence. Junior scientists (civil service grades GS-9 and GS-11) benefit somewhat more from "mutual influence" between chief and subordinates; senior scientists (GS grades 12 and up) benefit somewhat more from "separation."

It seems plausible that too much independence may deprive the subordinate of the stimulation that a competent chief can provide. On the other hand, too close dependence on the chief may stifle individual initiative. By this line of reasoning, highest performance should result if we can combine the benefits of frequent stimulation with the assurance of freedom for initiative. To test this hypothesis we analyzed not only independence but also amount of contact with the chief.

The results in Figure 5 support the hypothesis that at the junior level, performance is highest when independence from the chief is combined with frequent contact with him—when the individual has frequent interaction with the chief, but also has considerable voice in the final decisions. A similar but less striking tendency exists for senior-level scientists (data not shown).

LEADERSHIP FACTORS IN THE LABORATORY CHIEF

The final set of analyses to be reported were conducted by Howard Baumgartel. Studies in industry have indicated that a

"H. Baumgartel, "Leadership, Motivation and Attitudes in Twenty Research Laboratories" (unpublished doctor's dissertation, University of Michigan, 1955);
department head can influence the productivity and morale employees at several levels under him. Does the same hold in a research organization? To study this question, Baumga analyzed certain measures of the chiefs of twenty laborator. The latter were basic administrative units ranging in size six to thirty-three professional investigators, and as many professional assistants. A typical laboratory was subdivided three or four sections.

For this analysis it was not possible to use the measure of individual performance as a criterion, since the measure was originally obtained in part by comparing individuals with others in the same laboratory, thus reducing interlaboratory differences. But we have seen above that questionnaire items such as science-

oriented values do relate to performance; these and other attitude items were therefore used as criteria.

Baumgartel developed three measures of the laboratory chief. One was an index of the chief's "scientific performance and motivation," based on several intercorrelated items including his own score on performance and his motivation toward the science values. This index measures the extent to which a chief combines both high technical qualifications and strong motivation toward scientific goals.

A second index described patterns of supervision and was similar to the variable of "independence" discussed above. (The latter, in fact, was suggested by Baumgartel's analysis.) Examination of several items revealed three clusters or types: a "directive" type (characterized by high influence by the chief, little freedom for subordinates to make decisions, and moderate frequency of contact between them); a "participatory" type (high influence by the chief plus considerable freedom for subordinates, and frequent contact); and a "laissez-faire" pattern (little contact, little influence by the chief, and considerable freedom of decision by subordinates).

A third leadership factor was the extent to which the leader's actual methods of making decisions corresponded to the methods preferred by his subordinates. The discrepancy between these two measures constituted an index of "role conformity."

It was predicted that subordinates' motivations toward science values, their sense of progress toward these values, and their attitudes toward leadership would be higher under (a) chiefs with a high index of performance-and-motivation in comparison to a low index; (b) chiefs who used participatory leadership in comparison to those using directive; (c) chiefs who used participatory leadership in comparison to laissez-faire; (d) chiefs who conformed to the role expectations of subordinates in comparison to those not conforming.

A summary of results is given in Table 1. A "positive" relationship is one which conforms to the prediction; a "negative" relationship is one showing no difference, or a difference opposite to prediction.

Of forty-five tests where the direction of relationship was predicted, forty are positive, and sixteen of these are statistically
Table 1. Measures of scientists' motivations and attitudes related to factors in laboratory chief's leadership.*

<table>
<thead>
<tr>
<th>Leadership factors</th>
<th>Performance-and-motivation</th>
<th>Partic., not directive</th>
<th>Partic., not laissez-faire</th>
<th>Role conformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures from scientists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science motivations (based on 4 measures)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significantly positive...</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>No differences</td>
</tr>
<tr>
<td>Positive...</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Negative...</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>expected</td>
</tr>
<tr>
<td>Sense of progress toward scientific goals (based on 3 measures)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significantly positive...</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>No differences</td>
</tr>
<tr>
<td>Positive...</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Negative...</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>expected</td>
</tr>
<tr>
<td>Attitudes toward leadership (based on 8 measures)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significantly positive...</td>
<td>No differences</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Positive...</td>
<td>differences</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Negative...</td>
<td>expected</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

*This table summarizes the results of forty-five tests of relationship between leadership factors and scientists' motives and attitudes. (Science motivations were measured in four ways; sense of progress in three ways; and attitudes toward leadership in eight ways.) It was predicted that these relationships would be positive. The table shows the number of tests in which the relationships were positive and negative. A "significantly positive" relationship is a difference in the predicted direction which is large enough to attain the .05 level of confidence (using a one-tailed t test).

significant at the 5-per-cent level of confidence (using a one-tailed test). Only five results are negative. Thus the data in general support the hypotheses.

Some specific features deserve attention. First, the laboratory chief's own index of performance-and-motivation is more significantly related to his subordinates' motivation and sense of progress than is his pattern of supervisory behavior. In this organization, successful leadership depends not simply on administrative skill but also depends heavily on the leader's personal qualifications and his own motivation toward the task.
Second, there is fairly clear evidence that participatory leadership is more effective than directive leadership (and also slightly better than the laissez-faire pattern).

**SUMMARY**

In a large government organization conducting basic medical research, the level of individuals' scientific performance is found to be higher under the following conditions:

1. Strong personal emphasis placed upon science-oriented values of using one's abilities, having freedom to pursue original ideas, and making contributions to basic scientific knowledge;

2. Frequent (daily) contact with several scientific colleagues who on the average have been employed in settings different from one's own, who stress values different from one's own, and who tend to work in scientific fields different from one's own;

3. At the same time, frequent contact with at least one important colleague who has similar professional values;

4. A chief and a major colleague one of whom is in the same scientific discipline and the other in a different one, rather than both similar or both dissimilar;

5. A chief who gives neither complete autonomy nor excessive direction, but who frequently interacts with subordinates and who also gives them the opportunity to make their own decisions.

In addition to these findings on scientific performance, analyses of scientists' motivations and attitudes in twenty laboratories show that:

6. Motivation and sense of progress toward scientific goals are stronger under laboratory chiefs who themselves are highly competent and motivated individuals;

7. Motivations and attitudes also tend to be stronger under laboratory chiefs who employ participatory rather than directive or laissez-faire leadership.

To summarize these findings in a few words, it appears that many scientists may benefit from (a) close colleagues who represent a *variety* of values, experiences, and disciplines, and (b) supervisors who avoid both isolation and domination and who provide frequent stimulation combined with autonomy of action.