

NON-ADDITIVE RELATIONS IN ORGANIZATIONAL SURVEY DATA

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Studies concerning employee attitudes and perceptions of organizational climate, supervisory behavior, and quality of work life as measured by organizational questionnaires often try to explain particular perceptions as a function either of other perceptions or of "objective" characteristics of the person (e.g., gender, age) and of the employee's situation (e.g., department, job category). Most researchers have not considered interaction among the individually or organizationally defined characteristics. The research reported herein systematically addressed the question of interaction among the objective characteristics and perceptual and attitudinal measures as well as the magnitude of the relationships between objective and perceived measures.

Objective characteristics have been thought to influence perceptions in a number of ways. They are not infrequently used to index underlying psychological states which are unavailable to direct measurement (e.g., Blood & Hulin's [1967] use of community size to index worker alienation). A related rationale is the use of objective characteristics as summaries of past experience. For example, tenure provides a gross summary of experience in the organization. Lieberman (1955) found changes in attitudes associated with changes in one's work role (worker, union steward, etc.).

More recent studies have focused on the relative magnitude of the relationship between individually and organizationally defined characteristics<sup>1</sup> and work attitudes or perceptions. Table 1 summarizes three such studies. As shown, organizational characteristics explain at least as much or more variation than individual characteristics. The magnitude of the relationships ranges from .02 to .82 for organizational characteristics and from .08 to .39 for individual characteristics.

Two questions arise immediately when examining these results. First, is there interaction among the objective characteristics when predicting attitudinal and perceptual measures? Second, are the differences in the magnitudes between studies a consequence of their methodologies?

There are clear methodological differences among the studies of Table 1. Both Newman (1975) and Herman & Hulin (1971) used multiple discriminant functions (MDF) to define linear combinations of perceptual variables to predict, in effect, the objective characteristics. This reverses the usual implied causal relation between the independent and dependent variables. Perhaps more importantly, the statistical procedure utilized is sensitive to chance relationships, and replication is therefore critical.

Gavin (1975) analyzed a vector of six organizational climate factors using a three by three multivariate analysis of variance (MANOVA). The two "treatment" dimensions (independent variables) were factor analytic defined

Table 1

Ability of Individually and Organizationally Defined Characteristics to Explain Variation in Individual Perceptions<sup>1</sup>

	Herman & Hulin (1971) <sup>2</sup>	Newman (1975) <sup>2</sup>	Gavin (1975) <sup>3</sup>
INDIVIDUAL			
Age	.39	.30	Note 3
Education	.37	.08	Note 3
Gender	NA	.09	Note 3
Number of Dependents	NA	.11	Note 3
Summary	NA	NA	.12
ORGANIZATIONAL			
Tenure	.40	.28	Note 3
Hierarchical level	.43	.31	Note 3
Division or function	.60	.02	Note 3
Department	.82	.22	Note 3
Work group	NA	.34	Note 3
Summary	NA	NA	.15

<sup>1</sup>All entries are significant at least at  $p \leq .02$ .

<sup>2</sup>All entries are omega<sup>2</sup> from multiple discriminant function analyses.

<sup>3</sup>Gavin employed factor analytic techniques to summarize individual and organizational variables. Cell entries are eta<sup>2</sup>.

composites, one measuring individual characteristics and the other, organizationally defined characteristics. The MANOVA procedure allows for a test of interaction between the two "treatments," but only for interactions between the two composite measures, not between the variables within each composite. Thus, in accordance with his interest in person by situation interaction, Gavin examined only a subset of the possible interactions. He did not find significant interaction.

The present study applies a more general procedure to test for interactions among all objective characteristics and reports the magnitude of the relationships between objective characteristics and attitudinal or perceptual measures.

Method

These data were collected on a self-administered questionnaire survey of all employees in a high technology research and development organization. The survey was designed to assess organizational functioning and individual attitudes. A total of 3500 employees (an 88% response rate) voluntarily completed the survey, primarily in group administrations during normal working hours.

The measures of attitudes and perceptions (hereafter referred to as dependent variables) include 34 individual items and 38 multi-item indices. All items were originally measured on a five point Likert response scale. The indices are composed of from two to ten equally weighted items and have internal consistency reliabilities (alpha's) ranging from .62 to .92 with a mean of .74. All dependent variables are assumed to be interval level measures. Table 2 lists the six major content domains represented by the 72 dependent variables.

Table 2

Dependent Variables: Perceptual and Attitudinal Content Domains

Organizational Climate
Personnel Policies
Job Characteristics
Supervisory Behavior
Work Group Practices
Outcome Measures:
Satisfaction
Motivation
Performance

The self-report objective characteristics (referred to as independent variables) include the four individual characteristics and eight organizationally defined characteristics listed in Table 3.

Our basic strategy for the detection of non-additive effects involves comparing the proportion of each dependent variable's variance which is explained by the entire set of twelve objective characteristics using two analytic techniques.

Multiple Classification Analysis (Andrews, et al., 1973) is a sophisticated version of dummy variable multiple regression. The use of MCA assumes an additive relation between the dependent and independent variables. The proportion of variance explained by the additive model is measured by the R-squared statistic. MCA provides an R-square which is adjusted downward for the degrees of freedom used by the independent variables. It is these adjusted R-squares, one from the analysis of each of the 72 dependent variables, which are reported here.

The Automatic Interaction Detector (Sonquist, et al., 1971)<sup>2</sup> is a binary segmentation technique (Fielding, 1977). AID selects that set of binary splits, defined by the independent variables, which accounts for the largest proportion of variance in the dependent variable.

Table 3

Independent Variables:  
Individual and Organizationally Defined Characteristics

<u>Individual Characteristics</u>	<u>Number of Categories</u>
Education <sup>1</sup>	5
Age <sup>1</sup>	5
Gender	2
Ethnic Group	5
<u>Organizationally Defined Characteristics</u>	
Facility	5
Tenure with company <sup>1</sup>	5
Tenure in job assignment <sup>1</sup>	5
Tenure in job category <sup>1</sup>	5
Job Category	9
Per Cent time supervising <sup>1,2</sup>	6
Salary <sup>1</sup>	6
Organizational unit	4

<sup>1</sup> Variables treated as ordinal in the AID analyses. See text.

<sup>2</sup> Non-supervisors were coded as a separate category.

At step k in the analysis, k+1 groups exist. At the start of step k+1, all possible binary splits<sup>3</sup> of all existing k+1 groups are examined and the one split is made, yielding k+2 groups which explain the most variance. The process continues until the most powerful possible split explains less than some criterion proportion of variance. In these analyses, this criterion was set at 1%.

The total amount of variance explained by all splits which have been defined is reported as an eta-square statistic (squared correlation ratio) which is identical to the eta-square from an analysis of variance. This eta-square is the non-linear analog of R-square from MCA.

The splits defined by AID are completely unconstrained by any assumption of an additive relation between the independent variables and the dependent measure. Therefore, if non-additive relations (i.e., interactions) exist for a particular dependent variable, they will be revealed by an eta-square which is larger than R-square from the corresponding MCA.

Before presenting the results, three other methodological considerations merit mention. First, for economy of effort, the AID analyses were conducted for a sample of 41 of all 72 dependent variables. These 41 variables were selected to represent dependent variables: 1) from all six content domains (Table 2); 2) with the full range of R-squares (from the already conducted MCA's), and 3) which were both indices and individual items.

The analyses reported here were guided by only the most general of hypotheses and, therefore, were conducted first on a one-third random sample of respondents (N = 1000 + 10% once respondents with missing data were deleted). Any analysis which met or exceeded the criterion described below were replicated

on the entire sample. This was done in order to determine if the results should be attributed to chance while simultaneously obtaining the best estimate of various parameters for the total sample. This replication is especially important for the AID analyses as AID selects only the best splits from among all possible splits. Therefore, AID is particularly prone to producing results which may not replicate.

With the relatively large N's involved here, the traditional criteria of statistical significance lose much of their utility. The results of these analyses were evaluated in terms of the proportion of variance explained. An R-square or eta-square value of .10 or greater was selected as a criterion of "practical significance" for evaluating the relationships studied here. With these N's, R-squares and eta-squares of .10 or greater are always significant at least at  $p < .05$ . All MCA's or AID's which yielded an R-square or eta-square of at least .10 from the initial analyses were repeated on the total sample. In these instances, the statistic from the total sample is reported here.

### Results

The examination for interaction involved comparing the strength of relationships using an additive model (R-squared, MCA) with the corresponding analysis using the non-additive model (eta-squared, AID). For the 41 dependent variables examined, the range of increases was 0% to 6% (actual difference in percent variation accounted for) using a one-third developmental sample. The average increase was 2%. The largest increase of 6% could not be replicated on the total sample.

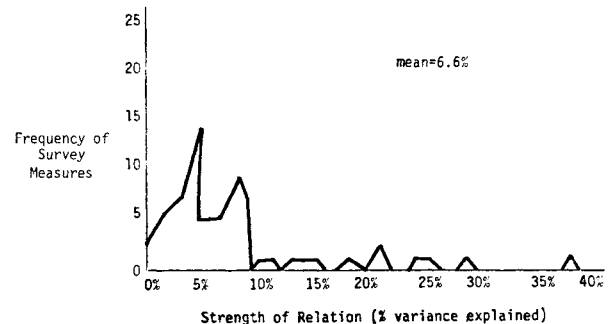
The second question can be stated, "How much of the variation in individuals' attitudes can be explained by the objective characteristics (12 variables) taken together using an additive model?" The answer, of course, depends on the particular attitude being measured. All 72 variables subsumed by the topics in Table 2 were examined to determine the extent they could be explained by the variables in Table 3. Figure 1 shows the distribution of answers, i.e., the frequency distribution of the R-squared between objective characteristics and all 72 attitudes, assuming an additive model. The average R-squared is .066.

There are twelve dependent variables with R-square valued of .10 or higher. Nine of the twelve come from the Job Characteristic (5 variables) and Personnel Policy (4 variables) domains. Only one each come from the Organizational Climate, Work Group Practice and Outcome Measures domains.

These analyses also provide results (not shown) bearing on the relative importance of organizational vs. individual characteristics for explaining variance in these twelve dependent variables. The relative importance of the two types of characteristics is a function of the content domains of the dependent variables. Perceived Job Characteristics are related almost exclusively to objective organizationally defined characteristics. Perception of Personnel Policies concerning personal characteristics (e.g., policies addressing ethnicity, gender, etc.) are related to both organizational and

individual characteristics, but more strongly to the latter.

Figure 1  
Strength of Relation:  
Objective Characteristics and 72 Employee Attitudes<sup>1</sup>



<sup>1</sup> 38 indices and 34 individual items

### Discussion

The above results indicate a virtual absence of interaction among the objective characteristics and employees' perceptions and attitudes concerning numerous aspects of organizational life. The broad range of objective and perceptual variables employed here increases confidence in the generalizability of these findings. While it is impossible to prove the null hypothesis, these results, which confirm and extend those of Gavin (1975), suggest support for the practice of examining primarily the main effects of objective characteristics on employee attitudes and perceptions. Replication of these findings in a variety of settings would allow increased confidence in the assumption of additivity required by numerous analytic procedures. Of course, specific interactions suggested by general theory or the dynamics of a particular organization should be investigated on a case by case basis.

Objective characteristic main effects in this study are much weaker than expected from both previous research and the expectations of organizational members. The few dependent variables which have at least ten percent of their variance explained are those relevant to phenomena which are explicitly related to objective characteristics (for example, tenure as a determinant of pay; organizational unit as

a determinant of job characteristics).

The general weakness of observed relations is in stark contrast to the findings of Herman and Hulin (1971) and Newman (1975), who used a very different method (MDF) and is consistent with Gavin (1975), who used a relatively similar method (MANOVA). It is our suspicion that the application of MDF to the present data would elevate the magnitude of relations substantially. However, in our opinion, the question to which MDF provides an answer is of little theoretical or practical significance in the present context.

These findings are also discrepant from commonplace beliefs at the research site regarding the existence of differences among groups of individuals defined according to these objective characteristics. While the repudiation of folk wisdom by systematic research and analyses is not uncommon, this discrepancy merits some attention. If one accepts these findings as accurate, then one must explain the erroneous beliefs of organizational members as well as the organizational homogeneity suggested by these results. Addressing only the latter, we suspect that the existence of a broad agreement regarding organizational purposes reduces conflict regarding goals which might have led to between group differences. Conflict regarding means may be resolved rationally, in light of agreed upon goals, further reducing dynamics which lead to systematically different perceptions. Increased rationality is of course a desired consequence of the bureaucratic form, which characterizes this organization and which seeks to treat everyone in a similar manner, i.e., according to the same rules. Thus, it is less than surprising that the differences reported here are not pronounced. Finally, the variety of functions performed in their organization is much less than that performed by other organizations, such as a manufacturing firm which could include Research and Development as one of several functions.

Of course, one could accept the beliefs of organizational members as more likely to be valid and reliable than the results of survey research. From this perspective, this research might be flawed by the omission of critical variables. In fact, large portions of the research site are structured as a matrix organization with much of the work being accomplished by teams composed of members of different organizational units. Information regarding membership on these teams was not collected as part of the survey and it may be that this single variable is more powerful than all twelve variables studied here. However, even if one accepts this argument, it does not detract from the finding of minimal effects for these twelve variables.

In summary, this research suggests that most objective characteristics have little effect, either alone or in interactions with other variables, on a wide variety of attitudes and perceptions relevant to organizational life. Further research is needed to address the following issues:

- 1) the consequences of alternative methods for addressing these relationships;
- 2) the possible effect of organizational forms, environments, and dynamics on the magnitude of these relationships;
- 3) the inclusion of dependent and independent variables which address organizational idiosyncracies as well as more general concepts.

#### FOOTNOTES

- <sup>1</sup>There is no accepted practice for distinguishing among these two types of characteristics. Here, individual characteristics are limited to those which can be measured with no reference to the organization.
- <sup>2</sup>An updated version of AID, called SEARCH (Survey Research Center, 1979) was used for these analyses.
- <sup>3</sup>In these analyses independent variables which are naturally ordinal (see Table 2) were constrained so that only splits between adjacent categories were considered.

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