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18 October 1962

Application of an Additive Model to Impression Formation

Abstract. A simple mathematical model, based on the hypothesis that the psychological process underlying behavior is additive, was applied to the data of an experiment on the formation of personality impressions. Of 12 subjects, only three made responses which deviated by statistically significant amounts from responses predicted from the additive model, and these discrepancies were relatively small.

Recent work on the formation of impressions of personality, departing from an early gestalt orientation (*1*), has centered attention on the relation of the response to the individual stimuli from which the impression is formed. Predictive schemes involving correlation analysis, multiple regression, and weighted averages have yielded stimulus-response correlations ranging from medium to high (*2*). However, the associated problems of assessing the (statistical) significance and the meaning of the discrepancies from the predictive scheme have been given little or no attention.

This report describes the application of an additive model to the data obtained from an experimental design which permits joint evaluation of predicted response and of the discrepancy between observed and predicted values. Sets of three adjectives, describing hypothetical persons, were rated on a 20-point scale according to the "likeableness" of a person so described.

The basic stimuli presented to each test subject were nine common adjectives. These nine adjectives were split into three subgroups, each subgroup containing one adjective each of high, medium, and low "likeableness" value. For example, the three subgroups used for the first two subjects were as follows: (i) *good-natured, bold, humorless;* (ii) *level-headed, unsophisticated, ungrateful;* and (iii) *tactful, solemn, irresponsible.* These three subgroups were then used in a 3^3 factorial design yielding 27 possible combinations or sets of three adjectives such that each combination contained one adjective from each subgroup.

The adjectives were randomly selected from lists of 60 adjectives of each "likeableness" value, as determined from a separate normative study. Six groups of nine adjectives were used, and two subjects judged the combinations formed from each group for "likeableness" on the 20-point scale.

Twelve advanced-undergraduate males received $5 each for serving five consecutive days. The eight initial (warm-up) sets of the day included two sets of very high value and two sets of very low value, presented to define the limits of the rating scale. An additional 27 sets were from the aforementioned six groups of adjectives; two subjects judged the combinations from each group. The eight initial sets and the 27 test sets were presented in a different random order each day, but each subject judged the same 35 sets each day.

The experimenter slowly read the adjectives of each set aloud. The card for the set was then handed to the subject, who read the adjectives aloud in reverse order and made his judgment. One set was presented each 20 seconds.

The basic purpose of the experiment was to study the degree to which the response to the sets of adjectives may be represented as the arithmetic mean of the psychological-scale values for the individual adjectives. Since three adjectives were used in each set, the following model is appropriate:

$$R_{ijk} = 1/3(a_i + b_j + c_k) + d_{ijk} + e, \quad i, j, k, = 1, 2, 3$$

Here R_{ijk} is the observed response to adjective set (i, j, k); a_i, b_j, and c_k are the psychological values of these adjectives; d_{ijk} is the discrepancy from additivity; and e is the prevailing response variability (unreliability). If perfect additivity prevails, then the d_{ijk} terms will all be zero.

This model is standard in the analysis of variance (*3*), which yields significance tests of goodness of fit, and least-squares estimates of the psychological-scale values. Separate analyses were made for each test subject, since the values for the adjectives on the psychological scale vary with the individual. Only the data from tests given on the last three days were analyzed, tests on the first two days being considered practice.

Table 1. The summary statistical analysis (see text). The numerical suffixes to the initials of the subject designate the basic group of adjectives used for that subject. For 6 and 54 *df*, an *F* ratio of 2.28 is significant at the .05 level; for 20 and 54 *df*, an *F* ratio of 1.78 is significant at the .05 level.

Subject	Correlation: observed, predicted	*F* ratio: Additivity, 6 *df*	*F* ratio: Nonadditivity, 20 *df*	Error mean square, 54 *df*
FF–1	.98	54.50	0.84	3.42
RH–1	.98	50.18	.48	1.67
AR–2	.99	223.94	1.65	0.57
AT–2	.97	52.33	0.94	1.75
JW–3	.99	126.87	.94	0.80
DB–3	.95	36.53	1.10	5.56
LL–4	.98	66.23	0.86	4.02
JZ–4	.96	54.75	1.37	2.02
BM–5	.97	31.41	0.67	6.11
FM–5	.95	74.65	2.53	1.47
MG–6	.94	105.97	2.84	2.90
NB–6	.95	74.88	2.45	2.79

Figure 1 is a plot of observed response versus response predicted on the basis of the additive model for three selected subjects, two of whom showed the largest and one of whom showed

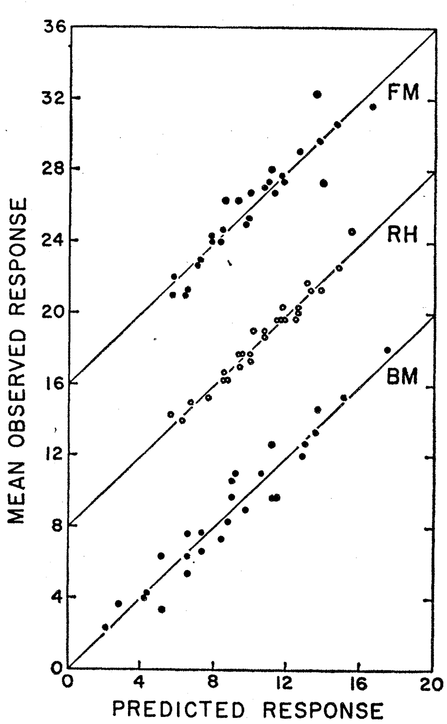

Fig. 1. Plots of observed response versus response predicted from the additive model for three selected subjects, two of whom showed the largest and one of whom showed the smallest deviations from the predicted values. The data points for subjects RH and FM are displaced upward by 8 and 16 units, respectively.

the smallest deviations from the predicted values. These deviations from the straight line represent response variability plus the discrepancy from additivity.

Table 1 gives a condensed statistical analysis. The correlations in column 2 are between observed response and response predicted on the basis of the additive hypothesis. The mean correlation is .967, so it appears that the additive model accounts for the behavior quite well. These correlations are descriptive indices whose significance is best tested by the F ratios in column 3, all of which are highly significant.

That the model has high predictive power indicates that it will be useful in several ways. However, predictive power is only one criterion of the goodness of a model, and it is to be expected that any reasonable model will have rather high predictive power. In assessing the model, therefore, it is vital to test the deviations from prediction.

The discrepancies between predicted and observed values were tested by the F ratios for nonadditivity. The results are given in column 4 of Table 1. These are significant only for the last three subjects, and even for them the discrepancies are relatively small.

The square root of one-third the error mean square given in column 5 of Table 1 is the standard deviation of a single data point for the corresponding subject of Fig. 1.

Breakdown of the nonadditive component into the several interactions of the 3^3 design gave no new information. In general, however, study of the separate interactions will be useful in searching for regularity in whatever nonadditivity may obtain.

The statistical analysis has shown that the greater part of the subject's response behavior can be accounted for by the simple additive model. In other words, it was as though the subject assigned a value to each single adjective and, when presented with a set of adjectives, gave the mean of the corresponding values as his response.

This may seem more reasonable if the psychological values of the adjectives are considered to be points of equal weight on a line. The mean is then that point at which the algebraic sum of the distances from the mean to the several points representing the adjectives is zero.

Whether a similar degree of additivity will obtain with other stimuli and other judgment tasks remains to be seen. No doubt additivity cannot be generally expected, and even if the nonadditivities are small, they may still be of major interest in many situations. In any event, these techniques should be a useful tool in helping to bring impression-formation processes within the domain of experimental analysis (*4*).

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22 June 1962

Pooled Estimates of Parent-Child Correlations in Stature from Birth to Maturity

Abstract. Correlations between the heights of children throughout their development and their parents' mature heights differ widely in different growth studies. The range of values, however, is shown to be within the limits of sampling error, making it possible to estimate correlations for each age from birth to maturity. Mother-child correlations are generally higher than father-child correlations, and for both comparisons the correlation increases when the child reaches early adolescence. There is no relation between the heights of the parents and the timing of the child's growth spurt, but there probably is a relation between the heights of the parents and the amount the child grows during early adolescence.

Stature is among the more heritable of human morphological characteristics. However, quantitative estimates, from different investigations, of the degree of correlation between the heights of the parents and the height of the child throughout the period of the child's growth show little agreement (*1*). The individual entries in Fig. 1 summarize the results we have been able to gather on this problem. The data are drawn from studies in which the children's heights were determined through standard anthropometric procedures and estimates of the heights of both parents were available (*2*). These correlations illustrate the wide discrepancies in the results obtained in different samples. Thus, in one investigation (*3*) there was higher correlation for parent and child of the same sex than for parent and child of opposite sexes, while in another (*4*), a higher correlation for father and child of either sex than for mother and child is suggested. Our own data from the Guidance Study of the University of California Institute of Human Development yield yet another pattern: the correlation for mother and child is generally the higher, regardless of the sex of the offspring (*5*).

The purpose of this study was to determine whether these disagreements are attributable to sampling error and, if they are, to combine the separate sample values for each of the four parent-child combinations into pooled best estimates of parent-child correlations for stature at each age level. Resolution of the disparity would seem to be a sufficient good in itself, but there were other reasons for making the study. The availability of more reliable parent-child correlations could increase the accuracy of multiple-regression predictions of children's mature height, whether the prediction was made from the parents' heights alone or from the parents' heights and the child's current height. Also, the matter of the inheritance of stature seems an open question, and such data may serve as reliable landmarks for theoretical speculation concerning the mechanisms involved.

In order to establish the legitimacy of pooling the correlation coefficients for each parent-child combination, the variation among the values available from different studies for a given parent-child combination at each age of the child was evaluated by the Snedecor chi-square test (*6*). In only five of the 84 [21 (ages) × 2 (parents) × 2 (sexes of child)] comparisons made was this variation statistically significant (*7*). Since these instances were so few, since they were scattered among the comparisons, and since the pooled values in these instances were in each case well in line with the adjacent pooled values, the values were permitted to contribute to the smoothed curves.

The pooled values of Fig. 1 were derived through a modification of the method of "moving averages," in which the correlation at any particular age is the weighted mean of coefficients