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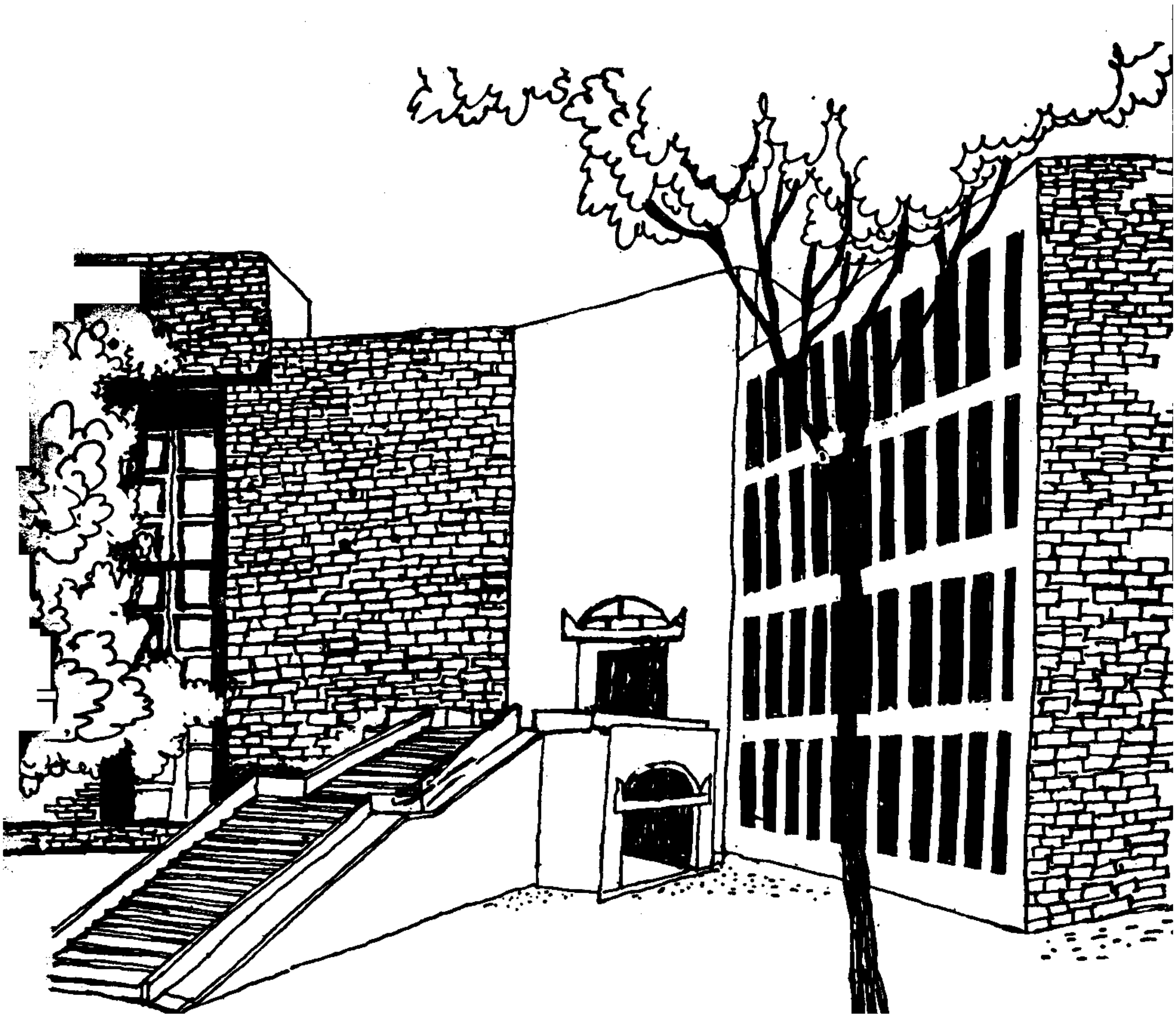

LIFE PERFORMANCE ≠ MOTIVATION X ABILITY X OPPORTUNITY: INDIVIDUAL DIFFERENCES IN PREDICTIVE MODELS

By

Ramadhar Singh

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INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA

Abstract

Previous research showed that prediction of life performance from information about motivation and ability follows the multiplying rule. The present experiment added a third supposedly multiplying factor, external opportunity, and tested the plausibility of the three-factor multiplying model. There was no evidence for the hypothesized model in either group or individual subject level analysis. Subjects (n = 72) employed as many as 11 different models. These models indicated that the opportunity information multiplied one of the two internal factors, either motivation or ability. Moreover, when it played an additive role, the relationship between motivation and ability was generally additive. Two rival hypotheses, differences in social theories about how the three factors determine life performance and differences in information valuation due to presence of separate initial opinions of motivation, ability, and opportunity in the subjects, were suggested to account for the individual differences in predictive models.

Recent research has shown that people multiply information about motivation and ability of a person when they predict his or her life performance (Singh, Bhargava, & Norman, 1986). The multiplying rule is supported by the result that the factorial plot of the Motivation x Ability effect exhibits a linear fan pattern and the entire interaction effect resides in just the bilinear trend (Anderson, 1982, pp. 72-79). The present experiment examined the effects of a third multiplying factor, namely, external opportunity available for growth (Anderson, 1976), on the relationship between motivation and ability information.

On purely rational ground, opportunity information may be expected to act as a third multiplier, as Anderson (1976) also suggested. If this proposition is correct, then

$$\text{Life Performance} = \text{Motivation} \times \text{Ability} \times \text{Opportunity}. \qquad (1)$$

In this case, the fan pattern in the Motivation x Ability effect should get amplified as opportunity for growth increases. Thus, each of the three two-factor interactions should be concentrated in the bilinear trend, and the three-factor interaction should be concentrated in the trilinear trend.

Previous studies of the three-factor multiplying model in other judgmental domains, however, show that some of the two-factor interactions did not reside in the bilinear trend alone, nor did the three-factor interaction reside in the trilinear trend alone in group-level analysis (Klitzner & Anderson, 1977; Norman, 1977). Even individual subject analyses did not yield overwhelming support for the three-factor multiplying model. For example, in judging the worth of adding a piece of information to a simple decision task on the basis of amount of prior information, diagnosticity of the added information, and payoff for a correct decision (Shanteau & Anderson, 1972), only 17 of the 32 subjects followed the complete three-factor multiplying model. The remaining 15 subjects employed compound adding-multiplying model of various forms. Therefore, Shanteau and Anderson agreed with the conclusion of Slovic and Lichtenstein (1968) that subjects may simplify complex tasks by using an adding rule in combining stimuli which should, on objective grounds, be multiplied.

The central idea behind the task-simplification explanation of the discrepancy from the hypothesized model is that human judgment should obey the prescriptions of rationality and optimality. Consequently, deviations from the model are errors and inaccuracies in human judgment. Such a position of rationalistic, normative theory may not be very useful if the purpose is to describe and understand cognitive processes. As Anderson (1985) rightly observes,

> Cognitive and normative approaches differ in their basic focus, one on process, the other on accuracy. Integration theory itself is primarily concerned with processes of valuation and integration. From this standpoint, the question of accuracy can be theoretically misleading... In place of accuracy, the study of <u>response patterns</u> can provide a base for cognitive analysis... This method, moreover, can also be used in the many situations in which no normative standard exists (pp. 17-18).

This cognitive approach of analyzing <u>response patterns</u> in judgment and decision (Anderson, 1981, 1982) has proven to be extremely useful in author's laboratory in studying imputations about missing information (Singh, in press), in establishing presence of separate initial opinions for qualitatively different types of information in judges (Singh & Bhargava, 1986; Singh et al., 1986), and in demonstrating cultural difference in cognitive algebra of exam performance (Gupta & Singh, 1981; Singh & Bhargava, 1985, 1986; Singh, Gupta, & Dalal, 1979). The last set of studies are of especial significance, for they showed that Indian subjects followed the constant-weight averaging rule instead of the normative multiplying rule (Anderson, 1983; Anderson & Butzin, 1974; Heider, 1958), and that the constant-weight averaging rule was attributable to a genuine cultural difference between Indians and Americans in their outlook on how motivation and ability determine exam performance and not to simplification of a multiplying task to an adding one (Singh, 1981).

Also of immediate relevance are findings from a study of the effects of reliability of motivation and ability information on prediction of life performance (Singh et al., 1986). The normative multiplying model predicts that the greater the reliability of one kind of information, the greater the effectiveness of other kind of information. Contrary to this, there was a complete independence between reliability of one kind of information and effectiveness of other kind of information. This happened because reliability of information caused averaging of external information with the corresponding initial opinion of the subjects at the first stage of integration and the estimated values of motivation and ability were multiplied at the second stage of integration. Interestingly, inclusion of two multiplying factors, namely, reliability of motivation cue and reliability of ability cue, both of which are supposed to affect weight p rameters (Anderson, 1981), did not alter the fan pattern in the Motivation x Ability effect.

Results of these studies question the adequacy of the task-simplification explanation and its emphasis on accuracy in judgment. In addition, they indicate that a better approach to human judgment is to focus on the ways in which people deal with information rather than the ways in which they ought to be dealing with information (Anderson, 1985).

Other than the multiplicative role of opportunity information, there exist two more possibilities. The first is an additive role. If opportunity information is interpreted as task difficulty in a manner identical to that in prediction of exam performance (Singh & Bhargava, 1985), then the pattern in the Motivation x Ability effect would remain the same across the different levels of opportunity but differ in only the origin. Thus, the two two-factor interactions of Motivation x Opportunity and Ability x Opportunity would show parallelism. The second is a moderating role in which fan, parallelism, and convergence patterns in the Motivation x Ability effect would emerge when opportunity for growth would be little, moderate, and great, respectively. Such a shift in pattern would take place only if opportunity is interpreted as task difficulty in a manner similar to that by American college students (Surber, 1981).

The main purpose of the present experiment was to assess the plausibility of the multiplicative, additive, and moderating role that opportunity information may play in prediction of life performance. Since previous tests of the three-factor multiplying model obtained ambiguous results in group level analysis due to either a small number of 15 (Klitzner & Anderson, 1977) and 24 (Norman, 1977) subjects or a wide variety of individual differences in integration models (Klitzner & Anderson, 1977; Shanteau & Anderson, 1972), the present experiment tested model at both the group and individual subject levels. There were a relatively greater number of subjects ($\underline{n}$ = 72) and more repeated judgments (n = 4) of the same stimuli than in the tests just mentioned. This provided a more thorough examination of the effects that the addition of a third multiplying factor produces in a social judgment task of predicting the performance of others.

Method

Stimuli and Design

Descriptions of high school students were typed on separate index cards. Each card listed information about motivation and ability of the stimulus person as well as external opportunity available for his or her growth.

Motivation was defined by the frequency of serious effort the stimulus person puts in on any assigned task, and it was described as never, very rarely, once in a while, sometimes, quite often, very often, and always. Ability was defined as student's intelligence, and was described as extremely low, very much below average, below average, average, above average, very much above average, and extremely high. Opportunity available for growth was estimated from the stimulus person's family and other conditions (e.g., socio-economic status; physical, social, and educational facilities; and scope for doing whatever one wishes). It was described along a 7-point scale: Not at all, a little bit of, some, a moderate amount of, fairly much, a good deal of, a great deal of, and all.

Stimulus descriptions were generated from a 3 x 3 x 3 (Opportunity x Motivation x Ability) factorial design. The three levels of opportunity were a little bit of (LITL), a moderate amount of (MOD), and a great deal of (GRT); the three levels of serious effort on the task were very rarely (LO), sometimes

(MOD), and very often (HI); and the three levels of ability were very much below average (VBA), average (AV), and very much above average (VAA).

In addition to the main set of 27 descriptions, nine filler descriptions were constructed. They were composed of levels more extreme than those used in the factorial design previously mentioned. Descriptions with extreme levels were intended to serve as end anchors and to ensure that subjects would use the response scale in a uniform manner (Anderson, 1981, 1982). There were also 10 practice examples which included four extreme descriptions from the fillers and six descriptions from the main set. A total of 46 (27 main, 9 filler, and 10 practice) descriptions were thus made.

Procedure

Subjects participated in the study over two successive evenings, and predicted life performance of male stimulus persons on one day and of female stimulus persons on the other day. The order of presentation of the male and female stimulus persons over the two sessions was balanced over half of the subjects of both sexes.

Subjects, gathered in groups of six, received a typed sheet of instructions that described the nature of judgment and their role as judges. The task was introduced as dealing with prediction of life performance of some Standard X students. Subjects were urged to assume that each student would enter to a profession, and that life performance would mean how high the student would go in that profession during his or her life time.

It was emphasized that prediction of life performance would be made on the basis of whatever was currently known about the motivation and ability of the stimulus student and external opportunity for growth available to him or her. The sources of information about opportunity, motivation, and ability were supposedly a teacher, a fast friend, and an another teacher of the stimulus person in order. They were in contact with the stimulus student since the last five years. Accordingly, subjects were asked to regard the opinions of the three sources as highly reliable and credible.

After reading the instruction sheet twice, each subject worked with the practice examples. He (she) read the information typed on card, and predicted how high the stimulus student would go in his or her profession during life time. This prediction was made along a 21-step ladder which had digits 1-21 written on the corresponding steps.

Before collecting the actual data, the main points of the instructions were summarized to the subjects by the experimenter. All queries about the task were answered. Finally, each subject rated the main and filler cards one by one over two trials of judgment in different shuffled orders. In each case, the subject wrote the code number of the stimulus person and the judgment of life performance on a response sheet supplied for this purpose. Data from both trials of judgment were coded and analyzed.

After the collection of data on the second day, the general purpose of the research was described to the subjects by the experimenter. Subjects were also thanked for their cooperation in the experiment.

<u>Subjects</u>

Three independent groups of subjects, each consisting of 12 males and 12 females, participated in the experiment. The first group had students from the

2-year postgraduate program in management of the Indian Institute of Management, Ahmedabad; the second group of subjects consisted of students from the 2-year master's of business administration program of the Biharilal Kanhaiyalal School of Business Management at Gujarat University, Ahmedabad; and the final group of subjects were research assistants in various projects undertaken at the Indian Institute of Management, Ahmedabad. The age of these subjects ranged between 19 to 25 years. All the 72 subjects volunteered to participate in response to the author's appeal. Subjects from the three different groups were intended to extend generality of the results.

Results

Group Analyses

Graphic analyses. Of the three possible roles that opportunity information might have played, the multiplicative role seemed to have been supported by the results. This can be seen in Figure 1 which plots mean life performance as a function of motivation (curve parameter) and ability under the conditions of little, moderate, and great opportunity from left to right in order. The three levels of ability are spaced on the horizontal axis according to the marginal means in the factorial design as prescribed in functional measurement (Anderson, 1981).

Figure 1 about here

The three-factor multiplying rule requires that all the three graphs of Figure 1 should have a linear fan pattern, and the magnitude of fanning should gradually increase from left to right as opportunity increases. This appears to have been satisfied. The vertical spread between top and bottom curves of the left, center, and right graphs increase about 25%, 32%, and 50%, respectively, over the given range of ability, as indicated by the respective equal-length vertical bars.

Similar picture is present in the three graphs of Figure 2 which plots the three two-factor interaction effects. The multiplying rule requires each of the three graphs to have the linear fan patterns and that also seems to have been met. The vertical spread between top and bottom curves of the left, center, and right graphs over the first to the last level of the factor listed on the horizontal axis are approximately 36%, 26%, and 31% in order, as indexed by the respective equal-length vertical bars. On the basis of the prevailing pattern of divergence in the six graphs of Figures 1 and 2, it may tentatively be said that the three-factor multiplying model may provide an approximate representation of the process underlying prediction of life performance.

Figure 2 about here

Statistical analyses. Results from detailed statistical analyses performed according to the logic and method of functional measurement (Anderson, 1981, 1982) qualified the above interpretation made from the general trend in the graphic plots. Although the three-factor interaction was statistically significant, $F\ (8, 528) = 4.39$, $p < .01$, it did not have trilinear trend, $F\ (1, 71) = 1.31$, contrary to the prescription of the three-factor multiplying model.

Table 1 presents $\underline{F}$ ratios for the Motivation x Ability effect as well as for four possible trend components in the Motivation x Ability effect at each of the three levels of opportunity factor. It is evident that left graph of Figure 1 can be regarded as having parallelism pattern, for all the four trend components are absent. The right graph of Figure 1 cannot be regarded as having exact fan pattern because both the Linear x Linear and Linear x Quadratic components are present. Only the center graph has an exact fan pattern as required by the multiplying model.

Table 1 about here

The picture presented by the two-factor interactions was not unambiguous either. Table 2 lists $\underline{F}$ ratios for each of the three two-factor interactions and for the four trend components in each interaction. These statistics indicate that the left and center graphs of Figure 2 have perfect fan pattern but the right graph has marked deviations from the fan pattern. Since the Linear x Quadratic component accounted for 35.86 per cent of the variance in the Ability x Opportunity effect, it may be accepted as showing near-parallelism. Tentatively, therefore, it seems reasonable to propose a compound multiplying-adding model,

Life Performance = Motivation x (Ability + Opportunity), (2)

in lieu of the three-factor multiplying model for the group level data.

Table 2 about here

The foregoing results confirm the difficulties encountered in tests of three-factor multiplying model by Klitzner and Anderson (1977) and by Norman

(1977). More importantly, they rule out the possibility that lack of power of the previous tests caused the difficulties. In the present analyses, the cell means of the two-factor and three-factor interactions were based on 864 and 288 observations, respectively, which are much larger than in the previous studies. Nevertheless, no clear model emerged for the three-factor multiplying task. This raises the possibility that there exists a wide variety of individual differences in handling a three-factor multiplying task.

Generality of results. Results related to the pattern in the two-factor and three-factor interaction effects described above were readily generalizable to the male and female subjects of three groups and to their two trials of judgment. These three factors or their two-way or three-way combinations did not interact with the two-factor and three-factor effects of motivation, ability, and opportunity information at all.

However, two four-way interactions involving sex of stimulus persons were statistically significant. The first was a Sex of subjects x Sex of stimulus persons x Motivation x Ability effect, $F\ (4, 264) = 2.48$, $p < .05$, in that male subjects had uniformly employed the multiplying rule with both sexes, whereas female subjects had followed adding with male but multiplying with female stimulus persons. The second was a Sex of stimulus persons x Motivation x Ability x Opportunity effect, $F\ (8, 528) = 2.16$, $p < .05$, attributable primarily to parallelism in the condition of little opportunity for males and to presence of both the Linear x Linear and Linear x Quadratic components, $F\ (1, 71) = 21.67$ and 5.26, in the condition of great opportunity for females. Since Sex of stimulus persons x Motivation x Ability and Sex of stimulus persons x Motivation x Ability x Opportunity effects were present randomly in only 10% individual subject analyses considered next, generality of results to even sex of the stimulus persons can be considered as good.

Individual Subject Analyses

Models followed by individual subjects were diagnosed in two phases. In the first phase, the three main effects, the bilinear component of the three two-factor interactions, and the trilinear component of the three-factor interaction were examined. A subject having all the seven effects as statistically significant at least at .05 level was identified as one who tried to follow the three-factor multiplying model; a subject having only the three significant main effects, in contrast, was identified as one who tried to follow the three-factor adding model. The same logic guided the classification of subjects who tried to use the compound multiplying-adding models of different forms.

The adding, multiplying, and compound multiplying-adding models all require that the residual components of the interaction effects should be statistically nonsignificant (Anderson, 1981, 1982). In the second phase, therefore, the residual components of the four interaction effects were considered. Subjects were adjudged as successful users of the model identified at the first phase only if all the four tests of the residual components failed to reach .05 level of statistical significance.

These analyses disclosed that a significantly greater number (i.e., 63 of the 72) of the subjects had tried to render judgments according to a model, $\underline{X}^2(1) = 40.50$, $\underline{p} < .01$. Judgments of the remaining nine subjects were not consistent with any sensible model or the effects of task difficulty on prodiction of exam performance found by Surber (1981). Accordingly, these cases were dropped from any further consideration.

Individual differences in models. Results confirmed the possibility that the ambiguity in tests of the three-factor multiplying model at the group level arises because subjects employ a wide variety of integration rules in such a task. It is evident from Table 3 that the subjects followed as many as 11 different models, and the hypothesized three-factor multiplying model (i.e., Equation 1) as well as the compound multiplying-adding model (i.e., Equation 2) tentatively proposed from the general trend in group data was each tried by only 8% of the 72 subjects.

Table 3 about here

The 11 models of Table 3 fall neatly into four categories. Category 1 has Model 1 which is the simplest: Prediction was based on just the motivation information. Category 2 consists of Models 2, 3, and 4. They all are additive models: The first two are a two-factor adding rule; the last one is a three-factor adding rule. Category 3 includes Model 5 through 10. They all are compound multiplying-adding models but of three different structures. One of the three factors plays an additive role in Models 5, 6, and 7; the two factors are added and then both are multiplied by the remaining factor in Models 8 and 9; and each of the three pairs of the three factors are multiplied separately and then their products are added in Model 10. Model 11 which is a complete three-factor multiplying model belongs to the fourth and final category.

It should be noted that five of the 22 subjects who had followed a clear model in the experiment of Shanteau and Anderson (1972) had used the compound models. Of the five subjects, two followed model similar to the present Model 10; two used model comparable to Models 8 and 9; and one employed model like Models 5-7. None of the 32 subjects had used two-factor or three-factor adding model. In the study by Klitzner and Anderson (1977), 12 subjects used models similar to Models 8 and 9; the remaining three subjects followed a three-factor adding model.

In the present experiment, the three-factor multiplying, compound multiplying-adding, and adding models were used by 8%, 47%, and 31% subjects, respectively. These figures are markedly different from those in the studies referred to above. Perhaps social cognition tasks elicit a greater variety of responses than other decision tasks. Furthermore, the simple additive and compound multiplying-adding models provide a complete representation of the judgment process of at least 78% subjects.

Effects of opportunity information. The 11 models of Table 3 allow precise specification of the effects that opportunity information produced. The effects are of five types. First, opportunity information played an additive role with 33% subjects (i.e., Models 3-5). Second, it multiplied just one of the two supposedly multiplying factors, either motivation or ability, with 35% subjects (i.e., Models 6-9). Third, it multiplied both factors separately with 7% subjects (i.e., Model 10). Fourth, it acted as a third multiplier, as originally proposed, with 8% subjects (i.e., Model 11). Finally, it was ignored by 4% subjects (i.e., Models 1 and 2).

Of the five roles played by opportunity information, the multiplicative role with one of the two multiplying factors and the additive role appear to be the more dominant ones. Interestingly, when opportunity information entered as an additive factor in the model, it did not leave the multiplicative relationship between motivation and ability intact. Of the 24 cases of an additive effect (see Models 3 and 4), only four maintained the multiplicative relationship between motivation and ability, $\underline{X}^2(1) = 10.66$, $\underline{p} < .01$.

It appears that it would not be always possible to predict the exact effects that the addition of a third supposedly multiplying factor would produce. Nevertheless, it is easy to interpret the different kinds of effects produced by a new factor by establishing cognitive algebra underlying the judgment. The present work illustrates this diagnostic power of functional measurement (Anderson, 1981, 1982).

Evidence against task-simplification. With respect to their complexity, the 11 models of Table 3 can be regarded as of seven graded levels. The complexity increases from top to bottom, and the models of the same structure and complexity are shown to fall within the limits of the adjacent rightside vertical bars. The number of subjects who tried (T) and succeeded (S) in using these models and the ratios of S to T are also given in Table 3.

If complexity of task engenders simplification strategy (Slovic & Lichtenstein, 1968), then the ratio of successful subjects to those who tried to follow a model should be greater for simple than for complex models. Thus, the S/T ratio should gradually decrease from top to bottom in the last column of Table 3. Although the S/T ratio is the highest for Model 1 which was used by just one subject and the lowest for Model 11, other ratios are not as expected. Moreover, the S/T ratios for models of the same structure and complexity (e.g., Model 5 vs 7, Model 6 vs 7) are quite different, $\underline{X}^2(1) = 16.32$ and

13.88, $p < .01$. What is most damaging to the task-simplification hypothesis is that the S/T ratio is greater for the three-factor adding model (i.e., Model 4), a more complex strategy, than for the two-factor adding model (i.e., Models 2 and 3), $X^2(1) = 18.00$. All these results cast serious doubt on the explanatory power of the task-simplification hypothesis for the failure of the three-factor multiplying model at both the group and individual subject level analyses.

Generality of results to sex of stimulus person. Sex of stimulus person, which had produced two significant interaction effects in group analysis as already noted, did not moderate any two-factor or the three-factor interaction effect at all in 90% individual subject analyses. The remaining 10% of the subjects belonged to both sexes about equally, and they had scattered interactions. Accordingly, the pattern in the two-factor and three-factor interaction effects also seems to be generalizable to the sex of stimulus person.

Discussion

The main finding of the present study is that people employ a wide variety of models when they predict life performance from information about motivation, ability, and opportunity of others. When information pertaining to the two internal variables, namely, motivation and ability, are given, subjects multiply the two (Singh et al., 1986). But the addition of a third multiplying factor of external opportunity engenders a different kind of responses.

The opportunity information did not play a multiplicative (Anderson, 1976), an additive (Singh & Bhargava, 1985), or a moderating (Surber, 1981) role as was originally hypothesized. Instead of acting as a third multiplier, opportunity information multiplied just one of the two internal factors, either motivation or ability. Moreover, when opportunity information played an additive role, the relationship between motivation and ability was generally additive, and not multiplicative. These results from individual subject analyses illustrate the diagnostic power of cognitive theory of judgment and decision (Anderson, 1981, 1982, 1985).

Previous studies (Klitzner & Anderson, 1977; Norman, 1977; Shanteau & Anderson, 1972) faced difficulties in the tests of three-factor multiplying model in other judgmental domains. The present study indicates that the problems are even more serious in social judgment. Also, the problems in the tests of three-factor multiplying model arise not from low power of the test as Klitzner and Anderson thought but from the heterogeneity in models used by the subjects. For such a task, therefore, both the group and individual subject analyses are essential. The overall group level analysis alone is not enough to either accept (Norman & Louviere, 1974) or qualify (Norman, 1977) the three-factor multiplying model.

Hypotheses for Individual Differences

Why did subjects employ as many as 11 models in the present task? Two hypotheses, differences in social theories and differences in separate initial opinions of motivation, ability, and opportunity, deserve serious consideration.

Differences in social theories. The first hypothesis is that people in fact vary widely in their social theories about how motivation, ability, and opportunity determine performance in real life, and that the predictive models that the subjects used reflect on their such theories. Subjects who tried to follow the three-factor multiplying model perhaps believe that all the three factors are necessary, that the effectiveness of one depends upon the values of the other two factors, and that absence of any one could render the person as totally ineffective. Subjects who followed the compound multiplying-adding models have a slightly different social theories. They perhaps believe that only two of the three factors are necessary but the presence of the third factor is always better than its absence.

Subjects who followed a three-factor adding model (i.e., Model 4) seem to think that all three factors determine life performance, that effectiveness of one factor is independent of the value of other factors, and that the higher the strength of the factors, the higher the life performance. In case these subjects followed an alternative constant-weight averaging rule which has been pervasive in previous work in India (Gupta & Singh, 1981; Singh & Bhargava, 1985, 1986; Singh et al., 1979), then their beliefs are markedly different from the interpretation made above. The averaging rule would imply that the three factors are compensatory: One can always make up for the deficiency in other respects.

It is also interesting to note that three subjects believed that motivation is not required; ability and opportunity are good enough; two subjects considered opportunity as irrelevant; and one subject thought that motivation is all that is needed to go up in life.

Two lines of evidence suggest the plausibility of the hypothesis of individual differences in social theories. First, all the subjects who employed the compound multiplying-adding models did not have the same factor in the multiplicative and additive roles. Similarly, all the subjects who followed simple additive models (i.e., Models 2-4) did not add or average all the given information. Second, past work on prediction of performance shows that cognitive algebra of task performance depends upon age and culture of subjects (Gupta & Singh, 1981; Kun, Parsons, & Ruble, 1974; Surber, 1980) as well as upon nature and difficulty of task (Singh & Bhargava, 1985; Singh et al., 1986; Surber, 1981). For tasks which do not have any well-developed normative model, therefore, individual differences in social theories are natural.

One implication of this hypothesis is that individual differences in cognitive algebra should not be confined to the three-factor tasks alone. The two-factor tasks should also yield evidence for similar individual differences. Results of Kun et al. (1974) directly bear upon this possibility. Second graders had the fan pattern in the overall Motivation x Ability effect. In the individual child analyses, however, only 38% subjects had the fan pattern. In a study of prediction of performance in human/computer applications from information pertaining to user proficiency and system power, Norman and Singh (1986) found evidence for the multiplying, averaging, and other models with 51%, 25%, and 24% subjects from the same population as in the present study. Accordingly, it may be concluded that differences in predictive models might have arisen from the preexisting differences in the social theories of the subjects about how motivation, ability, and opportunity determine an individual's life performance.

<u>Differences in separate initial opinions</u>. The second hypothesis is that the normative three-factor multiplying model (Anderson, 1976) is correct but the individual differences in the models emerge from the complicated information processing involved in the multiplying operation. Since qualitatively

different kinds of information are averaged first with their corresponding initial opinion (Singh & Bhargava, 1985; Singh et al., 1986), the values of given motivation, ability, and opportunity information undergo changes twice before the multiplying operation is actually undertaken. This is evident from Equation 3,

$$LF = \underline{w}'_M \left[\frac{\underline{w}_{Im}\ Im + \underline{w}_M\ M}{\underline{w}_{Im} + \underline{w}_M}\right] \times \underline{w}'_A \left[\frac{\underline{w}_{Ia}\ Ia + \underline{w}_A\ A}{\underline{w}_{Ia} + \underline{w}_A}\right] \times \underline{w}'_O \left[\frac{\underline{w}_{Io}\ Io + \underline{w}_O\ O}{\underline{w}_{Io} + \underline{w}_O}\right], \qquad (3)$$

where LF is life performance, M, A, and O are values of given information about motivation, ability, and opportunity of the stimulus person, Im, Ia, and Io are initial opinion of the subjects about motivation, ability, and opportunity, $\underline{w}_{Im}$ and $\underline{w}_M$ are relative weights of initial opinion and external information of motivation, $\underline{w}_{Ia}$ and $\underline{w}_A$ are relative weights of initial opinion and external information of ability, $\underline{w}_{Io}$ and $\underline{w}_O$ are relative weights of initial opinion and external information of opportunity, and $\underline{w}'_M$, $\underline{w}'_A$, and $\underline{w}'_O$ are relative weights of the estimated values of motivation, ability, and opportunity information from the first stage of integration.

Equation 3 indicates that values of motivation, ability, and opportunity information change first time after averaging of the external information with the corresponding initial opinion of the subjects (see the operation within each bracket) and second time before the actual multiplying operation is used (see three $\underline{w}'_M$, $\underline{w}_A$, and $\underline{w}'_O$). Even if experimental care is taken to ensure that the levels of the three factors represent the entire stimulus scale, the real psychological values of the levels of each factor may change contingent upon the value and weight of the initial opinion of each factor. For example, if subjects give high, moderate, and low weights to the respective initial opinion of motivation, ability, and opportunity, then the levels of each of the three factors would represent different portions of the stimulus continuum after the first-stage integration. Assignment of relative importance to the values estimated from the first-stage integration will bring further changes in those values. At the second-stage of integration, therefore, the multiplication of three stimulus values may not produce unambiguous evidence for the multiplicative model.

Two implications of Equation 3 deserve comments. First, the three-factor multiplying model could do better when subjects ignore their initial opinions than when they give greater weight. Second, the multiplying model may be more successful in two-factor than in three-factor tasks, for the second changes in the values due to relative weighting before multiplication would be less.

There is no way to judge to what extent the processes postulated in Equation 3 complicated the tests of multiplying model in past and present research. However, there are indications that the two-factor tasks (Anderson & Shanteau, 1970; Lopes, 1976a; Shanteau & Nagy, 1979) did relatively better than the three-factor ones (Klitzner & Anderson, 1977; Shanteau & Anderson, 1972) in individual subject analyses. Also, the three-factor multiplying model at times succeeds (Norman & Louviere, 1974).

<u>Comments.</u> The two hypotheses presented above suggest quite different loci of individual differences in the present experiment. The first hypothesis attributes the individual differences to the differences in the inte-

gration rules; the second one attributes them to differences in information valuation. The extant literature on information integration indicates that people differ in integration rules (e.g., Kun et al., 1974; Leon, Oden, & Anderson, 1973, p. 306; Norman & Singh, 1986) as well as in information weighting (e.g., Lopes, 1976b; Ostrom & Davis, 1979). Whether the individual differences demonstrated in the present work arose due to divergent cognitive algebra, different patterns of information valuation, or both cannot be ascertained from the available data. Future research should, therefore, examine the plausibility of these two hypotheses by using both the two-factor and three-factor tasks of the same social judgment domain with the same group of subjects.

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Correspondence concerning this article should be addressed to Ramadhar Singh, Organizational Behavior Area, Indian Institute of Management, Ahmedabad 380 015, Gujarat, India.

Table 1

F Ratios for Overall Motivation x Ability Effect and for Four Trend Components at Each Level of Opportunity

Opportunity	Overall effect (4,284)	Trend Components			
		L x L (1,71)	L x Q (1,71)	Q x L (1,71)	Q x Q (1,71)
Little	4.72**	3.79	0.25	1.84	0.82
Moderate	7.65**	23.22**	0.35	0.07	0.19
Great	12.67**	27.52**	5.21*	0.53	1.74

Note. The L and Q refer to linear and quadratic trends, respectively. The figures in the parentheses are dfs for the respective F ratios. In analyses of variance, the subjects' classification as to groups and sex were not included. Thus, the error term for the overall F ratio has df of 284, and not 264 as in the main analysis reported in Table 2.

* $p < .05$

** $p < .01$

Table 2

F Ratios for Overall Two-Factor Interaction Effects and for Four Trend Components in Each Interaction Effect

Interaction effect	Overall effect (4,264)	Trend Components L x L (1,71)	L x Q (1,71)	Q x L (1,71)	Q x Q (1,71)
Motivation x Ability	13.09**	30.03**	3.83	0.00	1.71
Motivation x Opportunity	9.36**	4.41*	2.30	1.00	0.40
Ability x Opportunity	23.52**	23.94**	14.24**	0.54	2.74

Note. The L and Q refer to linear and quadratic trends, respectively. The figures in the parentheses are *dfs* for the respective *F* ratios. The *df* for the error term of the overall *F* ratio is less than the sum of the *dfs* for the error term of the *F* ratio for four trend components because the overall analysis of variance included two between-subject classification factors of groups and sex.

* $p < .05$

** $p < .01$

Table 3

Number of Subjects Following Different Models in Prediction of Life Performance (P) from Information about Motivation (M), Ability (A), and Opportunity (O)

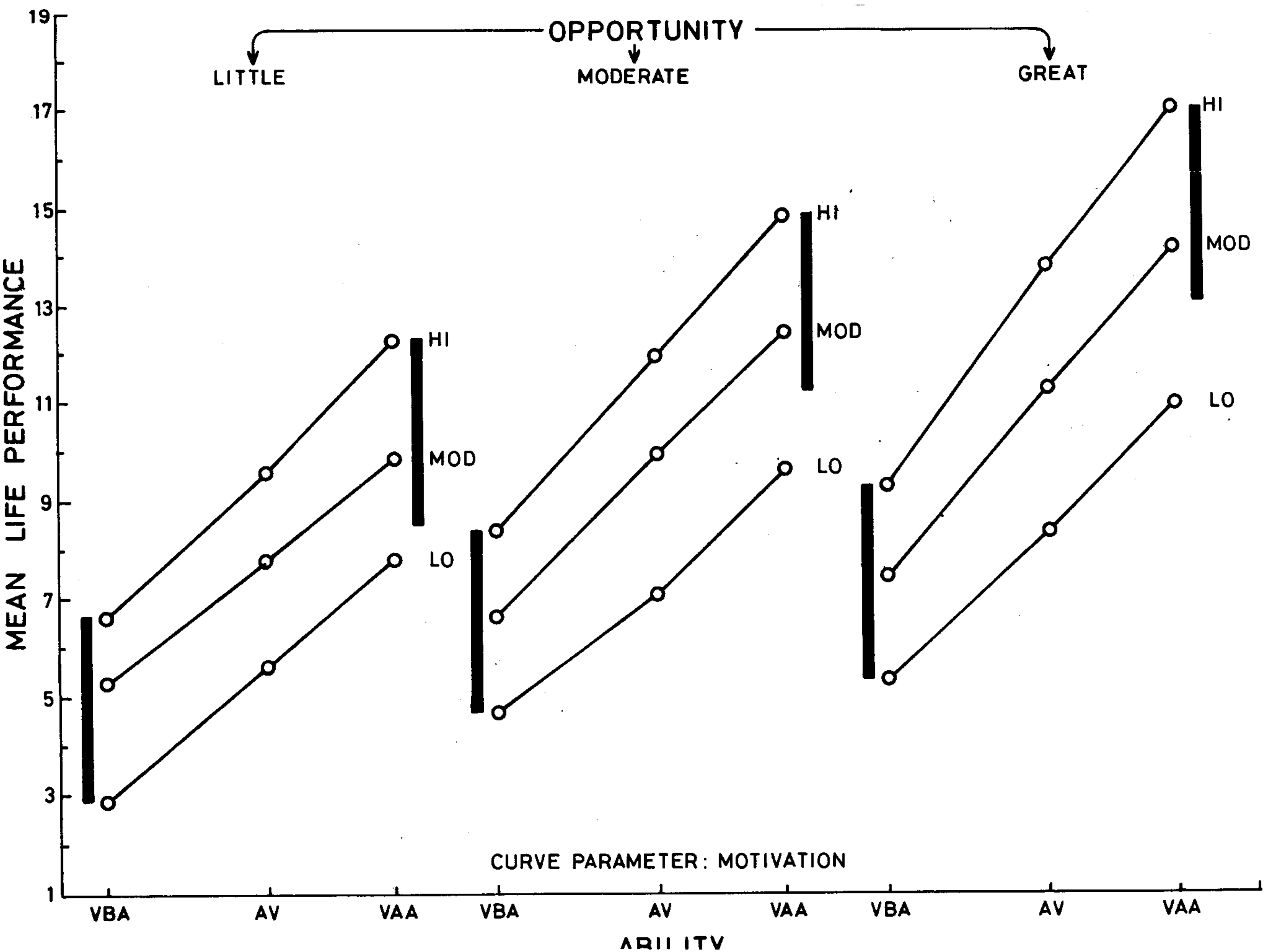
SN		Number of Subjects who Tried(T)		Number of Subjects who Succeeded(S)		S/T	
1.	P = M	1		1		1.00	
2.	P = M + A	2	5	1	2	.50	.40
3.	P = A + O	3		1		.33	
4.	P = M + A + O	17		15		.88	
5.	P = (M x A) + O	4	17	3	10	.75	.59
6.	P = (M x O) + A	7		5		.71	
7.	P = (A x O) + M	6		2		.33	
8.	P = M x (A + O)	6	12	3	7	.50	.58
9.	P = A x (M + O)	6		4		.67	
10.	P = (M x A) + (M x O) + (A x O)	5		3		.60	
11.	P = M x A x O	6		1		.17	

Note. The models are in their pseudoform, for they specify only the fundamental operations and not the factor weight or the weight and value of initial opinion of the judges. The models falling within the limits of a vertical bar are of the same structure and complexity.

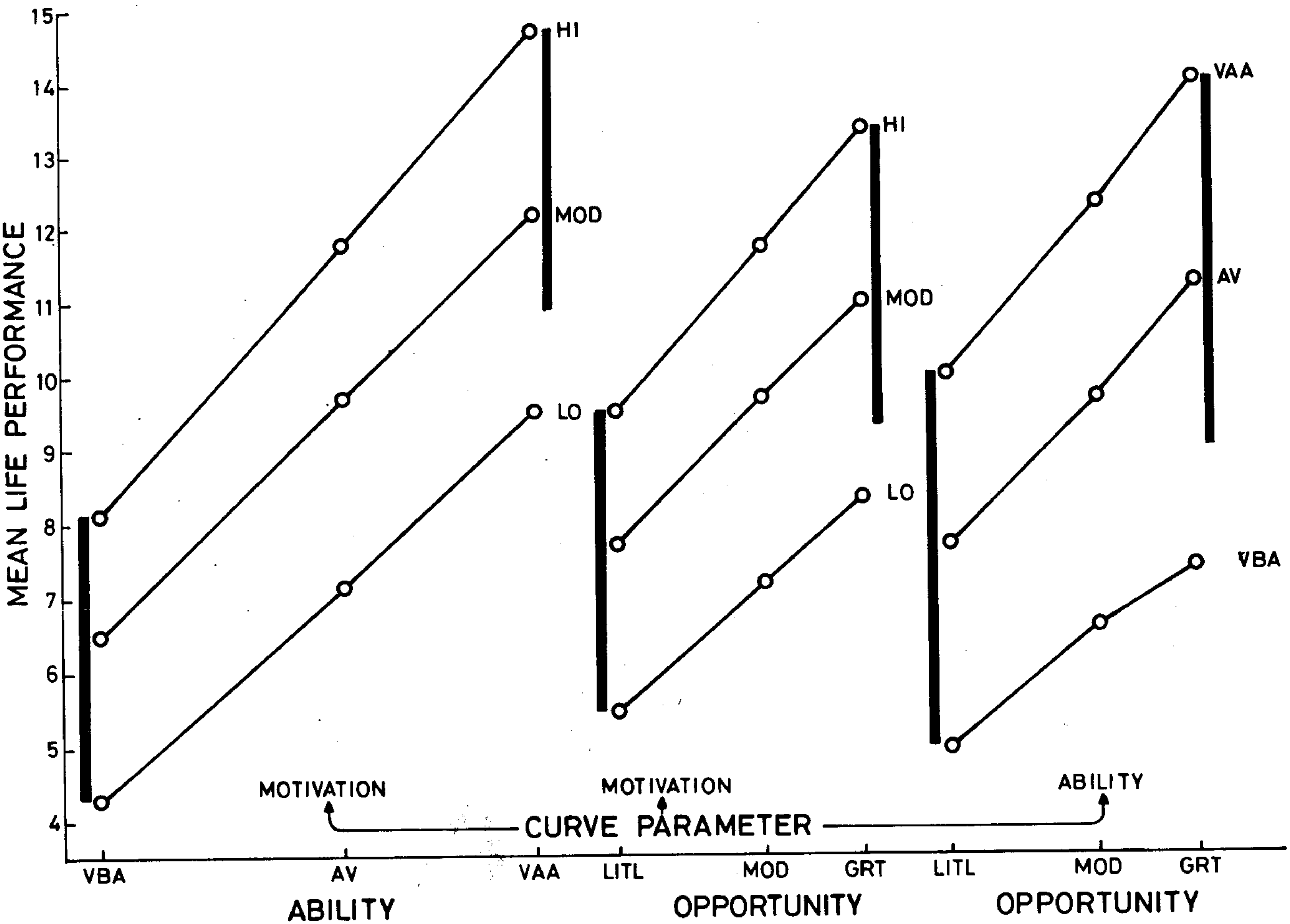
Figure Captions

Figure 1. Mean life performance as a function of motivation (curve parameter) and ability (listed on the horizontal axis) across three levels of opportunity available for growth. The abbreviations LO, MOD, and HI refer to low, moderate, and high levels of motivation, respectively; VBA, AV, and VAA refer to very much below average, average, and very much above average levels of ability, respectively.

Figure 2. Two-way factorial plots of Motivation x Ability, Motivation x Opportunity, and Ability x Opportunity effects. The abbreviations LITL, MOD, and GRT refer to a little bit of, a moderate amount of, and a great deal of opportunity, respectively. The other abbreviations are the same as in Figure 1.



OPPORTUNITY
LITTLE
MODERATE
GREAT
MEAN LIFE PERFORMANCE
19
17
15
13
11
9
7
5
3
1
HI
MOD
LO
HI
MOD
LO
HI
MOD
LO
CURVE PARAMETER: MOTIVATION
VBA
AV
VAA
VBA
AV
VAA
VBA
AV
VAA



MEAN LIFE PERFORMANCE
15
14
13
12
11
10
9
8
7
6
5
4
HI
MOD
LO
HI
MOD
LO
VAA
AV
VBA
MOTIVATION
MOTIVATION
ABILITY
CURVE PARAMETER
VBA
AV
VAA
LITL
MOD
GRT
LITL
MOD
GRT
ABILITY
OPPORTUNITY
OPPORTUNITY