INTRODUCTION

In our everyday life, we usually encounter two types of social perception tasks. The first is attribution of causality. Determining the causal relationship between some outcome and an event that may have caused that outcome. Finding answer to questions such as why our teammates have not done their share of work on our joint project, why our friend X married Y, and why did the examination department of the university delay processing of doctoral dissertation illustrate the attribution task. Attribution processes have been studied extensively by Jones and Davis (1965) and by Kelley (1972, 1973).

The second task deals with prediction of events from some of their known causes. Inferences about success of a student in his forthcoming examination, job performance of a newly hired supervisor, and life performance of a singer from information about their motivation and ability are examples of prediction task. Similarly, prediction of size of charitable gift on the basis of information about generosity and income of a donor is a prediction task. Although prediction processes have also been considered by attribution
theorists, systematic study of prediction has largely been stimulated by information integration theory (Anderson, 1981, 1982).

The present dissertation deals with prediction processes. It attempts to resolve the current controversy on how motivation and ability determine performance. The judgmental tasks required 4 to 16-year-olds to predict performance of stimulus persons on three tasks, namely, school examination, puzzle competition, and music competition. The major focus was on developmental changes in integration rule underlying prediction of task performance.

Because children are believed to have a limited cognitive capacity and the present research required them to coordinate multiple pieces of information, the notion of "limited cognitive capacity" in children also received systematic assessment. For this purpose, changes in ability to utilize given pieces of information (Anderson, 1980) and in nature of effect of order of presentation of information were systematically studied.

Performance = Motivation x Ability Controversy

In the literature on social cognition, it has been hypothesized that prediction of performance should be a multiplicative function of motivation (effort, trying) and
ability (aptitude, capacity, intelligence, potentiality). This is clear from the following quotation:

The personal constituents, namely, power (ability) and trying (effort) are related as a multiplicative combination, since the effective personal force is zero, if either of them is zero. For instance, if a person has the ability but does not try at all, he will make no progress toward the goal (Heider, 1958, p. 83).

If Heider's hypothesis is correct, then the factorial plot of Motivation x Ability should yield a diverging fan of straight lines. By the logic of functional measurement (Anderson, 1974, 1976, 1981, 1982), such a linear fan pattern implies the operation of a multiplying rule.

Tests of the multiplying model for prediction of performance have yielded mixed results. Some studies obtained clear evidence for the multiplying rule, whereas others obtained evidence for the averaging rule. Also, some studies found integration rule to be age-linked; others found it to be task-linked. Data from cross-cultural studies further suggested a possibility of cultural difference between American and Indian college students on how motivation and ability determine performance. Review of the studies which obtained evidence for the multiplying and nonmultiplying rules is given below.
Multiplying Rule

Six studies have obtained evidence for the multiplying rule in integration of information about motivation and ability as Heider hypothesized. These studies have used a number of tasks and subject populations. The details of the six studies are as follows.

Anderson and Butzin (1974). Anderson and Butzin provided tests of Heider's proposal, Performance = Motivation x Ability. College students in the United States received information about motivation and ability of applicants to graduate school and athletes trying for college track and predicted their performance in their respective fields. The factorial plot of Motivation x Ability data had the hypothesized linear fan pattern for both types of stimulus persons. Anderson and Butzin concluded, therefore, that prediction of performance is indeed made by a multiplying rule.

Kun, Parsons, and Ruble (1974). Kun and her associates followed the logic and method used by Anderson and Butzin in their study of prediction of performance on puzzles as a function of motivation and ability of stimulus child. They replicated the linear fan pattern with children beginning Standard II. The kindergarten children had parallelism pattern in the factorial plot of Motivation x Ability effect. Kun et al concluded, therefore, that multiplying rule develops out of an adding rule.
Surber (1980). In this experiment, subjects from Kindergarten, Standard III, Standard IV, and College predicted performance of hypothetical participants in a weight-lifting contest. Although the stimuli used in this experiment referred to weight-lifting rather than puzzle solving, Surber replicated finding of Kun et al (1974): The factorial plot of Motivation x Ability data of the Kindergarten children had near-parallelism but those of the other three groups of subjects had the linear fan pattern.

This experiment made two other notable contributions. One was that application of the "scale-free method" (Birnbaum, 1974) for separating integration function from judgment function favored the hypothesis of age difference in integration rule for prediction of performance. Another, and perhaps more important, was the use of distinguishing tests between multiplying and averaging interpretations of the linear fan pattern. Subjects were required to predict performance of stimulus persons on the basis of information about either motivation itself or ability itself. Results from these tests indicated that the multiplicative representation of prediction of performance was preferable only at the level of college students, and that judgments by the other three groups of subjects could very well be represented by an averaging rule.
Anderson (1981). The distinguishing test between alternative rules used by Surber (1980) cannot be expected to yield clear information if subjects impute value for the missing information. In fact, imputations are quite common in cognitive algebra (Singh, 1984). The experiment by Anderson (1981, p. 45), therefore, employed new distinguishing tests between multiplying and averaging rules which did not involve missing information at all. This task also required college students to predict performance of applicants to graduate school and results were much the same as in Anderson and Butzin (1974).

Singh and Bhargava (1982b). In a series of four experiments, Singh and Bhargava presented information about motivation, ability, and opportunity available to stimulus persons and asked postgraduate students of management to predict life performance of the so-described high school students. In all the four experiments, the factorial plot of Motivation x Ability effect had the predicted linear fan pattern. Furthermore, distinguishing tests disclosed that linear fan pattern was caused by a multiplying rule and not the alternative averaging rule with differential weighting.

Experiments of this series had manipulation of sex of stimulus persons, reliability of information, and magnitude of opportunity available. These factors had changed
the pattern in Motivation x Ability data from linear fan to parallelism in a few cases. These results suggest that the multiplying rule is not as general as it is believed to be.

**Bhargava (1983).** In his doctoral dissertation, Bhargava traced developmental changes in integration rule for prediction of life performance. He selected subjects from Standards V, VII, IX, and XI of a school, first year students of a college, and postgraduate students of management, and required them to predict life performance of high school students just as in Experiment 4 by Singh and Bhargava (1982b). The results were supportive of the hypothesis of age difference in integration rule: Postgraduate students' predicted life performance according to a multiplying rule; others followed an averaging rule.

**Summary.** The studies just reviewed show that performance on a number of tasks, namely, graduate school, puzzle competition, weight-lifting competition, and life indeed obey the hypothesized multiplicative rule, Performance = Motivation x Ability. There are, however, some moderating variables. For example, the linear fan shape in Motivation x Ability effect is present in Standard II in the United States but at postgraduate level in India.
Similarly, the same group of subjects make prediction of performance according to adding or multiplying rule depending upon sex of stimulus persons, reliability of information, and magnitude of opportunity for growth available to the stimulus persons. These studies suggest that Heider's hypothesis is not as general as it is believed to be.

Nonmultiplying Rules

The preceding section yielded some indications for the failure of data pattern predicted by the multiplying rule. This section reviews studies in which there was no evidence of multiplying rule at all.

Singh, Gupta, and Dalal (1979). Singh et al reasoned that the linear fan pattern reported by Anderson and Butzin (1974) and by Kun et al (1974) is consistent with both the multiplying and differential weight averaging rules. If lower values of motivation and/or ability had greater weight, then the averaging model would produce an approximate linear fan pattern (Anderson, 1971, p. 185). This possibility was noted by Anderson and Butzin also who said, "Since averaging processes are pervasive in judgment, a conjunctive integration rule deserves more consideration" (p. 602). A series of three experiments were, therefore, performed
on college students in India. Subjects predicted exam performance of students knowing their motivation and ability as well as one of the two, that is, motivation alone or ability alone.

Experiments by Singh et al yielded three main results. First, the factorial plot of Motivation x Ability effect had a parallelism or converging pattern, not the diverging pattern reported in American studies. Second, the single-cue, ability- or motivation-only curve crossed over the curve based on both motivation and ability information. Since the crossover interaction is a well-known evidence for averaging and against multiplying (Lampel & Anderson, 1968; Anderson, 1981, pp. 58-64, 113-128; Singh, 1984), it was concluded that prediction of exam performance obeys an averaging rule. Finally, subjects had imputed some value for the missing information when they were asked to make prediction of exam performance on the basis of either motivation or ability alone.

Because the two American studies (Anderson & Butzin, 1974; Kun et al, 1974) had clear evidence for linear fan pattern but the three experiments by Singh et al had near-parallelism, the authors proposed a hypothesis of difference in cultural outlook between India and America. Americans follow multiplying rule. Perhaps they believe that motiva-
tion will be more effective with persons of high than low ability. In contrast, Indian college students believe that effort will be equally effective with persons of low and high ability.

Gupta and Singh (1981). In this developmental study, subjects were from Standards II, IV, VI, and VIII of a school and adults from a college. The design was patterned after Experiment 3 of Singh et al and thus they provided a more sensitive test of the cultural-difference hypothesis mentioned above.

Data from all five groups of subjects were consistent with the cultural difference hypothesis. That is, there was a prevailing pattern of near-parallelism in the factorial plot of Motivation x Ability effect. Furthermore, the single-cue curve crossed over the two-cue curves and the two-cue curves crossed over the three-cue ones. Gupta and Singh concluded, therefore, that prediction of exam performance indeed obeys an averaging rule in India.

Surber (1981a). In a study of college students, Surber manipulated motivation, reliability of motivation information, ability, and reliability of ability information and tested the contradictory prediction of multiplying and averaging model. According to multiplying model,
weight of one factor should increase the effectiveness of another factor. But the averaging model predicts that increase in weight of one factor would decrease the effectiveness of another factor.

Surber obtained evidence for the prediction of averaging rule and against the multiplying rule. More importantly, she found a slightly converging pattern in the Motivation x Ability effect just as in the studies by Singh and his colleagues (Gupta & Singh, 1981; Singh et al, 1979). This failure of the linear fan pattern did not appear to be attributable to task-simplification, for the relationship between weight and scale value of each factor was clearly multiplicative. Accordingly, Surber questioned the cultural-difference hypothesis and suggested that difficulty of task may perhaps be a better explanation for the appearance of converging, parallelism, and diverging pattern in Motivation x Ability effect.

Surber (1981b). This experiment tested the task difficulty explanation by describing college exam as easy, moderately difficult, and very difficult. Consistent with her hypothesis of task difficulty, Surber found that factorial plot of Motivation x Ability effect displays converging, parallelism, and diverging pattern for exam described as easy, moderately difficult, and very difficult, respectively.
This experiment had also used single-cue descriptions just as in Singh et al (1979) and Surber (1980). The single-cue curves had clearly crossed over the two-cue curves at all the three levels of exam difficulty. Prediction of exam performance was thus made in accord with an averaging model.

Singh and Bhargava (1982a). In a series of seven experiments, Singh and Bhargava tested three hypotheses, namely, cultural difference, task difficulty, and imputation for missing information in prediction of exam performance. Subjects were high school and college students, postgraduate students of management, college teachers, and executive engineers in the State of Gujarat, India. Also, the experiments had manipulations of task difficulty, reliability of information, and missing information. No less important, the distinguishing test between alternative rules did not allow any imputation about the missing information at all.

This series of experiments obtained clear evidence against task difficulty explanation for the failure of linear fan pattern. In all the three conditions of task difficulty, the pattern in the factorial plot of Motivation x Ability effect was essentially the same. This
means that prediction of exam performance is indeed susceptible to cultural factors as Singh et al (1979) and Gupta and Singh (1981) suggested.

The importance of cultural factors in prediction of exam performance was also suggested by the difference in results obtained with manipulation of reliability of information. As already noted, Surber (1981a) found that increase in weight of motivation decreased the effectiveness of ability information and vice versa. This result supported an averaging interpretation for the near-parallelism obtained by Surber. Similar manipulations in India indicated the operation of an adding rule. In fact, postgraduate students of management had predicted exam performance according to an adding rule. Results from these studies also suggested the possibility of cultural difference in prediction of exam performance.

Experiments by Singh and Bhargava also had employed distinguishing tests which did not involve imputation for missing information at all. These tests showed that all cases of parallelism in Motivation x Ability effect do not reflect on the underlying averaging process. The single-cue curves at times exhibit crossover because subjects impute value of the missing information as a positive function of the given information. This means that the cross-
over interactions reported by Surber (1980, 1981b) cannot be accepted as an unambiguous evidence for averaging and against multiplying.

This series of experiments on prediction of exam performance made three important contributions. First, as far as exam performance is concerned, there is a cultural difference between India and America. Indian students predict performance by adding and averaging rules, whereas American college student made predictions by averaging and multiplying rules. Second, the hypothesis of task difficulty seems to be applicable with subjects from the United States, but not from India. Finally, the conventional tests, which use just one type of information to distinguish between rival rules of information integration, at times engender imputations about missing information. They cannot be, therefore, regarded as valid diagnostic tests. This means that the averaging interpretation for parallelism and fan pattern in Motivation x Ability effect found in American studies (Surber, 1980, 1981b) may not be accepted as evidence for averaging rule.

Bhargava (1983). The same postgraduate students of management predicted life performance according to multiplying rule (Singh & Bhargava, 1982b) but exam performance according to an adding rule. Since these two series of
experiments had tested Surber's (1981a, 1981b) task difficulty explanation rather rigorously and had found no evidence for it. Singh and Bhargava (1982b) suggested that nature of task may possibly be an alternative explanation for the failure of linear fan pattern in the factorial plot of Motivation x Ability effect.

Bhargava (1983, Experiment 3) tested the hypothesis of task difference in prediction of performance. As already noted, graduate students of management predicted life performance according to multiplying rule. Bhargava, therefore, required the same group of subjects to predict performance of management trainees on the basis of their motivation, ability, luck, and probability of success in the department. He found that information about motivation and ability were added in the prediction of performance of management trainees which supported his hypothesis that integration rule depends upon nature of task.

Bhargava's results also rejected two alternative interpretations, namely, task-simplification and task-difficulty for the failure of linear fan pattern in Motivation x Ability effect. Since subjects had a linear fan pattern in Ability x Probability of Success effect, the task-simplification explanation of the parallelism pattern
in Motivation x Ability effect cannot be accepted. Moreover, the same parallelism pattern was present across all the three levels of prior probability of success in the department. If Surber's hypothesis of task difficulty is correct, then the fan pattern in Motivation x Ability effect should have been obtained at least when the probability of success was low. This did not happen. Accordingly, Bhargava concluded that cognitive algebra of prediction of performance is task-linked.

Summary. The six studies reviewed above clearly show that prediction of performance does not necessarily follow the multiplying rule hypothesized by Heider (1958). In all the studies where task was prediction of exam performance, the hypothesized linear fan pattern failed to appear. However, there was a cultural difference in this task. Whenever the academic task was described as extremely difficult, the American college students did exhibit the linear fan pattern in Motivation x Ability effect (Surber, 1981b). This result is also consistent with multiplying rule reported by Anderson and Butzin (1974) and Anderson (1981). In India, however, no evidence for fan pattern was found in prediction of exam performance. It is also notable that the prediction of managerial performance also obeyed an adding rule in India.
Comments

From the preceding review of the literature on prediction of performance, it is clear that the cognitive algebra of prediction of performance is not restricted to the multiplying rule alone. Depending upon age and culture of subjects, difficulty of task, and nature of task, adding, averaging, and multiplying rules are employed. Furthermore, parallelism pattern seems to be a general characteristic of social cognition in India, whereas the fan pattern seems to be a general characteristic of social cognition in the United States.

The only exception to the hypothesized adding-type rule for Indian subjects is the evidence for the fan pattern in prediction of life performance. Since this trend is present at the level of postgraduate students, it is possible that the cultural difference hypothesis (Gupta & Singh, 1981; Singh, 1981; Singh et al, 1979) is restricted to undergraduate students only. Bhargava's (1983) results on life performance directly bear upon it.

But prediction of managerial performance by the same postgraduate students obeyed an adding rule. This was true with an older group of professional managers also. This means that age by itself cannot account for the different patterns in the Motivation x Ability effect. Perhaps nature
of task interacts with the age of the subjects in engendering a causal schema. This clearly emerges from the studies of exam performance (Singh & Bhargava, 1982a), life performance (Singh & Bhargava, 1982b) and life and managerial performance (Bhargava, 1983).

If nature of task determines prediction schema as the findings of studies cited above suggest, then it should be possible to yield evidence for linear fan pattern in Motivation x Ability effect with younger children in India. Perhaps prediction of performance in nonacademic domains such as performance on puzzles, weight-lifting contests, and music competitions may yield the linear fan pattern. It should be emphasized that the finding of linear fan pattern with American children came from such nonacademic tasks. Any rigorous test of the cultural difference hypothesis has, therefore, to study prediction of performance in nonacademic tasks. The first purpose of the present research was to determine effect of age of subjects and nature of task on the rule they use is prediction of task performance. Because both academic and nonacademic tasks were studied, the present research allowed a reappraisal of the cultural difference hypothesis (Gupta & Singh, 1981; Singh, 1981; Singh et al, 1979).
Hypothesis of Limited Cognitive Capacity

Any study of development of cognitive algebra faces two difficulties. One concerns the number of pieces of information that a child can actually handle. Another concerns the valuation of different pieces of information available for judgment. First problem is of information utilization, that is, do children have integrational capacity? The second problem is of information processing, that is, how do children understand and determine value and importance of the various pieces of information? Since the experimental tasks used in the present research required combination of information about motivation and ability by children of 4-16 years of age, both problems were considered along with the main purpose of studying development of cognitive algebra for prediction of task performance.

Information Utilization

In Piaget's (1941/1965, 1970) theory of cognitive development, it is believed that children upto 6-7 years of age are in their preoperational stage. So they center their attention on the most salient feature of the stimulus (Flavell, 1970; Ginsberg & Opper, 1969). As Flavell (1963) states,

The child is unable to decenter ... is confined to the surface of the phenomenon he tries to think about, assimilating only those superficial features which clamor loudest for his attention (p. 157).
This tendency to pay attention to just one aspect of the stimulus field is known as **centration**. As age increases, there is an increase in the integrational capacity. That enables children to divide their attention to the multiple aspects of the stimulus field. This tendency to attend to more than one feature of the stimulus is called **decentration**. If centration is indeed the style of attention of preoperational children, then they would not be able to follow any integration rule.

Integrational capacity in children can be studied by looking at the main effects of various factors in the analysis of variance for the individual child (Anderson, 1980). This approach has already been used in recent research (Anderson & Butzin, 1978; Anderson & Cuneo, 1978; Gupta & Singh, 1981; Kun et al., 1974; Wilkening, 1979, 1980). In all these studies, preoperational children had in fact ignored some of the stimuli available for judgment. All children of the age of eight and above had, however, used more than two pieces of information. It was concluded, therefore, that the number of significant main effects in the analysis of variance can be regarded as a measure of integrational capacity.

Gupta and Singh (1981) suggested that the number of significant main effects in the analysis of variance for the individual child may not necessarily be accepted as a
measure of integrational capacity. If different factors are weighted differently by children, they argued, then some of the nonsignificant main effects may be due to lower weight assigned to the information and not for want of integrational capacity.

A direct evidence for the point raised above was provided by Singh (1982). In his study, children received verbal and concrete reinforcements for their performance on a simple motor task and expressed their immediate happiness. According to centration hypothesis, there should be absence of one of the two main effects at the level of the younger children (4-5-year-olds); older children (8-9-year-olds) should yield both main effects. Contrary to this hypothesis, 4-7-year-olds used both concrete and verbal reinforcements but 8-9-year-old boys used just verbal reinforcement in the expression of their happiness. It can thus be said that the number of significant main effects in the analysis of variance reflect more on the relevance and importance of information than on the integrational capacity of children.

The second purpose of the present research was to demonstrate that preoperational children are able to utilize four pieces of information. Gupta and Singh (1981) used three pieces of information in their study of integrational
capacity. But Experiment 1 of the present research used four pieces of information. In addition, each child was studied for three consecutive days. Thus, the design of Experiment 1 provided a very powerful test of the integrational capacity of children in social cognition.

**Order Effects**

Whenever two pieces of information are provided for judgment, the order in which information appears may be a source of difference in judgment. Social psychologists have long been interested in such order effects, particularly in the area of communication and attitude change (Anderson & Parkas, 1973; Hovland, 1957), interpersonal attraction (Byrne, 1971), and person perception (Anderson, 1981, pp. 144-153; Asch, 1946; Jones & Goethel, 1971). When a particular piece of information appearing earlier plays more important role than that appearing later, the effect is called **primacy**. When the recent information plays more important role than the earlier one, the order effect is called **recency**. Since these two effects reflect on the attention judges pay to the various pieces of information, the developmental differences in order effect are important in developmental psychology as well. In fact, prediction of performance has also evinced order effect on processing of information about motivation and ability.
Kun et al. (1974, Experiment 2) systematically varied order of presentation of motivation and ability information. They found evidence for order effect on judgment by children of Standard I: Both motivation and ability information had received greater weight when they appeared later than when they appeared earlier in order of presentation. There was no evidence for any order effect with children of Standard III and V. This result seems to be consistent with the hypothesis of limited cognitive capacity in younger children.

Subsequent studies of the effect of order of presentation on judgment have also yielded evidence for recency effect. In studies of moral judgment from information about intention and consequence of the actors (Austin, Ruble & Trabasso, 1977; Surber, 1982), recency effect has been noticed with children upto Standard V. Singh (1982), who studied impact of verbal reinforcement on expression of happiness, also obtained evidence for recency effect with children of 4-9-years of age. These studies suggest that children's judgments are characterized primarily by recency effect.

Since the studies cited above have obtained evidence for recency effect with children, it may be said that recency effect is age-linked phenomenon. Moreover, it reflects on limited cognitive capacity of children. They
cannot pay equal attention to both pieces of information, and so pay more attention to the information encountered recently. If recency effect indeed bears on the limited cognitive capacity of children, then all tasks should yield evidence for recency effect in children's judgments.

The third and final purpose of the present research was to examine nature of order effect in three achievement tasks, namely, exam performance, performance in puzzle competition, and performance in music competition. If recency is the dominant style of information processing by children for want of cognitive capacity, then all three tasks should yield evidence for the very recency effect, and recency effect should decrease over age. But if order effect is actually linked with the nature of task similar to the position taken with respect to information utilization (cf. Gupta & Singh, 1981; Singh, 1982), then order effect should vary as a function of nature of task. Furthermore, the nature of order effect should show no definite age trend. The same child should show sometimes primacy and sometimes recency or no order effect.

Comments

The belief that children have a limited cognitive capacity has an intuitive appeal. Empirical support for this belief comes from the findings that ability to utilize
multiple pieces of information increases over age, and that children's judgments are characterized by recency effect. An alternative explanation for both findings may be that information utilization and order effects are task-linked. Because the present research employed three tasks, namely, school exam, puzzle competition, and music competition and much younger children than those used in previous studies, the hypothesis of limited cognitive capacity in children also received a systematic evaluation.

The Present Research

The present research tested two principal hypotheses. The first was that integration rules underlying prediction of performance depend upon the nature of tasks as well as the age of subjects. Some tasks may have just one integration rule or causal schema (Kelley 1972, 1973) but others may have multiple rules or causal schemata. Integration rules for tasks with multiple causal schemata are perhaps age-linked.

The second was that the number of significant main effects in analysis of variance for individual child and recency effect in children's judgment are also linked with the nature of task. Depending upon the requirements of
the tasks, children can utilize multiple pieces of information in their judgments efficiently. Furthermore, the often reported recency effect in children's judgments may be better accounted for by the nature of task than the limited cognitive capacity of children.

Tests of these two principal hypotheses were made by conducting a series of three experiments. Details of these experiments are described in Chapters 2, 3, and 4.