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Models of the Attribution Process: The Naive Analysis of Action

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INTRODUCTION

Philosophers and scientists alike have pursued an understanding of the relationship between the operation of causal chains and the phenomental perception of causality. In one of the earliest systematic investigations of phenomenal causality, Michette (1929) disputed the Humian dictum that we have no direct experience of causality and insisted that it was only through observation of causal relationships that we comprehend our environment. The causal impression, however is something quite other than the mere perception of movements and includes deductions from one or more universal laws (Popper, 1956). Psychologists have recently become interested in all forms of human cognitions including the perception of causality. This paper pursues this interest by investigating the rules an individual perceiver uses to understand causal sequences in his environment. First, the primary theoretical position of this paper is reviewed, then some past attempts to model the human judgment process are discussed, finally a direct experimental assault on one aspect of phenomenal causality is described along with the different methodological approaches it necessitates.

Attribution Theory

In one of the most influential works in social psychology Heider (1958) describes "common-sense psychology" as the manner in which the naive individual interprets another's actions and predicts his behavior in future situations. Since person perception is assumed to be characterized by the same processes as object perception, we perceive others' dispositional properties in the same way we perceive shape and size as constant attributes of objects. The perception of these properties in the form of motives, sentiments, intentions, wishes, and abilities enables the perceiver to understand, explain, and predict another's behavior. Just as in the perception of invariant characteristics of objects, dispositional properties appear immediately self-given; however, they represent a selective and constructive process which goes beyond the immediate stimulus or visual field.

The central question in this naive analysis of action is the attribution of causal influence. In matching causes to events, the perceiver uses the method of difference, or as Kelley (1971a) states: "an effect is attributed to the one of its possible causes with which, over time, it covaries." For example, in Strickland's (1958) study, participants took the role of supervisor over two workers for ten work sessions, Worker A was monitored during nine of these sessions and Worker B was monitored during two. When advised that both workers' final output had reached the same high level, supervisors judged Worker B more trustworthy than Worker A, even though they had observed Worker A's performance to be high over more work sessions. In this case, Worker A's output (effect) covaried with the supervisor's monitoring behavior (phenomenal cause) and thus was not taken as an indication of the worker's trustworthiness. Since Worker B was monitored only infrequently, his high performance (effect) could only be attributed to his trustworthiness (cause).

One of the primary characteristics of person perception is, however, that the perceiver rarely observes the covariation of effect and possible causes over time. In such cases, how does the perceiver determine if the behavior was intended by the <u>person</u>, evoked by a particular <u>stimulus</u> in the environment, or was the result of the <u>circumstances</u> of the action? Kelley (1967) has distinguished three cues which the perceiver utilizes in deciding among possible causes: <u>distinctiveness</u> information, the normative quality of the action for the actor; <u>consensus</u> information, the extent to which the action is typical of a number of people or just a few; and <u>consistency</u> information, the frequency with which the action occurs in other situations and/or at other times. In much the same manner as the scientist critically analyzing his sample of data and making estimates of population characteristics, the perceiver contrasts the variability between actions (distinctiveness) with the variability within actions (consistency over people and situations). McArthur (1971) found that person attributions were made most often with low distinctiveness and high consistency information, stimulus attributions were made with high distinctiveness and high consistency information, and circumstance attributions were made with low consistency information. For example, if we observe that Ralph trips over Joan's feet while dancing and we know that

a. Ralph trips over almost every other partner's feet (low distinctiveness),
b. In the past, Ralph has almost always tripped over Joan's feet (high consistency),

we will infer that Ralph is a clod (person attribution, McArthur, 1971, p. 181). In most situations the attribution process is not nearly as straightforward. If, in the example above, we have the additional information that

c. Almost everyone else who dances with Joan trips over her feet (high consensus),

we are left with the plausible hypothesis that Joan also is a clod (stimulus attribution). Kelley (1971b) has distinguished a number of similar situations in which more than one causal factor may be operating. A study by Jones, Davis, and Gergen (1961) in which respondents were to judge the personality of a job applicant from the tape of the job interview provides an example of a multiple plausible causal situation. Recordings were made of applications for two positions, an astronaut, which required an inner-directed, non-social personality and a submarine crew member, which required a friendly, obedient, cooperative personality. During the interview the job applicant created the impression that he was either friendly and sociable or inner-directed and non-social. Respondents who listened to tapes of either the inner-directed applicant for the astronaut position or the sociable applicant for the submarine crew were confronted with a dilemma. The job applicant may have created the impression he did because he wanted the job he was applying for (stimulus attribution) or because he actually possessed the personality traits he manifested (person attribution). These respondents were not confident in their opinions of the applicants' personalities. The respondents who listened to the tapes of the sociable astronaut applicant or the inner-directed submarine crew applicant were presented with a much simpler attribution problem. The impression created by the applicant could not have been caused by his desire for the job, since the impression was directly opposite that required for the position. In these cases, respondents were quite confident in their judgments that the applicant's personality was correctly reflected in the impression which he created in the interview.

Heider suggests that when we attempt to discover the dispositional properties which affect another's behavior, or when we are operating with only partial information, we base our inferences on causal schemata (1958, pp. 80-84). While other theorists (Delia & Crockett, 1973; DeSoto & Albrect, 1968a, b) have taken the term schema to apply to the Gestalt laws of prägnanz which characterize all of perception, attribution theorists define a causal schema as the conception an individual has of the manner in which two or more causal factors interact relative to a particular effect (Kelley, 1971b). A similar definition of abstract structure is given by Feather (1971), "internally consistent systems of rules or theories about what ought to be the case in the physical and social environment [p. 376]."

A causal schema is a rule which perceivers consistently use when interpreting events in their environments. Schemata are assumed to reflect the perceiver's implicit theory of causal influence for social situations. Kelley (1971b) describes two of the most common of these rules as multiple sufficient and multiple necessary causal schemata. The first is illustrated by the Jones, Davis, and Gergen (1961) study described above and is applied in situations where the individual has had the experience that different causes can independently produce the same effect. Anderson (1974) has described this rule as an additive force model:

$$A = I + E, \quad (1)$$

in which an action A can be obtained if <u>either</u> of the conditions are met. There needs to be some internal force, I, indicating that the person wanted to complete the action or some external force, E, which compelled the person to engage in the action. From the perceiver's perspective, either of these forces provide a perfectly acceptable explanation for the occurrence of the action, i.e., they are functionally similar. Implicit in Statement 1 is the reversibility assumption, that not only will the perceiver's predictions about the occurrence of an action follow from the additive combination of these two forces, but his inferences about the importance of either of the forces will also be made from the additive combination of the intensity of the action and the value of the other force. In the example cited above (Jones, <u>et</u> <u>al</u>., 1961), the internal force would be the job applicant's personality, the external force the role demands of the position applied for, and the action the behavior of the applicant presented on the tape of the interview. Reversing Statement 1, perceivers inferred the presence of internal force when the external force and the action had opposite values (e.g., when the applicant for the astronaut position came across as extroverted and cooperative). In multiple sufficient causal schemata, individual components are assumed to be functionally equivalent in relation to the outcome, differing not qualitatively but quantitatively.

A multiple necessary causal schema will be evidenced in situations where the perceiver has had the experience that several causes must be present at the same time for an event to occur. Causes are assumed to vary both quantitatively and qualitatively. Anderson (1971) describes this rule as a multiplying model typical of much of human judgment. For example, there is evidence that the overall effectiveness of a communication for producing attitude change is the product of the credibility of the source and the position advocated by the message (McKillip, 1974b; McKillip & Edwards, 1974). If the value of either of these parameters is low, the resultant communication effectiveness will also be low. These parameters differ qualitatively since no amount of source credibility can compensate for message extremity. A multiple necessary causal schema implies that an outcome will be dependent on the multiplication (interaction) of the values of the causes and not simply their additive (linear) combination. Such rules should also be reversible.

In summary, attribution theory predicts that the perceiver uses certain rules, causal schemata, when confronted with a problem of causal ascription. Although these rules may take different forms, their application is to be consistent and reversible.

Naive Analysis of Action

The central causal schema in Heider's (1958) common sense psychology concerns the constituents of an action sequence which lead the perceiver to know what another is trying to do, intends to do, or has the ability to do. An action is perceived to be the result of both personal and environmental forces. Effective personal force is composed of such dispositional properties as motivation, ability, and personality; effective environmental force is the result of environmental constraints, opportunity, and luck. Weiner (Freize & Weiner, 1971; Weiner, Heckhausen, Meyer, & Cook, 1972) has suggested the two way classification of these factors contained in Table 1. Heider (1958, pp. 86-87) suggests that stable internal and stable external factors form a multiple sufficient causal schema for judgments of those actions which another can accomplish:

$$\text{Can} = \text{Ability} + \text{Environmental Facility}. \quad (2)$$

A person can accomplish an action if he has high ability or if the task is easy. This dispositional property results when the imposed restraining forces are less than the individual's power to act. Heider further speculates an individual's motivational and *Can* properties form a multiple necessary causal schema for judgments of possible degrees of success:

$$\text{Outcome} = \text{Motivation} \times \text{Can}, \quad (3)$$

Table 1

Classification of Dispositional Properties

Stability	Locus of Control	
	Internal	External
Stable	Ability Personality	Task Demands Environmental Facility
Variable	Motivation Exertion	Luck Opportunity

and in combination with Statement 2

$$\text{Outcome} = \text{Motivation (Ability + Environmental Facility)}. \quad (4)$$

The perceiver is assumed to predict another's outcome from the perceived motivation of the other to succeed (intentions, exertion) and his interpretation of the capabilities of the other (Can) in a configural manner such that differences in the predicted outcome due to the level of motivation will be greater when the person judged is of high rather than low capability. The implications of Statement 4 are that ability and environmental facility will not interact but will combine linearly in the naive analysis of action. Motivation on the other hand, will combine configurally for predictions of another's outcome and will be inferred from the configural interpretation of his outcome and capabilities:

$$\text{Motivation} = \frac{\text{Outcome}}{\text{Can}} . \quad (5)$$

The distinctions which Heider draws between dispositional properties are important for the manner in which each is hypothesized to influence the naive analysis of action. While capability represents the perception of a "relatively stable relationship" between person and environment, motivation, including both intention and exertion, can vary independently of the environment and is central to the perception of personal causality and individual responsibility. Since an individual's capabilities are assumed to be constant for every attempt at a given task, variations in outcome are attributed to the energizing disposition of motivation. Heider predicts that personal responsibility for an outcome will be directly related to motivation rather than to ability.

Freize and Weiner (1971) found that internal attributions of causality (ability, effort) both increased as the distinctiveness of success increased (fewer successful others) and that for such cases effort attributions were higher than ability attributions. Feather and Simon (1971) found effort rather than ability attributions when participants expected failure but experienced success. Weiner and Kukla (1970) and Zander, Fuller, and Armstrong (1972) found greatest pride in success and least shame for failure when individuals perceived themselves to have low ability but high motivation. Similarly the least pride in success and the most shame for failure was experienced by individuals of high ability and low motivation. Assuming that pride in success and shame for failure are measures of perceived personal responsibility, these studies support the qualitative distinction between motivation and capability. Finally, Schmidt (1964) presented respondents with situations in which an individual did or did not have the ability and motivation to meet his responsibilities. Participants invoked moral obligations when the individuals lacked the motivation to meet his responsibilities regardless of his abilities.

Differences between multiple sufficient (Statement 2) and multiple necessary causal schemata (Statement 3) are important both mathematically and psychologically. The first suggests a linear or additive strategy of cue combination. For studies of judgment which utilize factorial cue combination, in an analysis of variance design this schema reduces to a significant main effect for each cue with no interactions (Anderson, 1970; Hoffman, Slovic, & Rorer, 1968). Psychologically this schema suggests functional equivalence for cues. A multiple necessary schema suggests a configural, specifically multiplying, strategy of cue combination. Analysis of judgments from factorial cue combinations should yield a significant cue interaction characterized wholly by the bilinear component. Psychologically, multiplying suggests dynamic as compared to static relationships and qualitative differences between cues.

Analysis of Statement 5 yields three hypotheses: (a) holding ability level constant, judgments of motivation will be a positive function of the extremity of the outcome cue; (b) holding outcomes constant, judgments will be an inverse function of the extremity of the ability cue; and (c) in a design which combines ability and outcome cues factorially, motivation judgments should yield a significant cue interaction characterized by the bilinear component.

Leventhal and Michaels (1971) had participants judge the deservingness of reward of the high jump performance (a measure assumed to reflect personal responsibility and perceived motivation) for individuals differing in ability, training (both internal stable properties), and effort. High jump performance was perceived as more deserving for (a) high as compared to low effort; (b) low as compared to high ability; and (c) relevant as compared to irrelevant training, supporting the first two hypotheses outlined above. While the Outcome X Training interaction was significant, the Outcome X Ability interaction was not. Kepka and Brickman (1971) had participants judge the motivation of students from their grades (outcome cue) and SAT scores (ability cue) and found that perceived motivation increased with outcome, decreased with ability and yielded a significant Outcome X Ability interaction. While the first two hypotheses again received support, evidence for the third was equivocal. Inspection of the cue interaction for both these studies indicates that the bilinear component would not have been significant. Anderson and Butzin (in press) present the clearest test of this third hypothesis along with an assessment of the reversibility of the causal schema. Participants made judgments of motivation from outcome and ability cues for applicants for graduate school and a college track team. For both judgments the critical Outcome X Ability interaction was significant and characterized by the bilinear component (81% of the interaction variance for judgments of athletes and 75% of this variation for judgments of graduate applicants). However, when participants made judgments of outcome from ability and motivation cues or judgments of ability from outcome and motivation cues, cue interactions were not found, violating the reversibility assumption.

In summary, there is good general support for both the qualitative differences between the dispositional properties of motivation and capability and the functional relationship between cues and judgment suggested by Heider's naive analysis of action. However, research has not provided unanimous support for the exact causal schema which Heider suggested either in consistency or reversibility of application.

Paramorphic Representation of Judgment

Attribution theorists are by no means alone in their interest in the rules used for combination of information in decision making. A number of researchers have attempted to model judgment policies by analyzing the correlations between cue values and final judgments with multiple regression equations. Hoffman (1960) borrowed the term "paramorphic" from mineralogy for the resulting mathematical models since in much the same way that two crystals may have identical chemical structures but different molecular structures, the

> . . . mathematical description of judgment is inevitably incomplete, for there are other properties of judgment still undescribed, and it is not known how accurately the underlying process has been represented [p. 125].

A mathematical model may yield results which parallel the actual judgments of an individual, however, this model does not necessarily represent the actual process of judgment utilized by the judge. While a large amount of the work in this paradigm has been done simply to aid the professional in understanding aspects of his own judgment policies (Goldberg, 1970), a topic of great theoretical interest had been the inclusion of non-linear terms in the resultant mathematical models of the judgment process. This question is directly related to the inclusion of configural terms in causal schemata.

Wiggins and Hoffman (1968) constructed models for the combination of 11 MMPI scales (cues) in the clinical prediction of "psychotic" or "neurotic" for each of 29 judges. A least squares fit of cue values to the judgments was determined for three derivation samples and cross-validated on four smaller samples. Cues for the linear model were simply the scores on the 11 MMPI scales. A second, quadratic model included these cues plus their squares and cross products. A third, sign model was also tested but is not directly relevant to the present research. The average multiple correlation between judgments predicted by the models and the judgments obtained from the cross validated samples was taken as an indication of the adequacy of the model. The quadratic model was superior to the linear model for only 9 of the 29 judges and the increase in correlation for the most non-linear judge was only .04. Studies similar to this one have generally found that linear models of cue combination account for nearly all the reliable judgment variation (Goldberg, 1968; Slovic & Lichtenstein, 1971).

The conclusion that judges uniformly utilize an additive strategy for cue combination is unwarranted, however, on three grounds. First, consistent non-linear cue usage has been demonstrated using this correlational methodology (Slovic, 1966). Secondly, it has been demonstrated that participants can learn to use cues in a configural manner although not as quickly as cues linearly related to a criterion (Hammon & Summers, 1965; Knowles, Hammond, Stewart, & Summers, 1971). Finally many of the studies have relied on the standard multiple regression equation to determine the goodness of fit for the linear model, a test for which this statistic is inadequate (Birnbaum, 1973). Anderson and others (Anderson, 1972; Hoffman, et al., 1968) have noted that in designs using factorial cue combination, analysis of variance provides a powerful test of goodness of fit for both linear and non-linear models. Generally, linearity would be reflected in significant main effects for a design with zero interactions. Configural judgment strategies would be reflected by certain significant components of the interaction terms. Slovic (1965) was able to demonstrate significant configural cue components for models of two stockbrokers' decisions to buy or sell stocks in imaginary companies with the analysis of variance methodology. Further, these cue combinations were interpretable in terms of the stockbrokers' own theoretical orientations. Similarly, configural cue utilization was exhibited for malignancy predictions from stomach ulcer characteristics by nine radiologists (Hoffman, et al., 1968). Sidnowski and Anderson (1967) have shown that even when the correlation between judgments and a linear combination of cues is as high as .98, interactions that are significant both statistically and psychologically can be detected by the use of analysis of variance. The support generally found for linear models of cue combination may thus be more a reflection of research methodology than underlying judgment principles.

Another important result of attempts to model human judgment processes has been the low consistency between expert judges. In the Hoffman, et al. (1968) study, radiologists judgments of malignancy were factor analyzed in order to discover groupings of judges by judgment strategies. Four factors emerged, although the authors report "it remains to be discovered exactly what distinguishes these types of judges [p. 345]." In this study the overall median inter-judge correlation was only .38. Wiggins, Hoffman, and Taber (1960) report on judgments of intelligence made by 145 adults from 199 profiles containing 9 cues. Factor analysis of these judgments uncovered 8 subject factors reflecting quite different judgment strategies. Wiggins (1973) argues that these factors reflect "characteristic styles in which individuals perceive, construe, and organize their environment [p. 173]."

Whether or not these subject factors directly reflect different integration strategies is not as important as the wide range of individual differences in cue utilization which they suggest.

Present Research

Two implications of the research reviewed are important for the present investigations of phenomenal causality. While attribution theory assumes that causal schemata are used to aid in assigning causal influence and that these rules possess the property of reversibility, paramorphic judgment studies have found that integration strategies differ widely between individuals. The implication of Anderson and Butzin's (in press) failure to support the use of a multiple necessary causal schemata for two of the three judgment tasks may not be that such rules were not used but rather that the analysis of aggregate data disguised different individual judgment rules. A number of recent studies of judgment strategies provided evidence that individuals use different combination rules for the same judgment task (Karabeniek, 1972; Shanteau & Anderson, 1972; Wallsten, 1972). In the Shanteau and Anderson (1972) study, while aggregate data provided support for a three variable multiplying model for judgments of the worth of an added piece of information in a simple decision task, analysis of individual participants' judgments revealed support for at least three additional compound adding-multiplying models.

The present study examined the implications of the research reviewed for the perception of causality in general and the use of causal schemata in particular. Most investigations of the use of judgment rules within the attributional framework have provided only qualitative tests of their use. However, the existence and results of the use of this type of cognitive albegra need to be demonstrated more rigorously if causal schemata are to be taken as representations of the naive analysis of action (Anderson, 1974). Analysis of judgments of other's actions were expected to reveal consistent relationships to dispositional property cues (Hypothesis 1). Specifically, judgments of possible outcomes will be positively related to the cues of ability, environmental facility, and motivation.

In addition, judgments of ability will be positively related to outcome and negatively related to environmental facility and motivation.

Not only will judges use cues consistently, but the causal schemata will be more complex than a simple linear combination of cue values, involving cue interactions. Individual causal schema were expected to evidence significant configural cue components generally paralleling Heider's (1958) formulations (Hypothesis 2). The configurality will tend to take the form suggested by Statement 4. Mathematically, motivational cues should be shown to stand in a multiplicative relationship to both ability and environmental facility cues for judgments of outcome. Psychologically, in terms of Table 1, judges should first assess the stable dispositional properties of ability and environmental facility and then qualify this assessment by the amount of effort the individual will extend to realize the outcome (internal variable disposition). Anderson (1973, personal communcation) has suggested an alternative causal schema for this judgment task:

$$\text{Outcome} = (\text{Ability X Motivation}) + \text{Environment Facility}, \quad (6)$$

where the motivation cue multiples only the ability cue. Psychologically, judges should first assess the effect of the internal causal dispositions and combine this assessment with the influence of external factors. While the two schemata seem quite similar, they suggest different psychological processes and can be differentiated statistically.

The test of this second hypothesis will be provided by the presence or absence of significant bilinear components for the three, two-way interactions of the ability, the environmental facility and the motivation cues. Both Statements 4 and 6 suggest an Ability X Motivation interaction for which differences in outcome judgments due to the motivation cues will be greater at high as compared to low ability levels and that the highest outcomes will be predicted for the high ability, high motivation cue combination. Statement 4 suggests a similar Environmental Facility X Motivation interaction while Statement 6 suggests that the effect of the motivation cue will be independent of the level of environmental facility. Both formulations suggest that differences in outcome judgments due to ability cues will be independent of the level of environmental facility.

Individual causal schemata for judgments of outcome from the cues of ability, environmental facility and motivation should be algebraically similar to judgments of ability from the cues of outcome, environmental facility and exertion (past motivation). An individual's causal schema was expected to be reversible for judgments within the same general framework (Hypothesis 3). Reversing

Statement 4 for judgments of ability yields:

$$\text{Ability} = (\text{Outcome}/\text{Motivation}) - \text{Environmental Facility}, \quad (7)$$

where judgments of ability are the result of the division of outcome cue values by motivation cue values combined with the environmental facility cue. A similar reversal of Statement 6 yields:

$$\text{Ability} = (\text{Outcome} - \text{Environmental Facility})/\text{Motivation}, \quad (8)$$

where judgments of ability are the result of the combination of the outcome and environmental facility cues divided by the motivation cue value.

As a test of this hypothesis, Statements 7 and 8 predict an Outcome X Motivation interaction of the form that differences in judged ability due to motivation level are greater at high as compared to low outcome levels and that the highest ability judgments are made for the low motivation, high outcome cue combination. Statement 8 predicts that the Environmental Facility X Motivation interaction will take the form that differences due to motivation will be greater for low as compared to high environmental facility and that the highest ability judgments will be made for the low environmental facility, low motivation cue combination. While this interaction is not predicted by Statement 7, Heider (1958, p. 111) does discuss a similar interaction for judgments of ability. Both Statements 7 and 8 anticipate that judgments of ability from outcome cues will be independent of the level of environmental facility.

Hypotheses 1-3 allow for differences in individual strategies for cue utilization but give no clue for understanding these differences. Within the attributional literature, two individual difference measures have been suggested to account for differences in cue usage. Kukla (1972) found high achievement oriented respondents were more sensitive to effort requirements for performance than were low achievement oriented respondents. Presumably, differential perception of this crucial variable will be reflected in attributional strategies manifest in the judgment tasks outlined. Karabenick (1972) demonstrated differing perceptions of the valence of success and failure for respondents varying on internal-external locus of control (Rotter, 1966). Internal respondents gave more extreme evaluations of both success and failure than did externals. Weiner, *et al*. (1972) criticize the use of this personality dimension for failure to take into account the stable-variable dimension of causal attribution, as described in Table 1. McKillip (1974a) has developed a measure which attempts to differentiate respondents according to their use of internal-external and stable-variable causal explanations which should be related to different rules for cue combination. In addition, intelligence may be an individual difference variable related to the tendency to use configural cues in forming judgments. Previous published research has not included an intelligence measure. Individual differences in causal schemata were also expected to be related to the personality dimensions of achievement motivation and causal attributions (Hypothesis 4).

In summary, the present study examined group and individual patterns of causal attributions to evaluate the use of causal schemata and the relationship between different judgmental strategies and cognitive styles.

<u>Method of Analysis</u>

Anderson's functional measurement (1970) provided the primary method of assessment in the present study. Using factorial cue combination and analysis of variance, functional measurement provides two tests for the use of causal schemata, one graphic and the other statistical. Graphically, the use of multiplicative terms is evidenced by sets of (here, four) diverging straight lines; statistically, two cue interactions should be characterized wholly by the bilinear component. Simple additive combination, in contrast, should yield four parallel straight lines and only significant cue main effects. Use of Statement 4, for example, is supported by significant Ability X Motivation and Environmental Facility X Motivation interactions characterized wholly by the bilinear components with nonsignificant Ability X Environmental

Facility and Ability X Environmental Facility X Motivation interaction terms. Significant residual components for any interaction terms suggest non-interval response or stimulus scales. If this is the case, a monotone transformation of the judgment data should be available to eliminate this source of variation. Non-significance for the bilinear components of the first two interactions terms mentioned above or significant components for the second two terms suggest the use of a causal schema different from Statement 4. Use of Statement 6 is supported by a significant bilinear component for the Ability X Motivation interaction only. Similar requirements must be met for the use of Statements 7 or 8. Reversibility of causal schemata is supported by the utilization of algebraically similar judgment rules for both of the judgment tasks. Recent papers by Leon, Oden and Anderson (1973) and Shanteau and Anderson (1972) provide examples of the use of functional measurement to study modes of information integration.

METHOD

Respondents participated in five experimental sessions, one group session in which individual difference measures were administered and four individual judgment sessions. During the first two of these individual sessions, participants made judgments of outcome from the cues of motivation, ability and environmental facility. During the final two sessions, participants made judgments of ability from the cues of motivation, outcome and environmental facility. The judgment cues of motivation, ability, outcome and environmental facility were operationalized as study habits, IQ, grade point average (GPA), and course load, respectively. Both outcome and ability judgments were made by drawing a perpendicular to a point along the 6 inch judgment scale graded in 1.5 inch segments.

Participants

Twenty-nine introductory psychology students from Loyola University volunteered to fulfill part of a course requirement. The 19 male and 10 female participants ranged in age from 17 to 22 years with a median of 18 years. The sample included 6 (21%) minority group members.

Judgment Tasks

Judgments of outcomes were predictions of the first semester GPA for a stimulus person from knowledge of his ability, environmental facility, and motivation. Ability was operationalized as IQ, environmental facility as course load for first semester, and motivation as a three trait personality description indicating study habits. Four levels for each cue were identified and labelled, as indicated in Appendix A. In discussion these cue levels will be denoted as L, M-, M+, and H ranging from low to high. Identifications for cue levels presented in Appendix A were the result of extensive pretesting in an attempt to attain equal spacing between cue levels. The task consisted of participants reading aloud the levels of the three cues of each stimulus person and indicating their judgment of the first semester GPA.

Judgments of ability were inferences of the intelligence of a stimulus person from knowledge of his outcome, environmental facility, and motivation. Outcome has operationalized as first semester GPA, environmental facility as first semester course load, and motivation as relative amount of study during the first semester. The four levels of each judgment cue identified and labelled are presented in Appendix A. The ability judgment task was identical to that for outcome judgment except that the dependent measure was inferred ability.

Judgments of outcome and ability were made on similar 6 inch scales labelled at 1.5 inch intervals. For outcome judgments, labels indicated possible grade point averages from 0.0 to 4.0 in steps of 1.0. For ability judgments, labels indicated degree of ability from 0 for very low ability to 4 for very high ability in steps of 1. The principle dependent measure was the distance to the nearest 1/32 of an inch from the zero point of the scale to the perpendicular drawn to indicate the judgment. Scores could range from 0.0 to 6.0.

Procedure

Each participant completed five experimental sessions within a period of eight days. During the first session, a group of from 5 to 8 participants completed the following individual difference measures: (a) intelligence, Otis Quick-Scoring Mental Abilities Test (Otis, 1939); (b) a measure of resultant achievement motivation, Mehrabian's Achievement Risk Preference Scale (Mehrabian, 1969); and (c) the Causal Perceptions Questionnaire (McKillip, 1974a) which contains subscales for internal-external and stable-variable causal assignment.

During the judgment sessions, judgment cues and their relationship to the task dimension were explained. These relationships were displayed before participants during the entire session. Next, participants were instructed in the use of the response scale and a number of single cue judgments were made to insure familiarity with the scale. Finally the experimental task was explained. For each stimulus person, levels for the three cues were printed on single 5 inch by 8 inch cards. Participants read the cues aloud and made their judgments in an answer booklet containing one scale per page. Presentation of judgment cases was self paced with the restriction that the maximum interval between judgments was 20 seconds and the minimum 10 seconds. Order of presentation was randomized by shuffling the deck of stimulus cases before each experimental session. During each session, participants made judgments of one complete replication of the design (64 cases) preceded by 16 anchor and practice trials. During the first two individual sessions, participants made judgments of outcomes, and during the final two sessions, they made judgments of ability.

Data Analysis and Design

Each judgment task yielded 128 judgments per participant with two replications and factorial combination of each of four levels of three cues. These data were analyzed by analysis of variance and causal schemata were constructed for each participant for each judgment task by the techniques of functional measurement. Finally, the use of particular causal schemata was related to the individual difference measures.

RESULTS

Outcome Judgments: Aggregate Analysis

The results of a repeated measures analysis of variance with the three judgments cues, ability, environmental facility, and motivation, treated as fixed factors and replications (2) and participants (29) treated as random factors are presented in Table 2. Fixed factor effects and their interactions are tested against a pooled error term. In addition to $\underline{F}$ values, Table 2 contains the percentage of variance estimates, ω^2 (Vaughn & Corballis, 1969).

Table 2 reveals that the three cue main effects of Ability, Environmental Facility and Motivation are significant and account for approximately 50% of the total variance. Mean outcome judgments for each level of these three cues are presented in Table 3. It is apparent from this table that the equal spacing assumption for cue levels was not met. Therefore, weights for trend analysis of interaction terms were determined from these marginal means (Grandage, 1958). Table 2 also reveals that none of the two-way interactions were significant. The means for these interactions are presented in Figures 1-3. The self-spacing along the

Table 2

Analysis of Variance for Outcome Judgment Scores

Source	*MS*	*df*	*F*	ω^2
Subjects	11.99	28		.066
Replications	.01	1		.000
Ability (A)	439.09	3	808.64*	.255
Environmental Facility (B)	79.47	3	146.35*	.049
Motivation (C)	328.42	3	604.82*	.202
A X B	.43	9	.79	.000
A X C	.74	9	1.38	.000
B X C	.46	9	.85	.000
A X B X C	.34	27	.63	.000
Polled Error	.54	3619		

*$p < .01$

Table 3

Outcome Judgment Means for Cue Main Effects

Cue	Level			
	L	M-	M+	H
Ability	2.87	3.11	4.00	4.30
Environmental Facility	3.19	3.53	3.67	3.88
Motivation	2.94	3.20	3.93	4.20

Note.- Means can range from 0.0 to 6.0, the higher the mean the higher the predicted outcome (GPA).

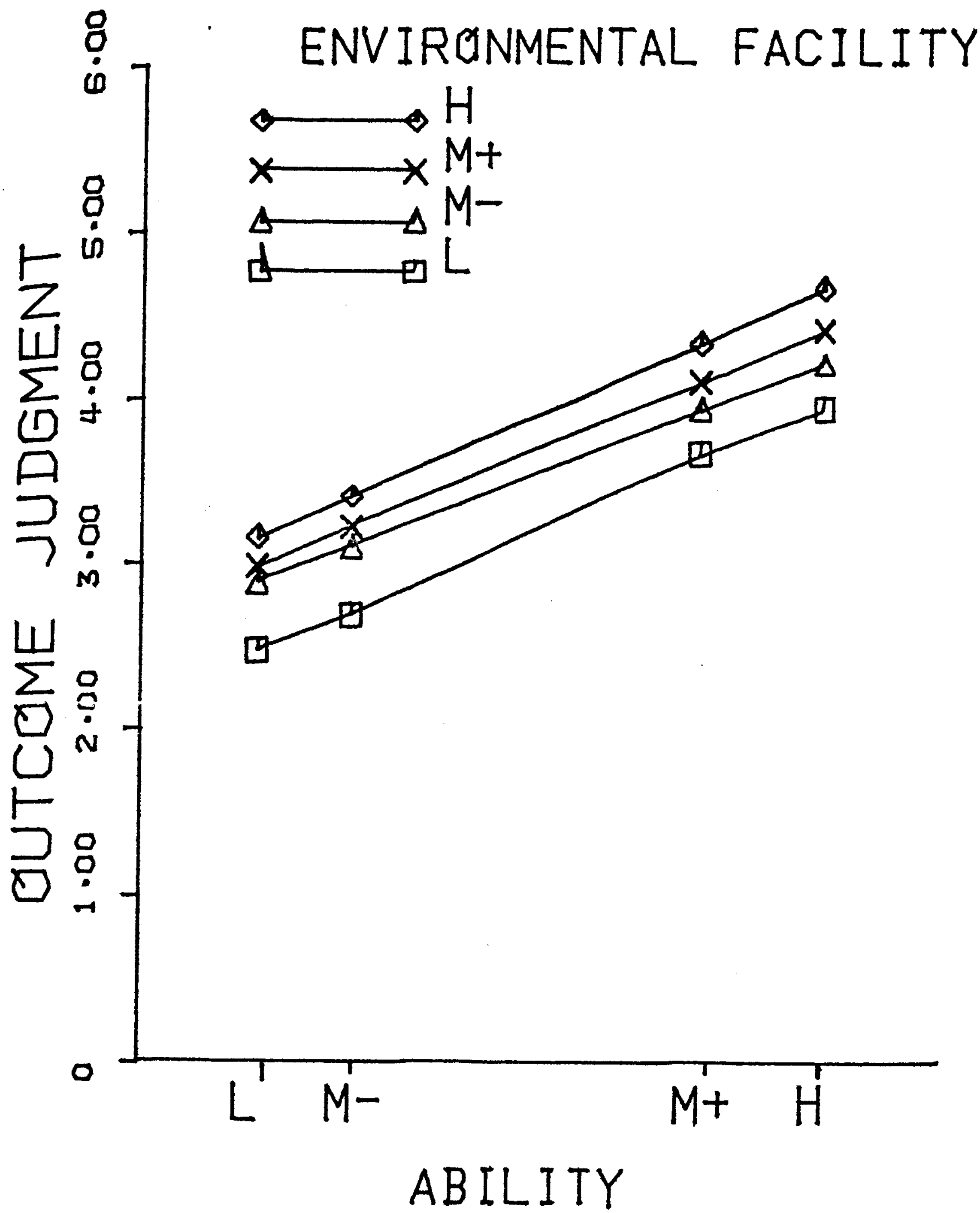

FIGURE 1. MEAN OUTCOME JUDGMENTS FOR ABILITY X ENVIRONMENTAL FACILITY INTERACTION, ALL PARTICIPANTS.

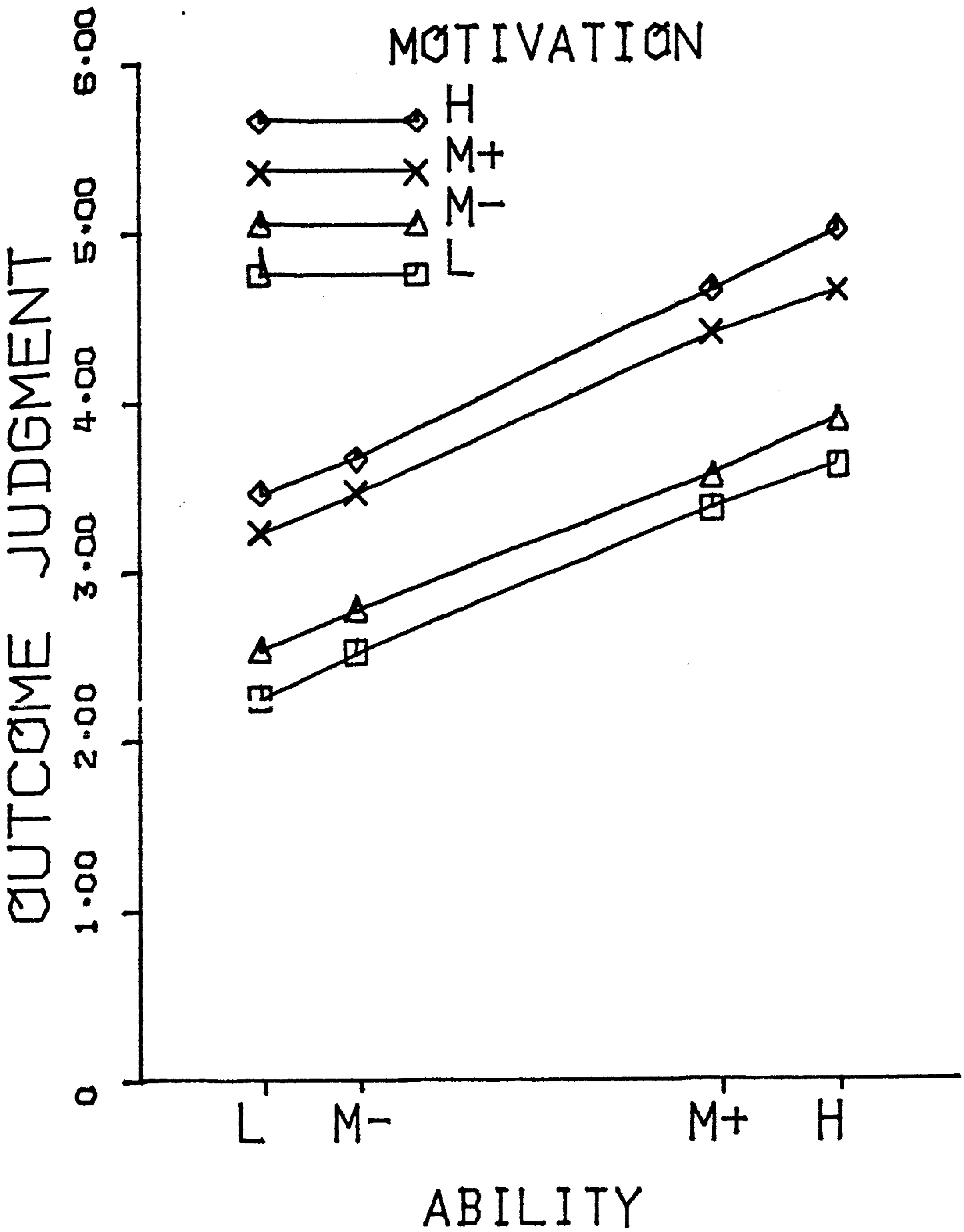

FIGURE 2. MEAN OUTCOME JUDGMENTS FOR ABILITY X MOTIVATION INTERACTION. ALL PARTICIPANTS.

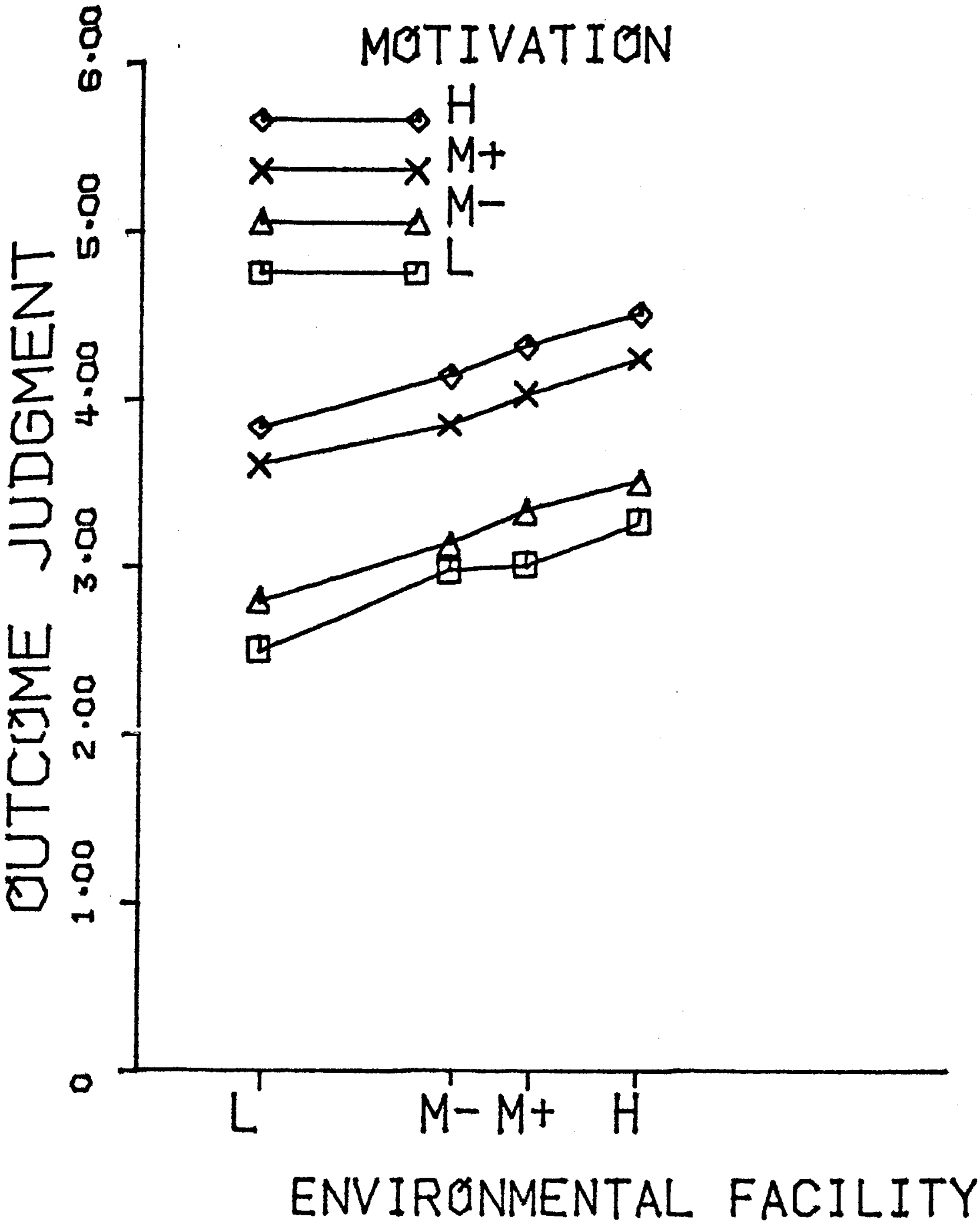

FIGURE 3. MEAN OUTCOME JUDGMENTS FOR ENVIRONMENTAL FACILITY X MOTIVATION INTERACTION, ALL PARTICIPANTS.

abscissa was derived from the marginal means (Table 3). The parallelism portrayed in each of these figures suggests additive rather than multiplicative cue combination. Analysis of aggregate data suggested that participants used a multiple sufficient causal schema of the form:

$$\text{Outcome} = \text{Ability} + \text{Environmental Facility} + \text{Motivation}, \qquad (9)$$

where outcome judgments increased with increases in any of the three cues but that the effect of any one cue was independent of the level of either of the other two cues. This analysis supports a simple linear model rather than the more complex configural models of Statements 4 and 6.

Outcome Judgments: Individual Analysis

A repeated measures analysis of variance of outcome judgments was performed for each participant with replications treated as a random factor. In addition both the bilinear trend and the residual component of each of the two-way interactions was tested. The results of these analyses are presented in Table 4 with participants grouped to aid discussion. Percentage of variance estimates for all analysis terms are presented in Appendix B.

Main effects. For all participants the Ability and Motivation main effects were significant and for all but two (7 and 8) the Environmental Facility main effect was significant. In all cases except one, outcome judgments

Table 4

F Ratios for Model Analysis, Outcome Judgments

Participants with only Main Effects	Main Effects: Ability (A)	Main Effects: Environmental Facility (B)	Main Effects: Motivation (C)
1	101	11	108
2	20	28	22
3	56	19	32
4	68	12	108
5	45	56	36
6	141	15	121
7	335	.25	93
8	14	2.06	4
Participants with significant interactions			
9	90	86	61
10	46	9	37
11	69	10	89
12	55	15	110
13	283	46	332
14	79	16	59
15	24	28	73
16	47	15	46
17	78	8	22
18*	51	15	38
19	132	16	47
20	107	7	83
21	199	10	69
22	85	8	13
23	131	13	77
24	99	37	66
25	57	26	144
Participants with significant residuals			
26	27	399	62
27	99	7	104
28	105	40	78
29	204	13	167
df	3/63	3/63	3/63

Note: Significant and nonsignificant *F*s given to 0 and 2 decimal places, respectively.

* Squareroot transformation

Table 4 (Continued)

F Ratios for Model Analysis, Outcome Judgments

Participants with only Main Effects	Bilinear Interactions		
	A X B	A X C	B X C
1	.11	1.09	1.87
2	.17	.80	.52
3	1.94	1.89	3.38
4	3.14	.37	.83
5	2.96	2.04	.00
6	.03	.71	3.14
7	1.69	1.49	.00
8	.09	.06	2.46
Participants with significant interactions			
9	7	24	20
10	5	7	5
11	4	4	6
12	11	12	9
13	10	21	.09
14	4	19	1.02
15	4	7	1.31
16	5	5	2.53
17	.00	11	.56
18*	.78	5	1.17
19	.37	9	.24
20	.66	11	1.22
21	.95	8	1.53
22	5	.07	.57
23	.57	5	5
24	.63	.40	9
25	.04	2.69	4
Participants with significant residuals			
26	.00	.53	.49
27	3.75	2.43	.07
28	.01	.02	.11
29	1.58	11	3.48
df	1/63	1/63	1/63

Table 4 (Continued)

F Ratios for Model Analysis, Outcome Judgments

Participants with only Main Effects	Residual Interactions A X B	Residual Interactions A X C	Residual Interactions B X C	Three-Way Interaction A X B X C
1	.71	.94	.88	1.04
2	1.60	.92	.26	.58
3	.26	.91	.27	.67
4	1.42	.83	.41	.64
5	1.12	.41	.65	1.13
6	1.20	.38	1.92	.81
7	.66	.28	.54	.99
8	.58	.49	.78	1.29
Participants with significant interactions				
9	.72	.79	.79	1.62
10	.33	.34	.99	.60
11	2.00	.87	.66	1.09
12	.48	.57	.19	.38
13	1.98	1.69	1.53	.79
14	.48	1.06	.54	.94
15	1.20	.84	1.02	1.40
16	.18	.33	1.01	.75
17	.89	.88	.34	.76
18*	1.81	1.18	1.33	1.28
19	1.13	.46	.51	.98
20	1.34	.67	.51	.50
21	1.89	.70	2.08	.97
22	.46	.51	.42	.43
23	1.80	.24	.52	.50
24	1.06	.63	.31	.88
25	.89	1.62	.01	1.53
Participants with significant residuals				
26	3	1.24	3	2
27	3	.58	2	.94
28	3	1.42	2	1.24
29	.97	2	.50	1.46
df	8/63	8/63	8/63	27/63

increased as cue levels increased, in a pattern similar to that of Table 3. Participant 22 seemed to have reversed the ordering of environmental facility cues since he predicted higher outcomes (GPA) for lower environmental facility (heavier course loads). On the average the Ability, Environmental Facility and Motivation main effects accounted for 37.5, 11.1, and 29.4% of the outcome variance, respectively.

According to functional measurement theory, a significant bilinear interaction component and a nonsignificant residual component provide support for the use of a multiplicative judgment term. A significant residual interaction component may indicate an invalid model (multiplicative term) or may simply reflect non-interval scaling properties. In the latter case a monotonic transformation may be found which causes the residual interaction to disappear. Fortunately, residual interaction components were significant for only 5 of the 29 participants (18 and 26-29). For participant 18, a square root transformation ($x^1 = \sqrt{x} + \sqrt{x+1}$, Kirk, 1968, pp. 64-65) rendered the Ability X Environmental Facility interaction residual nonsignificant, so that the results of this transformation are reported in Table 4. No suitable transformation could be found for the other four participants and the results of their individual analyses will not be discussed further. The general lack of significant residual interaction components lent good support to the assumption that stimuli and response scales have interval properties.

Ability X Environmental Facility interaction. In line with Statements 4 and 6, the Ability X Environmental Facility interaction was not significant in the analysis of aggregate data. However, individual analysis yielded a number of significant interaction terms, for participants 9-16 and 22. For these participants, the bilinear components accounted for an average of 53% of the interaction sum of squares. The means on which this interaction is based for participants 9, 10 and 12-15 are presented in Figure 4. As can be seen, the general picture is that of four diverging straight lines. The ability and environmental facility cues combined multiplicatively such that differences in outcome judgments due to environmental facility are greater for high than for low ability levels. For these participants the importance of the course load in determining GPA was greater for high as compared to low intelligence.

The pattern of this interaction, however, was not the same for all participants. These differences in pattern contributed to the nonsignificant interaction for aggregate analysis. The means reflecting this interaction for participants 11 and 16 are presented in Figure 5. While the multiplicative relationship between ability and environmental facility is again evidenced, differences in

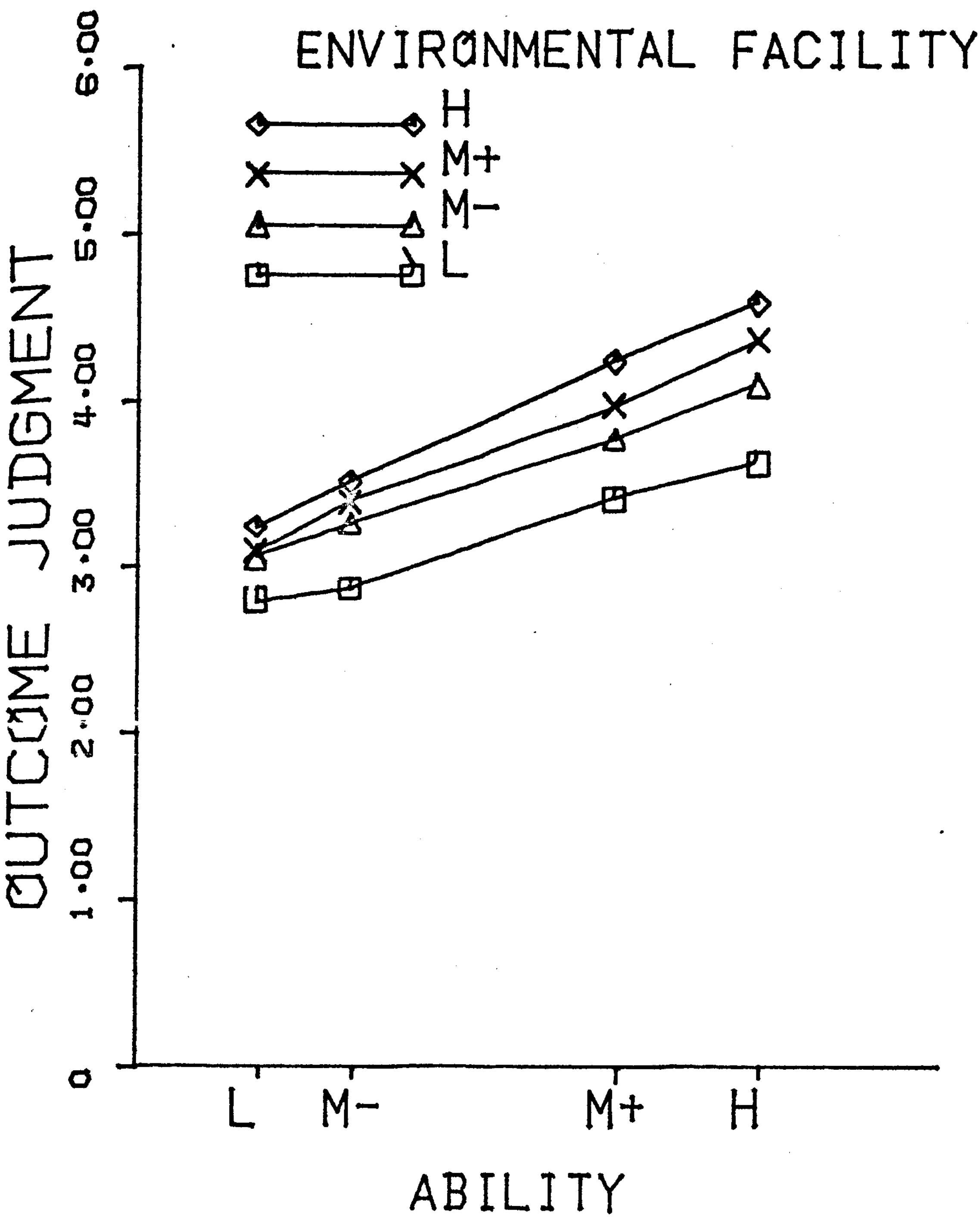

FIGURE 4. MEAN OUTCOME JUDGMENTS FOR ABILITY X ENVIRONMENTAL FACILITY INTERACTION, PARTICIPANTS 9, 10, 12, 13, 14, AND 15.

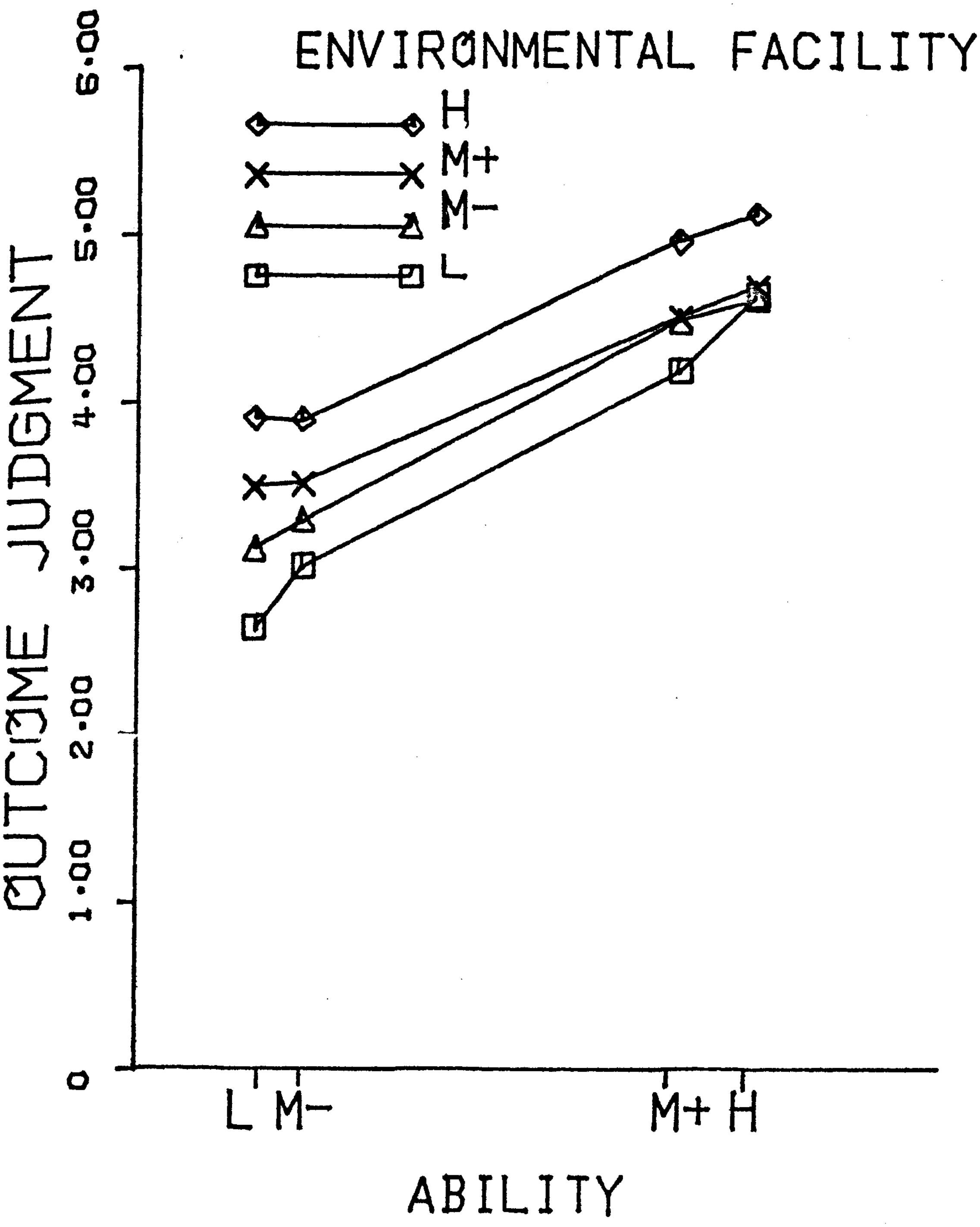

FIGURE 5. MEAN OUTCOME JUDGMENTS FOR ABILITY X ENVIRONMENTAL FACILITY INTERACTION, PARTICIPANTS 11 AND 16.

outcome judgments due to environmental facility were greater at low as compared to high ability levels. For these participants course load was more important for predictions of GPA at low rather than high intelligence levels.

The pattern for participant 22 showed four diverging straight lines, as in Figure 4, except that higher outcome judgments were made when environmental facility was low rather than high.

Differences between Figures 4 and 5 may be more apparent than real, depending upon the definition of ability. If low ability is considered a zero point and higher ability levels a deviation from that point, the pattern of Figure 4 would be expected. If, on the other hand, high ability were defined as the zero point and lower ability levels taken as a deviation from that point (negative numbers), the pattern described in Figure 5 would be expected. Differences similar to those described by Figures 4 and 5, appeared for a number of two-way interactions. These patterns could result if the participants contributing to Figure 4 considered ability as a deviation from a certain baseline while the participants contributing to Figure 5 considered ability as a deviation from an ideal.

Ability X Motivation interaction. The Ability X Motivation interaction is central to the descriptions of the naive analysis of action provided by Statements 4 and

6. Although not significant for aggregate analysis, the bilinear component of the Ability X Motivation interaction was significant for 14 participants (9-21, and 23), accounting for an average of 62% of the interaction sum of squres.

The pattern of means of this interaction for 11 of these participants (9,10,12-15, 18-21, and 23) is presented in Figure 6. The picture is of 4 diverging straight lines, although there is apparently little difference between the two highest motivation levels. The pattern is essentially that predicted by Statements 4 and 6 where differences due to motivation are greater at high as compared to low ability levels. Differences in predicted GPAs due to study habits were greater at high as compared to low intelligence. These results are similar to those found by Anderson and Butzin (in press).

The means for the Ability X Motivation interaction for participants 11, 16 and 17 are presented in Figure 7. The pattern is similar to that of Figure 5 presenting four converging straight lines. In constrast to Figure 6, this pattern reflects greater importance for differences in motivation at low rather than high ability levels. For these participants differences in study habits for the prediction of GPAs are more important for low intelligence than for high intelligence.

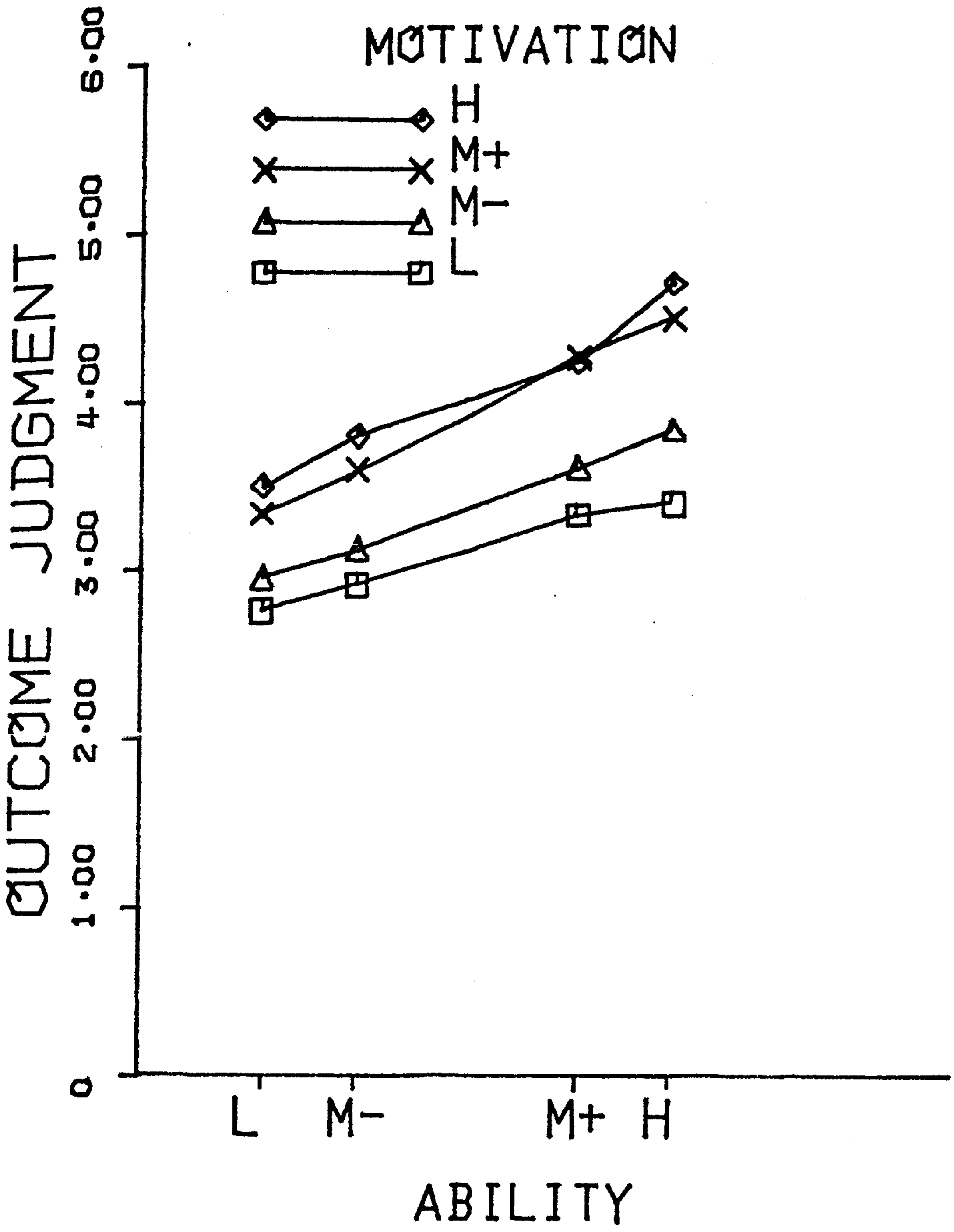

FIGURE 6. MEAN OUTCOME JUDGMENTS FOR ABILITY X MOTIVATION INTERACTION. PARTICIPANTS 9, 10, 12-15, 18-21, AND 23.

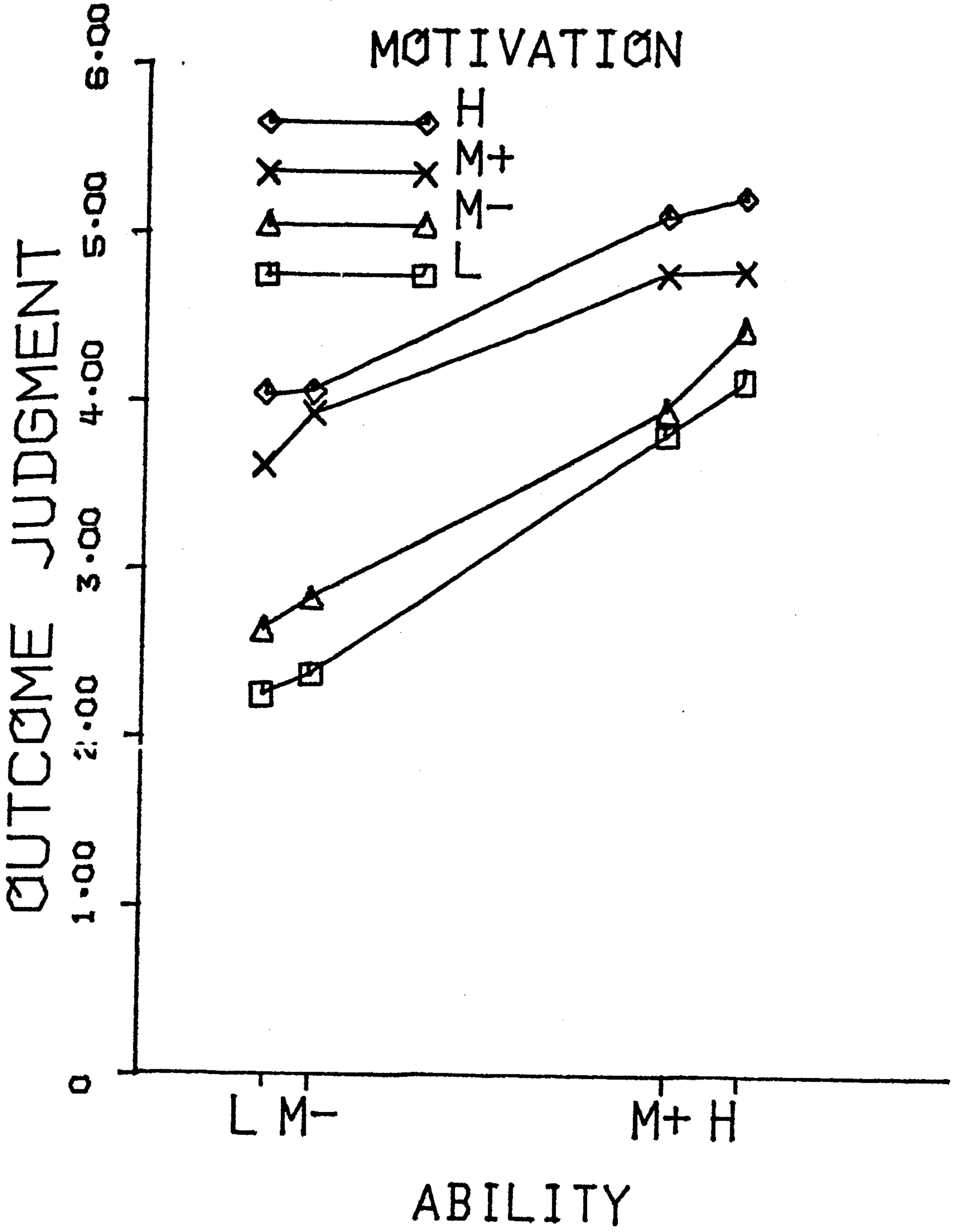

FIGURE 7. MEAN OUTCOME JUDGMENTS FOR ABILITY X MOTIVATION INTERACTION. PARTICIPANTS 11, 16, AND 17.

<u>Environmental Facility X Motivation interation</u>. This third two-way interaction is predicted by Statement 4 but not Statement 6, and, as will be recalled, was not significant by aggregate analysis. Individual analysis revealed a significant bilinear component for the Environmental Facility X Motivation interaction for seven participants (9-12, and 23-25) accounting for an average of 53.7% of the interaction sum of squares.

The means for the Environmental Facility X Motivation interaction for three participants (9, 10, 15) are presented in Figure 8. The pattern is of four diverging lines where differences in outcome judgments due to motivation are greater under high as compared to low environmental facility. It is this pattern which is predicted by Statement 4. For these participants the importance of study habits in determining GPA was greater when the course load was light as compared to heavy.

Figure 9 represents the means for participants 11, and 23-25. The pattern is of four converging lines where differences due to motivation are greater under low as compared to high environmental facility. Differences between Figures 8 and 9 are trivial if for the first three participants (Figure 8) environmental facility ranged from near zero (L) to some positive value (H) while for the other four participants (Figure 9) the range was from some negative value (L) to near zero (H).

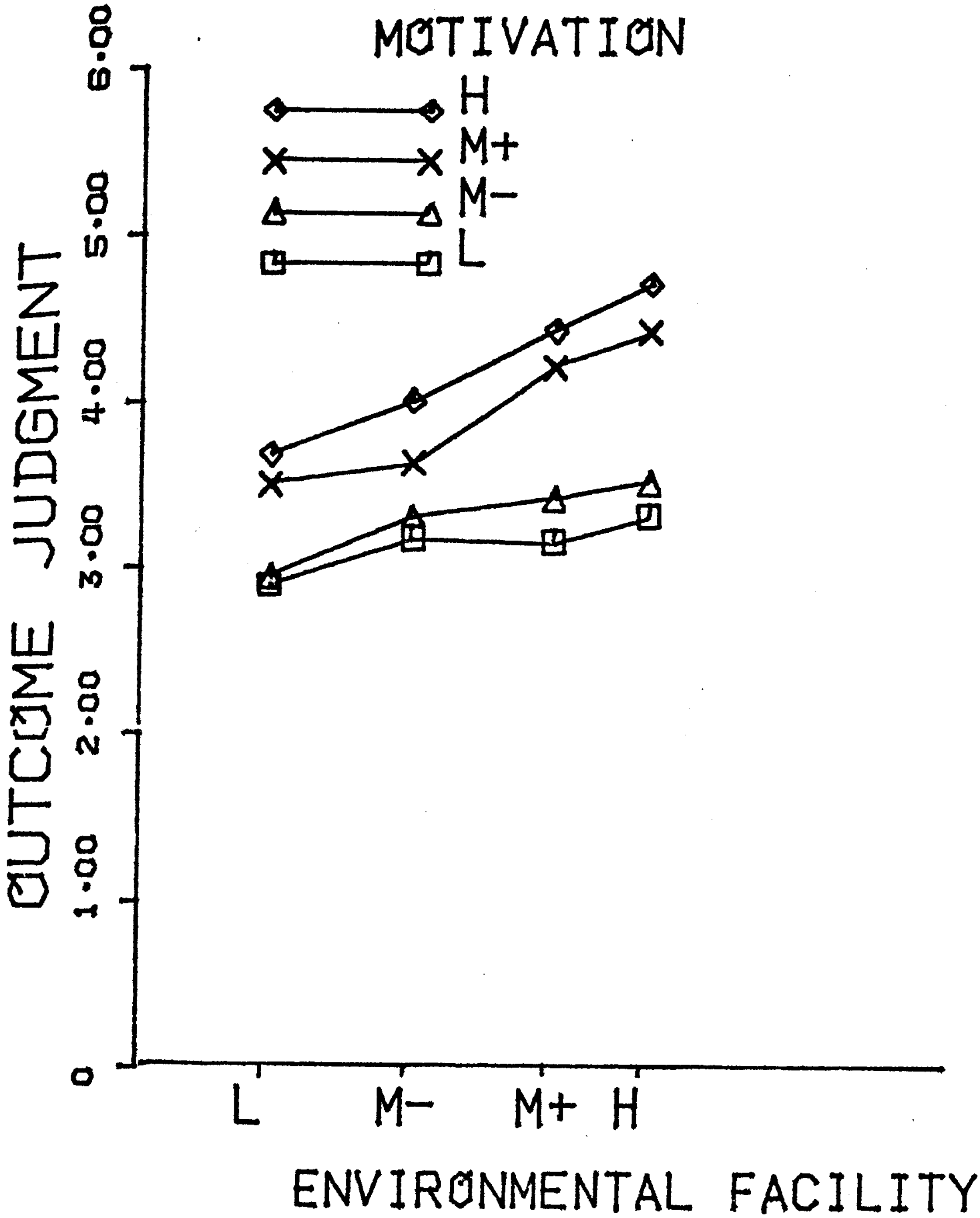

FIGURE 8. MEAN OUTCOME JUDGMENTS FOR ENVIRONMENTAL FACILITY X MOTIVATION INTERACTION PARTICIPANTS 9, 10, 12.

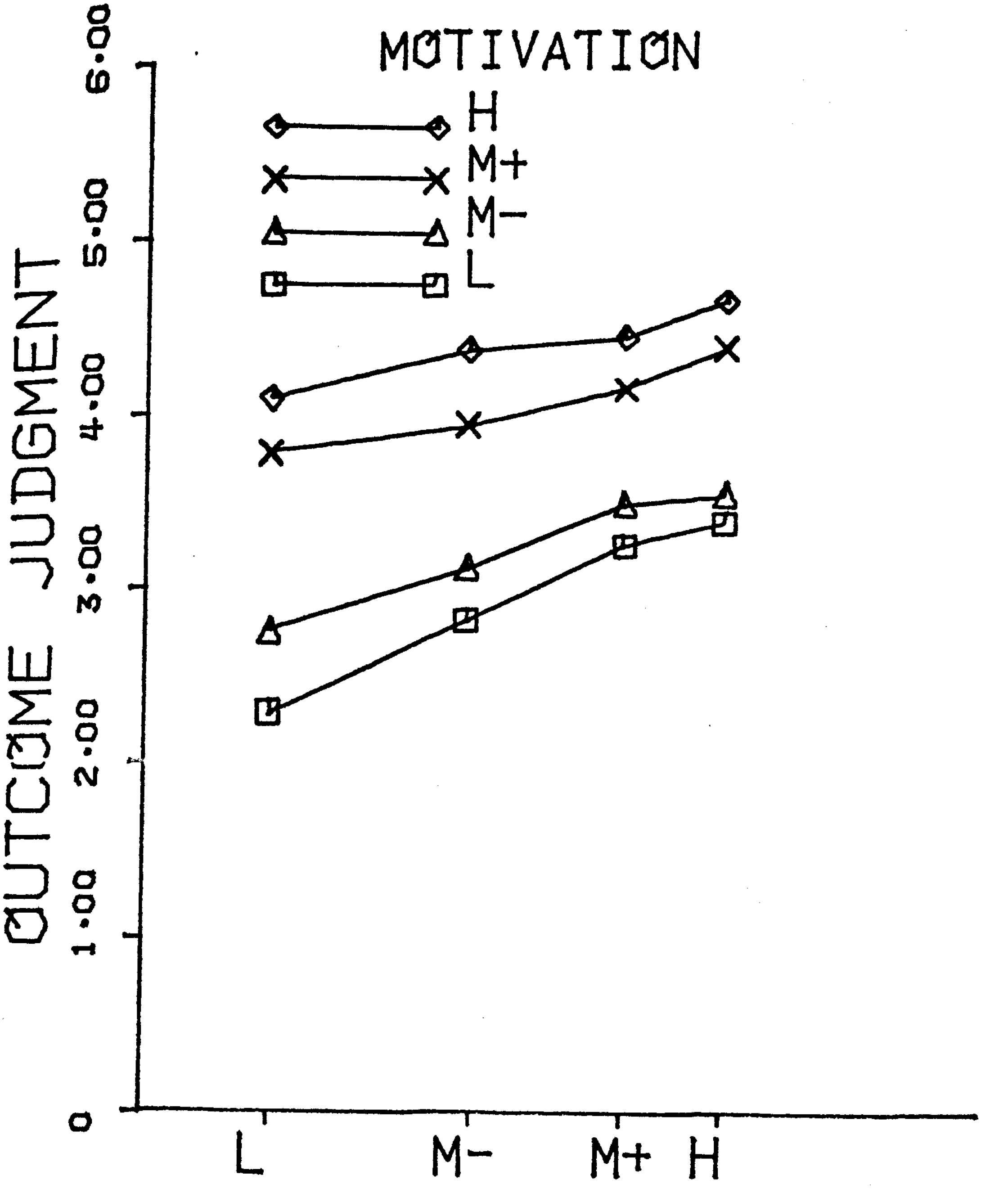

FIGURE 9. MEAN OUTCOME JUDGMENTS FOR ENVIRONMENTAL FACILITY X MOTIVATION INTERACTION FOR PARTICIPANTS 11, AND 23-25.

Ability X Environmental Facility X Motivation interaction. Analyses of the trilinear component of the three-way interaction were made for the four participants for whom the three, two-way interactions were significant. This was done to test the possibility that these participants used a three-cue multiplying model (Shanteau & Anderson, 1972). The results of these analyses are presented in Table 5. The trilinear component was significant for participants 9-11 but not for participant 12.

Model Analysis

Causal schemata were constructed for participants in accordance with functional measurement theory. The presence of multiplicative terms was supported by cue interaction concentrated in the bilinear component. When interaction terms were not significant additive cue combination was evidenced by significant main effects.[1]

---

[1]According to functional measurement theory (Anderson, 1970) multiplicative terms are indicated by significant cue interactions characterized wholly the Linear X Linear (bilinear) components and additive terms are indicated by significant cue main effects and nonsignificant cue interactions. When cue values all have the same sign, the simple multiplicative model, $r_{aj} = w_a s_j$, anticipates both a significant bilinear interaction component and significant main effects. For this reason when both the interaction component and the cue main effects are significant only the multiplicative term is included in the judgment model. When the main effects are significant and the interaction component is not, additive terms are included in the model. Strictly speaking, the simple multiplicative model described about cannot be distinguished from a more general model which includes both additive and multiplicative components:

Table 5

F Ratios for Trilinear and Residual Components of The Three-Way Interaction for Outcome Judgments

Participant	Trilinear	Residual	Proportion of Sum of Squares
9	4.28*	1.52	.34
10	6.24*	.38	.40
11	18.85*	.41	.65
12	.32	.38	.03
df	1/63	26/63	

*$p < .05$

Strictly speaking, only four participants' judgments could be characterized by Statement 6 (18-21), while participant 17 used a similar judgment model. Only one participant (23) showed both the Ability X Motivation and the Environmental Facility X Motivation interactions anticipated by Statement 4, and the latter interaction was of a form different from that expected. Together, some twelve different models were needed to characterize the judgments of the 25 participants. Ignoring the differences in orientation illustrated by comparison of Figures 4, 6 and 8 with Figures 5, 7 and 9, some seven different causal schemata were needed. These will be discussed in turn.

Participants 1-8 used variations of a general linear model. For the first six of these participants, this schema took the same form as that for the aggregate data:

Outcome + Ability + Environmental Facility

+ Motivation. (9)

Participants 7 and 8 ignored the environmental facility cue and thus their model included only two terms:

Outcome = Ability + Motivation. (9a)

Statements 9 and 9a represent multiple sufficient causal schemata where the effect of any one cue was independent of the others.

The Ability X Environmental Facility interaction

$r_{aj} = c_1w_a + c_2s_j + c_3w_as_j + c_4$, where the c's are constants (Anderson, 1970, p. 165).

was not expected by either Statements 4 or 6 and was not evidenced for aggregate analysis. The finding of a significant bilinear component for 9 of 26 participants is far above the number expected by chance (1 of 20) and does not support Heider's (1958) hypothesized multiple sufficient causal schema for inferring another's capabilities (Statement 2).

The judgment rule for three participants included this Ability X Environmental Facility interaction with the expected Ability X Motivation interaction (13-15):

$$\text{Outcome} = \text{Ability (Environmental Facility} + \text{Motivation)}, \quad (10a)$$

where ability multiplied both environmental facility and motivation. These two interactions were also significant for participant 16 except that differences due to environmental facility and motivation were smaller at high rather than low ability levels. Assuming that this difference was due to a different orientation to the ability cue, the judgment model would be:

$$\text{Outcome} = (-) \text{ Ability (Environmental Facility} + \text{Motivation)}, \quad (10b)$$

where this symbol (-) indicates that the participant's subjective view of the cue level ranged from negative (L) to zero (H) rather than from zero (L) to positive (H). Similar notation will be used throughout the paper.

While participants 17-21 only showed a significant

Ability X Motivation interaction indicating that Statement 6 was the appropriate causal schema, differences due to motivation levels for participant 17 converged rather than diverged at high ability levels. The causal schema for this participant is described in Statement 6a:

Outcome = ((-)Ability X Motivation)
+ Environmental Facility. (6a)

While analysis of participant 23's judgments revealed both interactions anticipated by Statement 4, differences due to motivation were smaller at high rather than low environmental facility levels. This judgment model can be described:

Outcome = Motivation (Ability X (-) Environmental
Facility), (4a)

where differences due to motivation diverged as ability increased and converged as environmental facility increased.

Only two participants (24 and 25) showed only an Environmental Facility X Motivation interaction, although this interaction was significant for 7 of 26 participants overall. The pattern of the interaction was such that differences due to motivation were smaller at high compared to low environmental facility levels indicating this schema:

Outcome = Ability+((-)Environmental Facility
X Motivation). (11)

Four participants, 9 through 12, utilized all three, two-way interactions. In addition, the trilinear component of the Ability X Environmental Facility X Motivation interaction was significant for participants 9-11, suggesting a three cue multiplying model. For participants 9 and 10 the judgment model is:

Outcome = Ability X Environmental Facility
X Motivation, (12a)

where differences in outcome judgment due to motivation increased as environmental facility increased and this increase in differences due to motivation increased as ability increased. The model for participant 11 presents a different picture,

Outcome = (-) Ability X (-) Environmental Facility
X Motivation, (12b)

where differences in outcome judgments due to motivation decreased as environmental facility increased and this decrease in motivation differences decreased as ability increased. The judgment model for participant 12 contains the products of the three two-cue combinations:

Outcome = (Ability X Environmental Facility)
+ (Ability X Motivation)
+ (Environmental Facility X Motivation), (12c)

which includes aspects of Statements 4 and 10a.

The judgments of participant 22 differ significantly from those of other participants since outcomes increased as environmental facility decreased. This judgment pattern may reflect the natural covariance between high marks and heavy course load due to selection on ability. While the independence of the three cues was explained fully to each participant, participant 22 may have ignored these instructions or may have been unable to ignore the natural covariance between grades and course load. The resultant schema for this judge is:

$$\text{Outcome} = (\text{Ability}/\text{Environmental Facility}) + \text{Motivation}. \qquad (13)$$

Ability Judgments: Aggregate Analysis

Results of the analysis of ability judgments for all 29 participants are presented in Table 6. Again Participants and Replications are treated as random factors and the judgment cues are treated as fixed factors.

Table 6 reveals that the three cue main effects were significant, accounting for approximately 67.3% of the total variance. The mean ability judgments for each level of these three cues are presented in Table 7. Judged ability increased as outcome increased and decreased as both environmental facility and motivation increased. It should also be noted from this table, that the equal spacing assumption for cue levels again is not met. Therefore, weights for trend analysis of the interaction terms were computed from the marginal means.

Table 6

Analysis of Variance for Ability Judgment Scores

Source	MS	df	F	ω^2
Subjects	14.33	28		.024
Replications	3.27	1		.000
Outcome (A)	721.65	3	1958.48**	.470
Environmental Facility (B)	207.09	3	561.98**	.135
Motivation (C)	104.19	3	282.74**	.068
A X B	3.68	9	9.99**	.006
Linear X Linear	25.30	1	68.38**	.829a
Residual	.90	8	2.43*	.171a
A X C	1.41	9	3.83**	.002
Linear X Linear	7.31	1	19.76**	.645a
Residual	.65	8	1.74	.355a
B X C	.25	9	.68	.000
A X B X C	.34	27	.92	.000
Polled Error	.37	3619		

* $p < .05$

** $p < .01$

[a]Estimate of proportion of interaction variance accounted for by specific interaction component (Vaughn & Corballis, 1969).

Table 7

Ability Judgment Means for Cue Main Effects

Cue	Level			
	L	M-	M+	H
Outcome	2.47	2.76	3.90	4.30
Environmental Facility	3.88	3.62	3.05	2.87
Motivation	3.73	3.49	3.25	2.95

Note.- Means can range from 0.0-6.0; the higher the mean, the higher the judged ability.

In addition to the main effects, both the Outcome X Environmental Facility and the Outcome X Motivation interaction were significant. The bilinear trend of the Outcome X Environmental Facility interaction accounted for nearly all the interaction variance (82.9%) although the residual component of this interaction was also significant. The means for this interaction are presented in Figure 10 and, generally, present a picture of four diverging straight lines. A slight deviation from this trend is observable since ability levels for M+ and H environmental facility converge rather than diverge at H outcome. The primary relationship depicted in this figure is that low as compared to high environment facility caused higher ability judgments and that this difference was accentuated as outcome increased. The bilinear trend of the Outcome X Motivation interaction was also significant accounting for 64.5% of the interaction variance. The residual component of this interaction was not significant. The means for this interaction are presented in Figure 11, showing a picture of four diverging straight lines. Low as compared to high motivation led to higher ability judgments and this difference increased as outcome increased.

The means for the Environmental Facility X Motivation interaction are presented in Figure 12. Since this interaction was not significant, the anticipated picture is of four parallel straight lines. This is the case.

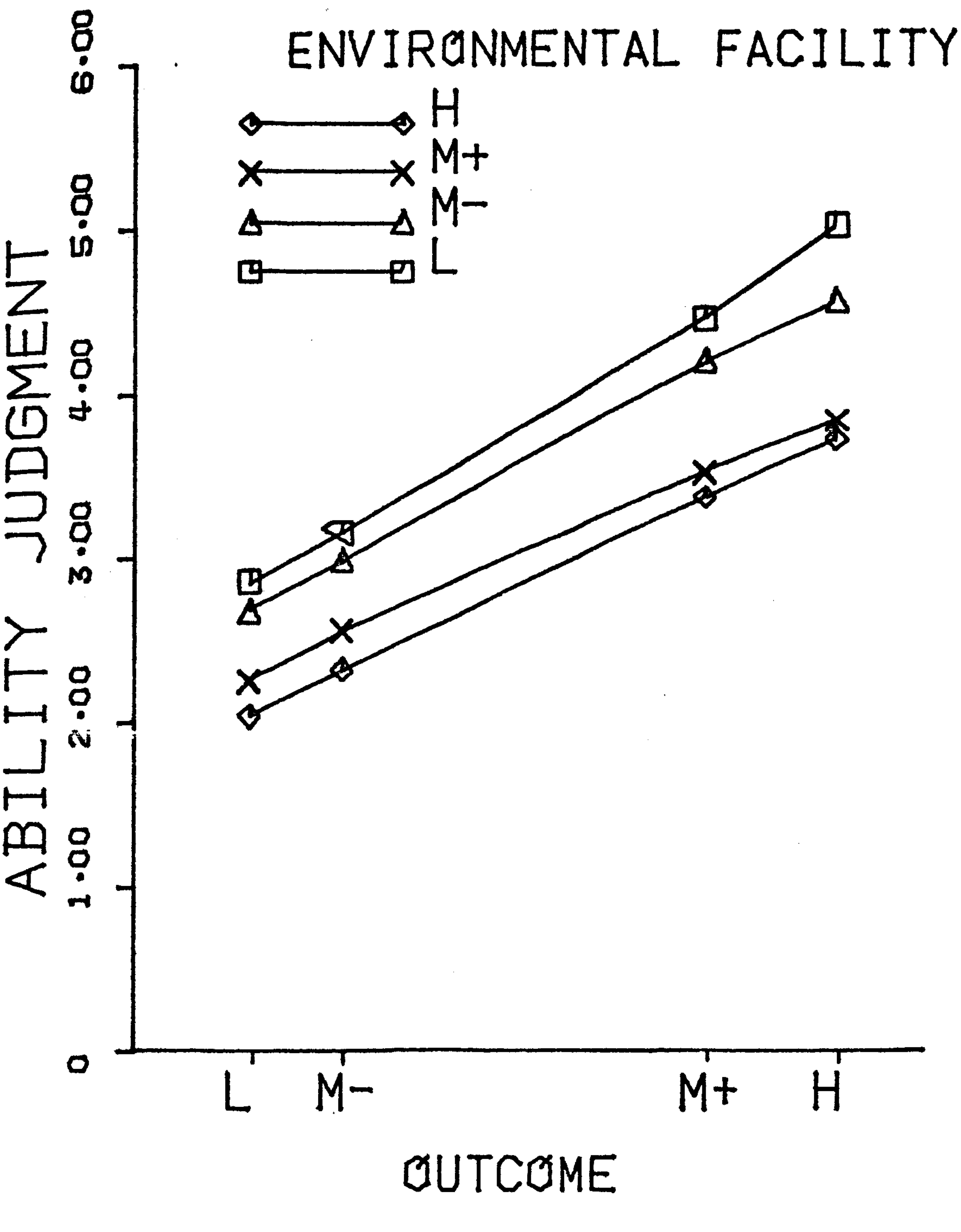

FIGURE 10. MEAN ABILITY JUDGMENT FOR OUTCOME X ENVIRONMENTAL FACILITY INTERACTION, ALL PARTICIPANTS.

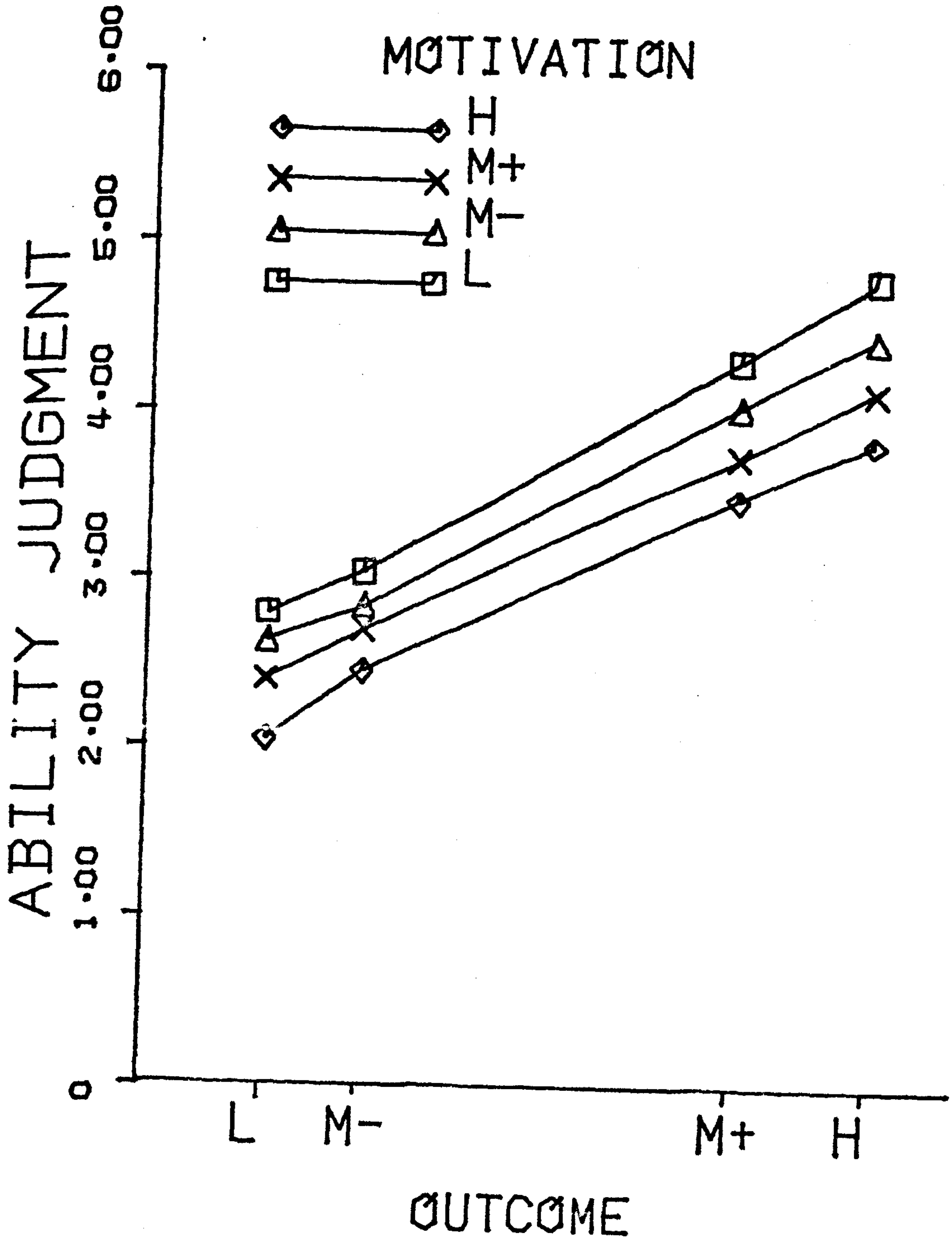

FIGURE 11. MEAN ABILITY JUDGMENTS FOR OUTCOME X MOTIVATION INTERACTION, ALL PARTICIPANTS.

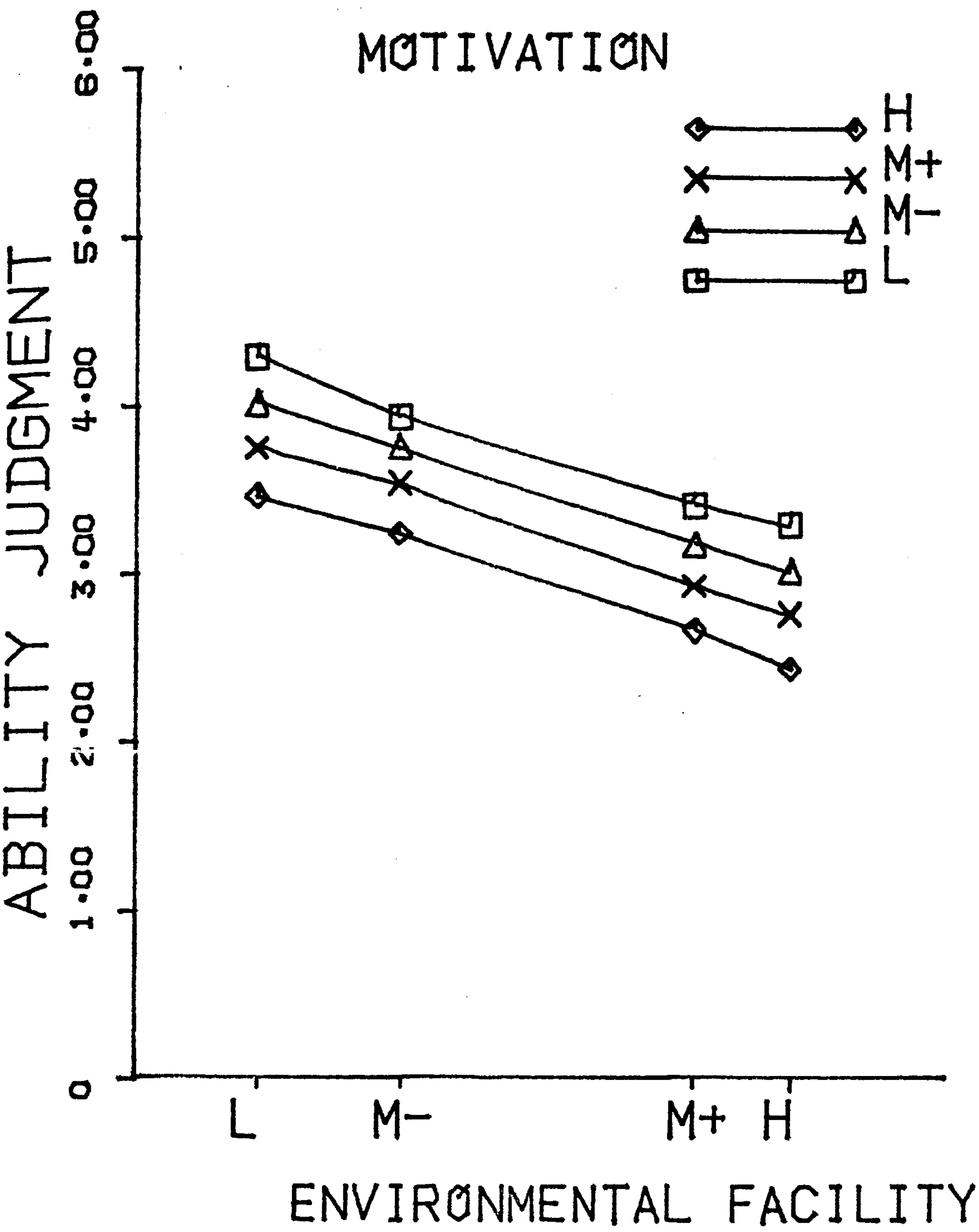

FIGURE 12. MEAN ABILITY JUDGMENT FOR ENVIRONMENTAL FACILITY X MOTIVATION INTERACTION, ALL PARTICIPANTS.

Assuming that the significant residual component of the Outcome X Environmental Facility interaction was due to non-interval scale properties for some participants, the analysis presented in Table 6 yields this causal schema:

$$\text{Ability} = \frac{\text{Outcome}}{\text{Environmental Facility}} + \frac{\text{Outcome}}{\text{Motivation}}, \qquad (14)$$

where ability is equal to the sum of the ratios of outcome to environmental facility and outcome to motivation.

Ability Judgments: Individual Analysis

A repeated measures analysis of variance, similar to that performed on outcome judgments, was performed on each participant's ability judgments. The results of this analysis are presented in Table 8. Percentage of variance estimates, ω^2, for analysis terms are presented in Appendix B.

Main effects. The Ability and Environmental Facility effects were significant for all participants and the Motivation main effect was significant for all but two (2 and 22). In all cases judged ability increased with higher GPAs (outcome) and decreased with lighter course loads (environmental facility) and with higher effort (motivation). On the average, outcome, environmental facility and motivation cues accounted for 53.2%, 16.7%, and 8.9% of the judgment variance, respectively.

Table 8

F Ratios for Model Analysis, Ability Judgments

Participants with only Main Effects	Main Effects: Outcome (A)	Environmental Facility (B)	Motivation (C)
1*	204	48	31
7	354	79	25
16	59	34	19
25	114	44	67
Participants with significant interactions			
2	71	35	1.41
3*	190	28	12
9	126	74	42
11	87	38	55
12	200	37	19
13	254	166	15
17	58	43	8
24	205	101	46
26	63	23	6
4	66	58	26
10	211	34	5
15	147	62	26
22	119	11	1.89
28	56	9	34
5	70	37	17
14	115	17	21
18	318	138	28
19	73	14	7
20	295	12	18
23*	139	86	49
29	770	63	61
8	52	65	25
Participants with significant residuals			
6	628	88	75
21	234	13	29
27	345	76	74
df	3/63	3/63	3/63

Note.- Significant and nonsignificant Fs given to 0 and 2 decimal places, respectively.

*Squareroot transformation.

Table 8 (Continued)

F Ratios for Model Analysis, Ability Judgments

Participants with only Main Effects	Bilinear Interactions A X B	A X C	B X C
1*	1.58	3.41	.09
7	2.10	.80	.41
16	3.76	.57	.31
25	.22	.02	2.49
Participants with significant interactions			
2	6	17	.27
3*	6	6	1.70
9	10	24	.09
11	19	27	.09
12	13	8	.19
13	68	11	2.06
17	41	39	1.31
24	79	16	.02
26	27	12	.78
4	5	.48	.12
10	4	.01	.56
15	13	.24	.00
22	8	2.61	.36
28	11	2.44	1.05
5	.85	11	.50
14	.78	4	.35
18	2.45	4	.10
19	.52	24	.56
20	3.36	12	1.25
23*	2.66	1.99	7
29	.08	.20	8
8	9	2.82	5
Participants with significant residuals			
6	6	7	8
21	5	2.09	.09
27	.42	.00	2.11
df	1/63	1/63	1/63

Table 8 (Continued)

F Ratios for Model Analysis, Ability Judgments

Participants with only Main Effects	Residual Interactions			Three-way Interaction
	A X B	A X C	B X C	A X B X C
1*	2.01	1.43	.96	1.21
7	1.16	.63	1.74	1.14
16	1.20	1.08	.49	1.04
25	.85	.93	.58	.31
Participants with significant interactions				
2	.81	1.41	1.26	.92
3*	1.96	1.33	.58	.91
9	1.72	.70	.89	1.49
11	.59	.60	1.84	1.68
12	1.09	.51	.65	1.27
13	.27	.54	.54	.62
17	1.61	1.22	.80	.80
24	1.59	1.05	.57	.87
26	1.09	.45	1.16	1.05
4	1.31	1.27	1.99	1.67
10	1.45	1.62	1.61	.63
15	1.27	1.02	.95	1.41
22	.76	1.53	.87	.55
28	.98	.91	.30	.92
5	.70	1.46	1.19	1.30
14	1.78	1.79	1.25	.50
18	.28	1.38	1.23	1.01
19	.46	1.01	.61	.79
20	1.31	.82	1.45	.72
23*	1.98	.80	1.15	.65
29	.88	.99	.62	1.39
8	.62	.74	.18	.30
Participants with significant residuals				
6	3	2	2	1.71
21	2	5	1.81	1.29
27	2	1.39	.77	1.70
df	8/63	8/63	8/63	27/63

Since analysis of aggregate data found the residual component of the Outcome X Environmental Facility interaction significant, it was important to examine this term in the individual analyses. The residual component of this interaction was significant for 6 of 29 participants. For 3 of these participants (1, 3, and 33) a square root transformation eliminated this source of variation. Since no transformation could be found to eliminate the residual variance for participants 6, 21, and 27, the results of analysis of their judgments will not be discussed further. Since none of the residual components for three two-way interactions were significant for 23 of the 29 participants, the assumption that stimulus and response scales had interval properties was supported.

Outcome X Environmental Facility interaction. While neither Statement 7 nor 8 anticipanted that the Outcome X Environmental Facility interaction would be significant, both the bilinear and residual components were significant for aggregate analysis. Individual analyses indicated a significant bilinear component for the Outcome X Environmental Facility interaction for 15 of the 26 participants accounting for an average of 60% of the interaction sum of squares. These participants are 2, 3, 9, 11, 12, 13, 17, 24, 26, 4, 10, 15, 22, 28, and 8, as listed in Table 8. The means of this interaction for these participants are presented in Figure 13. For once the pattern of interaction

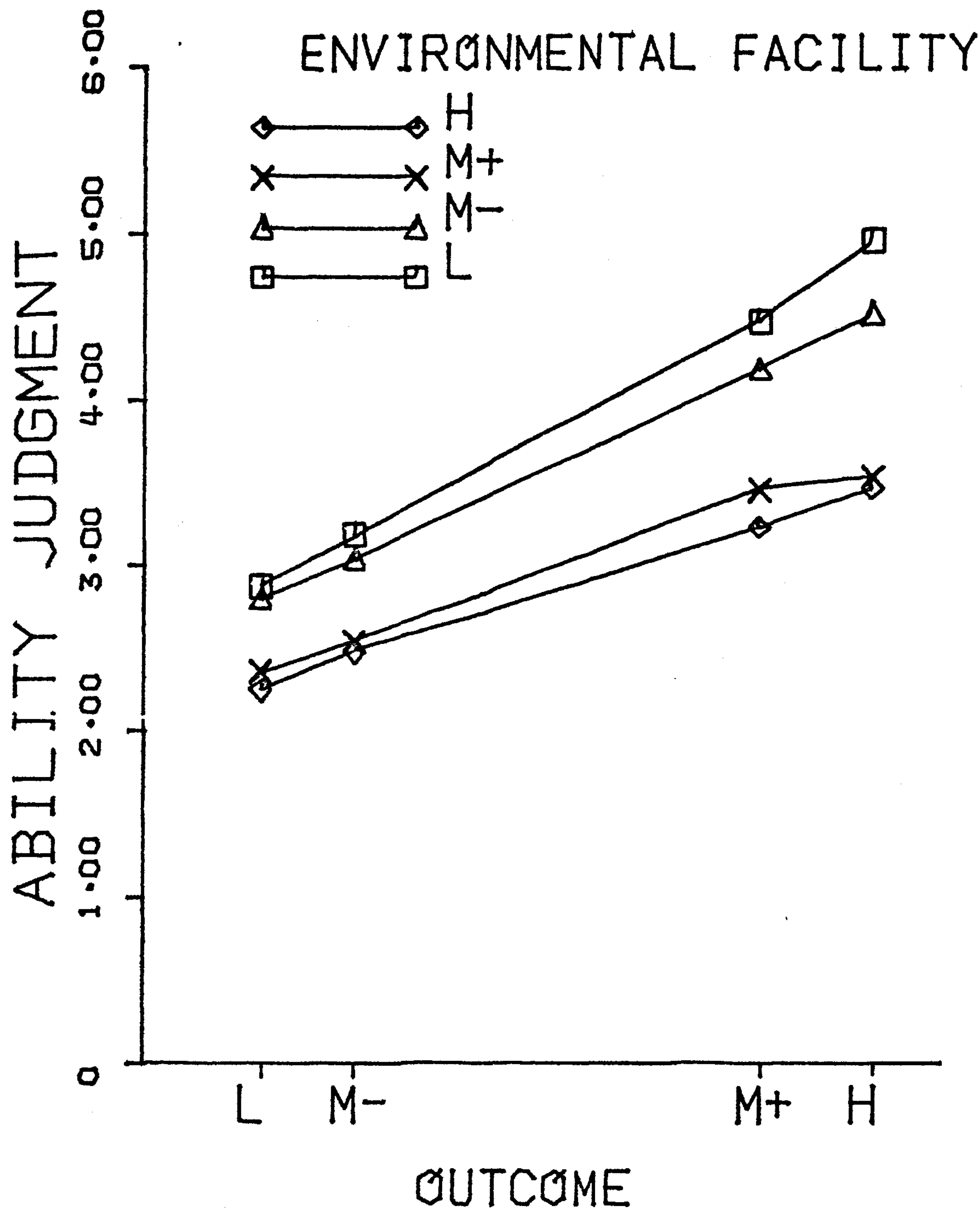

FIGURE 13. MEAN ABILITY JUDGMENT FOR OUTCOME X ENVIRONMENTAL FACILITY INTERACTION, PARTICIPANTS 2, 3, 9, 11–13, 17, 24, 26, 4, 10, 15, 22, 28, AND 8.

has taken only one form for all participants. The pattern shown in this figure is of four diverging straight lines where low environmental facility causes greater ability judgments than high environmental facility and this difference is accentuated as outcome increases. This participants inferred greater ability when course load was heavy as compared to light and this difference increased as GPA increased. A slight divergence from the bilinear trend, similar to that evidenced for aggregate data, can be noted for M+ and H environmental facility at H outcome. These points are closer than would be expected from the bilinear trend.

Outcome X Motivation interaction. This interaction was predicted by both Statements 7 and 8 and only the bilinear component was significant for aggregate analysis. The means for this interaction for twelve of the 14 participants for whom the bilinear component was significant are presented in Figure 14. These participants, in order listed in Table 8, are 2, 3, 9, 11, 12, 13, 17, 24, 26, 5, 19, and 20. For these participants the bilinear component accounted for an average of 69.8% of the interaction sum of squares. The pattern presented in this figure is of four diverging straight lines where greater ability is inferred for low as

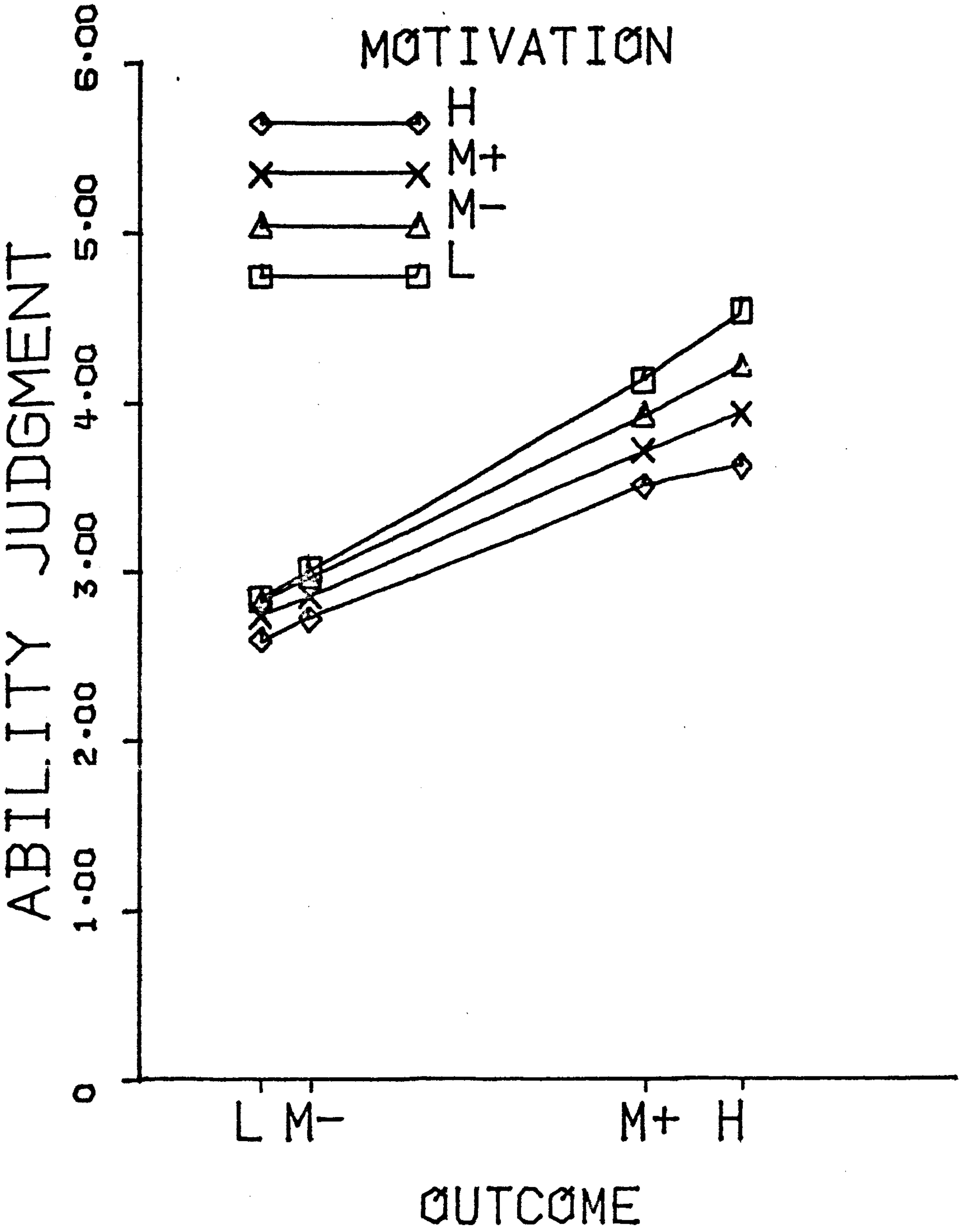

FIGURE 17. MEAN ABILITY JUDGMENT FOR OUTCOME X MOTIVATION INTERACTION, PARTICIPANTS 2, 3, 9, 11–13, 17, 24, 26, 5, 19, AND 20.

compared to high motivation and this difference is accentuated as outcome increases. Participants assigned greater ability when effort was low as compared to high and this difference increased as GPA increased. This interaction was not observed by Anderson and Butzin (in press) but appears to be quite strong in these data.

The means for this interaction for participants 14 and 18 are presented in Figure 15. Generally this picture is of four converging lines but deviations form linearity are apparent. In addition, the bilinear trend accounted for the lowest proportion of the interaction sum of squares of all bilinear components discussed, 27.0%. For these participants, low as compared to high motivation caused greater ability judgments but this difference decreased as outcome increased.

Environmental Facility X Motivation interaction. The form of the Environmental Facility X Motivation interaction predicted by Statement 8 would have higher ability judgments for low as compared to high motivation with this difference decreasing as environmental facility increases. However, this pattern was not exactly that shown by participants 23, 29, and 8 whose data yielded significant bilinear components for this interaction. The pattern of means for these participants are presented in Figure 16. While higher ability judgments were made for low as compared to high motivation, this difference increased as

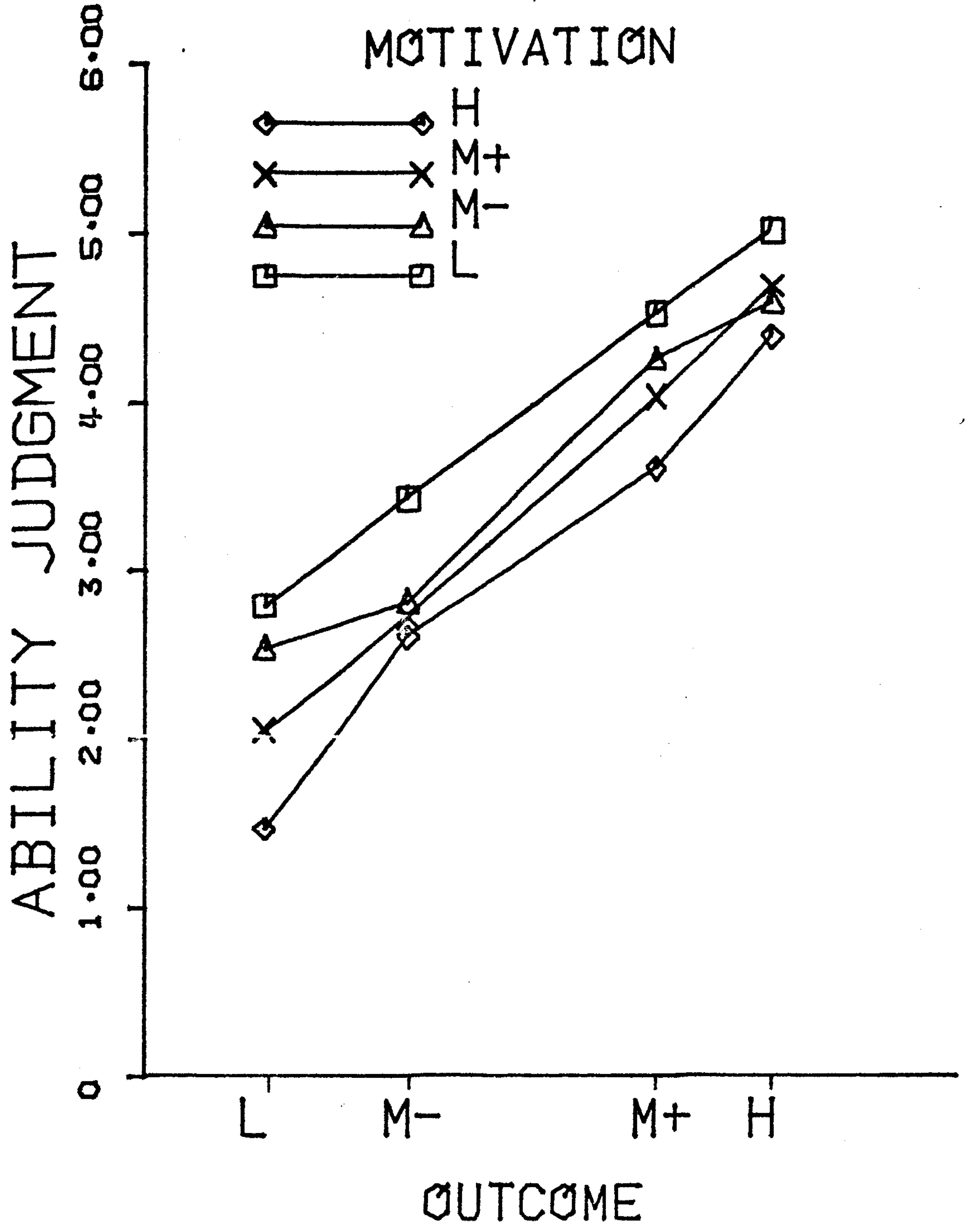

FIGURE 15. MEAN ABILITY JUDGMENT FOR OUTCOME X MOTIVATION INTERACTION. PARTICIPANTS 14 AND 18.

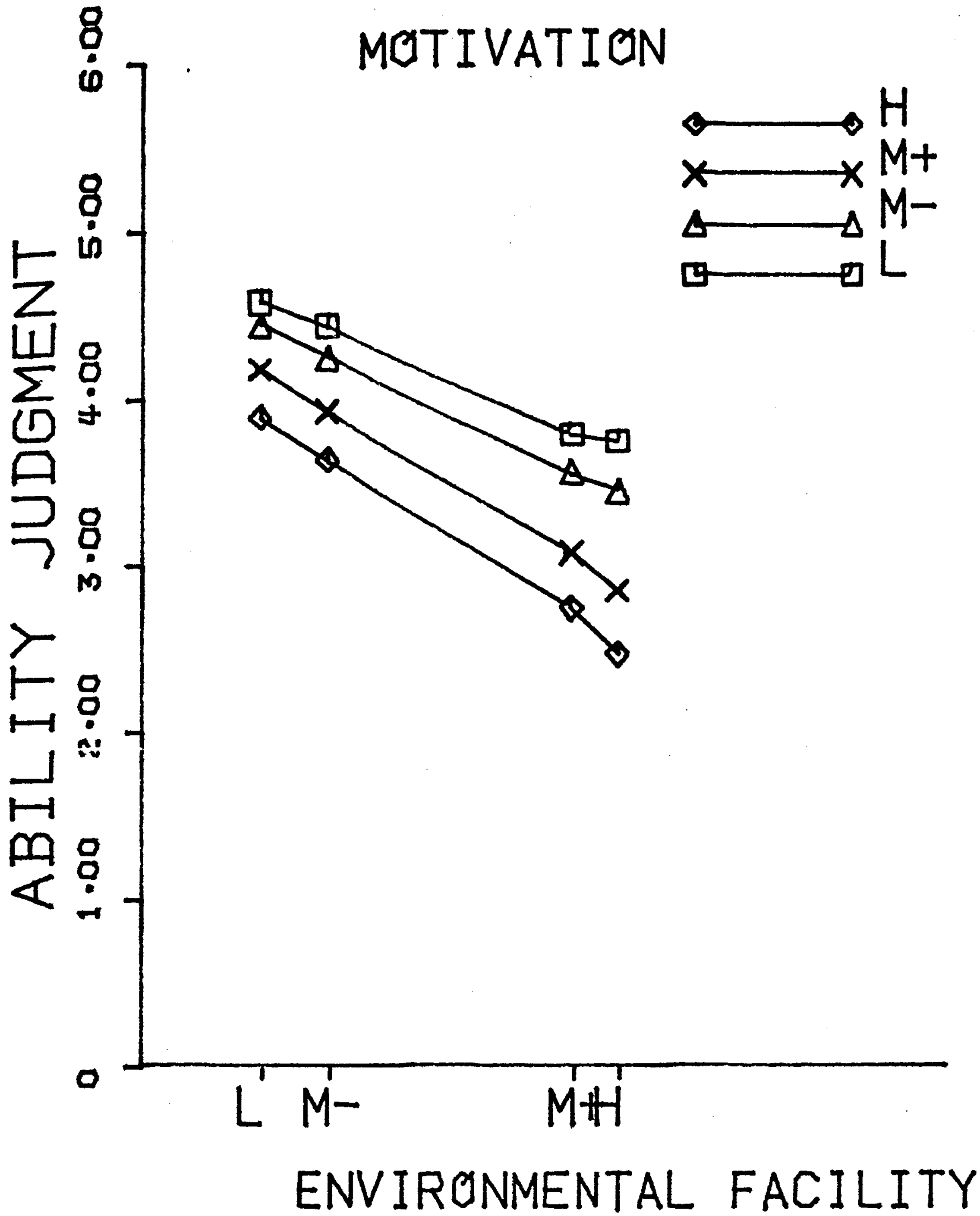

FIGURE 16. MEAN ABILITY JUDGMENT FOR ENVIRONMENTAL FACILITY X MOTIVATION INTERACTION, PARTICIPANTS 23, 29, AND 8.

environmental facility increased. For these participants, differences in judged ability due to effort expended were most apparent for lighter course loads. While the number of participants for whom this interaction was significant was small, it was greater than would be expected by chance. Also, the bilinear components accounted for an average of 63% of the interaction sum of squares.

Outcome X Environmental Facility X Motivation interaction. This interaction was of borderline significance for two of the participants, 11 and 4. The trilinear component of this interaction was not significant for either participant ($F < 1$; $F = 3.42$, $df = 1/63$, $p > .05$, respectively). Since 2 of 26 was not much higher than would be expected by chance (1 of 20) and since both interactions were of borderline significance, the discrepancies which these interactions suggest were ignored.

Model Analysis

Taken together, six models were needed to describe the causal schemata used by the 26 participants discussed, ignoring differences illustrated by contrasting Figures 13 and 14. Generally, the problem was not as severe for ability judgments as for outcome judgments.

Four participants 1, 7, 16, and 25, used an additive model for combining outcome, environmental facility, and motivation in making ability judgments,

$$\text{Ability} = \text{Outcome} - \text{Environmental Facility} - \text{Motivation} \quad (15)$$

For these participants, ability judgments increased with outcome and decreased with environmental facility and motivation. Each cue was independent of the other two. Two of these participants, 1 and 7, also used additive models in making outcome judgments.

Nine participants, 2, 3, 9, 11, 12, 13, 17, 24, and 26, used the same schema suggested by aggregate analysis (Statement 14). These participants combined the Outcome X Motivation interaction predicted by Statements 7 and 8 with the Outcome X Environmental Facility interaction which neither statement anticipated. This model indicates that differences in ability due both to environmental facility and to motivation increased as outcomes increased.

For four participants, 1, 10, 15, and 28, only the Outcome X Environmental Facility interaction was significant. In this case only differences due to environmental facility (and not motivation) increased with outcome. The schema for these participants is:

$$\text{Ability} = \frac{\text{Outcome}}{\text{Environmental Facility}} - \text{Motivation.} \qquad (15a)$$

Participant 22 also showed a significant Outcome X Environmental Facility interaction but no Motivation main effect. For this participant the model is:

$$\text{Ability} = \frac{\text{Outcome}}{\text{Environmental Facility.}} \qquad (15b)$$

Five participants showed only the Outcome X Motivation interaction, as suggested by Statement 7. However for three of these participants, 5, 19, and 20, differences due to motivation increased with outcomes while for the other two, 14 and 18, differences due to motivation decreased as outcomes increased. In the first case the model is:

$$\text{Ability} = \frac{\text{Outcome}}{\text{Motivation}} - \text{Environmental Facility} \quad (16a)$$

and in the second:

$$\text{Ability} = \frac{(-)\ \text{Outcome}}{(-)\ \text{Motivation}} - \text{Environmental Facility.} \quad (16b)$$

The sign, (-), has the same meaning here as in previous examples. It will be recalled that the interactions which necessitated model 16b were the two weakest of the interactions discussed.

Three participants showed a significant Environmental Facility X Motivation interaction as predicted by Statement 7, although not of the same form. In addition, in no case was a participant's causal schema the same as that predicted by Statement 7, including both the Outcome X Motivation and the Environmental Facility X motivation interactions. For two of the participants for whom this latter interaction term was significant (23, 29), ability judgments were higher for low as compared to high motivation and this difference increased as environmental facility increased. In addition, ability judgments increased as outcome increased, but this cue was independent of the other two. In this case the judgment model is:

$$\text{Ability} = \text{Outcome} - \frac{\text{Environmental Facility}}{(-)\ \text{Motivation}} \quad (17a)$$

For participant 8, differences due to environmental facility also increased as outcome increased indicating this model:

$$\text{Ability} = \frac{\text{Outcome}}{\text{Environmental Facility}} - \frac{\text{Environmental Facility}}{(-)\ \text{Motivation}} \quad (17b)$$

In summary, neither Statements 4 and 6 for outcome judgments nor Statements 7 and 8 for ability judgments received much support from either aggregate or individual analysis.

Reversibility

The validity of Hypothesis 3, that an individual's causal schema will be algebraically similar for both outcome and ability judgments, cannot be assessed statistically. However, it appears that reversibility is not a characteristic of the naive analysis of action, as represented in this study. Of the 23 participants for whom both outcome and ability judgment models could be developed (excluding participants 6, 21, and 26-69) only 3 showed strict algebraic equivalence and only one of these, 13, used configural terms. Participants 1 and 7 used additive models for both judgment tasks, but for participant 7 environmental facility was not part of his outcome judgment rule. Finally, reversibility was not evidenced for aggregate analysis.

If reversibility is assumed only to apply only to individual terms in the causal schemata and not to the entire schema itself, and if differences in interaction patterns indicated by the (-) symbol are ignored, the concept of reversibility receives some support. Six participants[2] (26.1%) showed both an Ability X Environmental Facility interaction for outcome judgments and an Outcome X Environmental Facility interaction for ability judgments. Nine participants (39.1%) showed both the Ability X Motivation interaction for outcome judgments and the Outcome X Motivation interaction for ability judgments. For one participant (4.6%) the Environmental Facility X Motivation interaction was significant both for outcome and for ability judgments. The chance levels for the co-occurrence of these corresponding interactions are 19.8%, 31.9%, and 2.6%, respectively.

Individual Difference Measures

Four individual difference measures were administered to each participant: a measure of intelligence (IQ); a measure of achievement motivation (Ach); and a measure with preference subscales for internal or external causal explanation (IE) and stable or variable causal explanation (SV).

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[2]Participant 22 was omitted from this analysis since the form of his Ability X Environmental Facility interaction differed from that of all other participants.

Since the number of participants in the study was small, the relationship between these measures and use of particular judgment rules is taken as speculative and hypothesis generating. Also, since consistency in the use of any one model was low, participants were divided into three groups for each of the two-way interactions: (a) consistent, corresponding interaction terms were significant for both outcome and ability judgments; (b) inconsistent, only one of the corresponding interaction terms were significant; and (c) none, neither of the corresponding interaction terms were significant. The mean scores on each of the individual difference measures for each group are presented in Table 9.

It should be noted that none of the differences between means of any cue interaction are significant by Duncan's Multiple Range Test at the .05 level. This can be attributed to a number of factors including size of sample and restriction in range due to homogeniety of sample.

While there are no statistically significant differences between groups on the individual difference measures, there are two tendencies which can be used to guide further research. It appears that those participants for whom interaction terms were significant (consistent and inconsistent groups) had slightly higher IQ scores than those not showing significant interaction

Table 9

Mean Individual Difference Scores for Participants Grouped By Consistency of Usage for Three, Two-way Interactions

Ability X Environmental Facility
Outcome X Environmental Facility

		Measure			
Group	N	IQ[a]	Ach[b]	IE[c]	SV[d]
Consistent	6	121.3	-.67	23.5	24.0
Inconsistent	8	120.5	10.25	25.5	25.0
None	8	116.9	.06	23.6	23.7

Ability X Motivation--Outcome X Motivation

		Measure			
Group	N	IQ	Ach	IE	SV
Consistent	9	120.0	-.22	23.8	23.6
Inconsistent	8	119.0	2.25	25.1	24.6
None	6	116.3	10.00	25.0	24.8

Environmental Facility X Motivation

		Measure			
Group	N	IQ	Ach	IE	SV
Consistent	1	111.00	-.80	24.0	26.0
Inconsistent	7	121.29	6.00	24.4	24.7
None	15	118.00	4.13	24.4	24.0

[a]Higher the mean, the higher the IQ.

[b]Higher the mean, higher achievement motivation.

[c]Higher the mean, greater the preference for external causes.

[d]Higher the mean, greater the preference for variable causes.

terms. In addition, the correlation between IQ scores and the number of significant interaction terms overall was low but positive (r = .25, df = 21). There was also a tendency for those consistent in their use of interaction terms to have lower achievement scores. The correlation between achievement scores and the number of significant interaction terms is negative for outcome judgments (r = -.36, df = 23) and positive (r = .13, df = .23) for ability judgments, suggesting that those participants with higher achievement scores tended to perceive the tasks as different. For these participants, the prediction of outcomes and the inference of ability, in the particular achievement setting used, may represent different judgment tasks.

There seems to have been little correspondence between use of interaction terms and either IE or SV scores.

DISCUSSION

The results of this study contain a number of important implications for understanding human attribution. First, quantitative analysis of judgments of other's actions is not only possible but fruitful and enlightening. Secondly, the naive analysis of action is indeed a complex process involving a number of configural cues. And thirdly, the individual difference measures studied did not reveal much information about why any one individual used a certain pattern of cue interaction. Each of these topics will be discussed in turn.

Functional Measurement and Cognitive Algebra

Functional measurement analysis was quite useful in uncovering patterns in the judgments of outcome and ability. Since only the bilinear component was significant for most interaction terms, both the interval scaling assumption and the underlying judgment model received good support. Also, the participant by participant analysis was quite important since aggregate analysis obscured wide individual differences in judgment strategies. This individual analysis is not open to the criticism that it capitalized on chance since the bilinear component had only one degree of freedom, specifically congruent with multiplicative effects (Shanteau & Anderson, 1972).

The question of reversibility in cognitive algebra is of great importance for the construction of individual judgment rules. If the causal schemata constructed in this study do in fact characterize the participants judgment strategies, strict reversibility should have been evidenced. The fact was that individual and aggregate judgment rules were not reversible from outcome to ability judgments, thus underlying the "paramorphic problem" for mathematical models of human judgments. The algebraic models developed for individual participants cannot be said to represent fully individual judgment strategies since reversibility was not found. Even if this lack of consistency were due to participant's perceptions of the outcome and ability judgment tasks as qualitatively different, as was hypothesized for participants high in achievement motivation, the objective similarity between these two laboratory judgment tasks far exceeds the similarity to be found between any two judgment tasks participants would normally encounter. Support for the reversibility of individual cue interactions suggests that this concept may not be dichotomous but rather a continuous variable along which both individuals and tasks can differ. Some individuals such as the more intelligent or the cognitively simple, may exhibit greater consistency in the use of judgment rules. Some tasks, such as predictions (outcome judgment) or inferences (ability judgment), may encourage greater consistency. Finally, the lack of consistency may be due to the complexity of the judgment tasks used. Some participants may have simplified multiplicative cue combinations to additive combinations on either the outcome or the ability judgment task. Shanteau and Anderson (1972) suggest this possibility as an explanation for individual differences in models which they found for judgments of the value of certain pieces of information. While there is no evidence to support this hypothesis in the present study, it implies that further qualification of algebraic models of human inference judgments is necessary.

The tentative conclusion is that algebraic judgment models are only analogous to individual causal schemata since the algebraic property of reversibility is not possessed by individual causal judgment strategies. Anderson (1974) classifies algebraic rules as "formal, as if models" since the underlying mechanisms of averaging and multiplication cannot be specified. The use of related judgments tasks in the present study, however, helped to uncover the additional qualification of algebraic models of causal judgments that individuals show different causal schemata for judgments of outcome and of ability.

The Perception of Causality

While the quantitative analysis of individuals' judgments of another's actions did not yield precise mathematical formulas, it did uncover at least two configural terms often used in attribution. One was the energizing and qualifying effect of another's motivation and effort. For 15 of 25 participants, the combination of ability and motivation for prediction of outcome was not additive but rather configural, the importance of the ability was dependent on the motivational cue. Similarily, 14 of 26 participants combined the outcome and the motivation cues in a configural manner for judgments of ability. For these participants the evidence of ability shown by the outcome level needed to be qualified by the amount of effort expended. These findings are generally supportive of the attributional theory of performance proposed by Heider (Statement 3) and developed by Weiner, Kukla and their associates (Kukla, 1972; Weiner, Frieze, Kukla, Reed, Rest, & Rosenbaum, 1972).

The other configural terms often used in the naive analysis of action were the combination of ability and environmental facility cues for outcome judgments (9 of 25 participants) and the combination of outcome and environmental facility cues for ability judgments (15 of 26 participants). These interactions contradict the multiple sufficient causal schema for judgments of capability (Statement 3) suggested by Heider (1958). For these participants the ability and environmental facility cues were not functionally equivalent since the importance of one cue was dependent on the level of the other.

The meaning of the Environmental Facility X Motivation interactions for both judgments tasks is not clear since this term was used only by a few participants. The lack of interaction for outcome judgments may be taken as support for the model of judgment suggested by Anderson (Statement 6) if the assumption of reversibility is not made. Generally, it appears that, for the judgment tasks studied, intended or expended effort does not qualify the facility of the environment.

Two points need to be made concerning the percentage of variance accounted for, ω^2, by the cue main effects and interactions. For the outcome judgment task used in the present study (GPA), the environmental facility cue (course load) was not as important as either the ability or the motivation cue. While this may be due to constriction in the range of values that the environmental facility cue was allowed to assume, pretesting seemed to rule out this interpretation. In addition, the outcome cue accounted for nearly half of the ability judgment variance (aggregate analysis). Both these findings may be taken as evidence for a general tendency to underestimate the importance of extenuating circumstances when judging another's actions. Jones and Nisbett (1972, p. 80) present evidence that

> . . .there is a pervasive tendency for actors to attribute their actions to situational factors, whereas observers tend to attribute the same actions to stable personality dispositions [emphasis omitted].

In the present study, participants tended to base judgments of another's actions (GPA) on internal rather than external factors, and another's outcomes were of primary importance in determining his ability. In the latter case, extenuating circumstances, such as course load or expended effort, were of relatively little importance.

The second point concerning the use of the statistic is that the general linear model (analysis of variance) will not accurately reflect the amount of variance due to interaction terms. Yntema and Torgensen (cited in Green, 1968) generated data which was related to the independent variables only in an interactive way, $y_{ijk} = ij + jk + ik$. Analysis of variance showed that the three main effects accounted for 94% of the variance allowing only 6% of the variance for the interactions. Similar results were evidenced in the present study where the average estimate of variance accounted for by all interaction terms in individual analysis was 2.8% for outcome judgments and 3.7% for ability judgments. It appears that the general conclusion favoring strictly linear models over those which incorporate configural terms (e.g., Wiggins, _et al_., 1969) has rested on a methodology (regression analysis) which, like analysis of variance, utilizes the general linear model. Since these models are insensitive to the amount of variance accounted for by configural components, it is quite possible that more subjects were using configural models than the researchers were aware of.

Individual Differences

While the analysis of both outcome and ability judgments revealed wide and important differences in causal schemata, the individual differences measures used in this study added little to the understanding of these rules. Whether this was due to the unreliability of the measures, restriction of the sample, or a genuine lack of relationship is unknown. More work on this important topic is obviously necessary. In addition, no discussion has been made of demographic characteristics (age, sex, race) which are of obvious importance to the perception of causality since there were so few participants. This omission, of course, limits the generalizability of the findings. Finally, efforts need to be made to extend this type of quantitative analysis to other judgment tasks such as predicted poker winnings or marriage success.

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APPENDIX A:

Cue Labels and Identification for Outcome and Ability Judgment Tasks

Table A-1

Cue Labels and Identification for Outcome Judgment Task

	L	M-	M+	H
Ability				
Level	L	M-	M+	H
Label	Low	Below Average	Above Average	High
Identification	90 IQ	105 IQ	115 IQ	130 IQ
GPA[a]	1.8	2.3	2.8	3.3
Environmental Facility (Course Load)				
Level	L	M-	M+	H
Label	Heavy	Above Average	Below Average	Light
Identification	Calculus 4 Gen. Biol. 4 Gen. Chem. 4 Inter. Fr. 3 Amer. Lit. 3 Intro. Psych. 3 21 Hrs. Total	Phil. of Man 3 Writing I 3 Inter. Span. 3 Speech 3 World History 3 Algebra 3 18 Hrs. Total	Art Apprec. 3 World Hist. 3 Old Test. Theol. 3 Natural Science 3 Intro. Psych. 3 15 Hrs. Total	Basic Spanish 3 Nat'l Science 3 Algebra 3 Speech 3 12 Hrs. Total
GPA	1.5	2.2	2.9	3.6
Motivation (Studies)				
Level	L	M-	M+	H
Label	Little	Below Average	Above Average	Hard
Identification	Sleepy Aimless Inefficient	Immature Aggressive Impulsive	Compulsive Orderly Anxious	Conscientious Dedicated Ambitious
GPA	1.7	2.2	2.7	3.2

[a]Expected quartile average.

Table A-2

Cue Labels and Identification for Ability Judgment Task

Outcome (GPA)				
Level	L	M-	M+	H
Label	Low	Below Average	Above Average	High
Identi-fication	First Quartile	Second Quartile	Third Quartile	Fourth Quartile
GPA	1.5	2.1	2.7	3.3

Environmental Facility (Course Load)

(Same as Table A-1)

Motivation (Studied)				
Level	L	M-	M+	H
Label	Little	Below Average	Above Average	Hard
Identi-fication	Lowest Quarter	Less than Average	More than Average	Highest Quarter
GPA		(Not used)		

APPENDIX B:

Percentage of Variance Estimates, ω^2, for Individual Analyses of Outcome and Ability Judgments.

Table B-1

Percentage of Variance Estimates, ω^2, Related to the Effects Of the Analyses of Variance of Outcome Judgments

Participant	Ability (A)	Environmental Facility (B)	Motivation (C)	A X B	A X C	B X C	A X B X C	Total
1	.387	.038	.413	-.004	.000	.001	.050	.869
2	.182	.260	.197	.012	-.003	-.021	-.040	.651
3	.393	.126	.219	-.011	.000	-.009	-.022	.738
4	.299	.050	.477	.008	-.003	-.007	-.015	.834
5	.250	.311	.198	.005	-.006	-.006	.009	.773
6	.444	.043	.381	.000	-.006	.010	-.007	.878
7	.720	-.002	.198	-.001	-.004	-.003	.000	.918
8	.231	.018	.050	-.024	-.028	-.002	.044	.343
9	.308	.265	.208	.005	.025	.021	.019	.851
10	.349	.065	.276	.001	.002	.012	-.028	.705
11	.317	.044	.412	.017	.004	.005	.003	.802
12	.246	.067	.495	.009	.013	.002	-.024	.832
13	.395	.063	.464	.008	.012	.002	-.003	.944
14	.391	.075	.291	-.001	.038	-.006	-.003	.795
15	.138	.157	.421	.011	.011	.002	.023	.763
16	.336	.101	.276	-.008	-.002	.035	-.017	.748
17	.526	.051	.144	-.005	.022	-.013	-.016	.743
18*	.330	.095	.243	.014	.014	.007	.020	.723
19	.550	.066	.193	.001	.006	-.007	.011	.827
20	.496	.034	.386	.016	.026	.006	.016	.980
21	.605	.030	.210	.008	.005	.010	.001	.869
22	.539	.005	.096	-.013	-.013	-.009	-.039	.744
23	.503	.047	.296	.007	-.002	.002	-.018	.845
24	.399	.149	.268	.000	-.005	.004	.011	.831
25	.206	.095	.525	-.002	.008	-.006	.018	.852
26	.048	.726	.111	.009	.001	.010	.018	.923
27	.379	.025	.400	.026	-.002	.010	-.002	.840
28	.550	.006	.193	.001	.006	-.007	.011	.827
29	.467	.029	.382	.000	.016	-.001	.010	.904

*square root transformation.

Table B-2

Percentage of Variance Estimates, ω^2, Related to the Effects Of the Analyses of Variance of Ability Judgments

Participant	Outcome (A)	Environmental Facility (B)	Motivation (C)	A X B	A X C	B X C	A X B X C	Total
1*	.615	.143	.091	.009	.006	-.008	.007	.781
7	.705	.155	.049	.002	-.002	.003	.002	.913
16	.381	.219	.117	.009	.001	-.010	.002	.729
25	.440	.169	.257	-.003	-.002	-.002	-.024	.866
2	.451	.224	.003	.009	.043	.003	-.004	.733
3*	.685	.100	.041	.015	.009	-.028	-.002	.855
9	.420	.247	.138	.018	.023	-.003	.014	.860
11	.326	.139	.206	.009	.020	-.003	-.006	.706
12	.655	.121	.062	.014	.004	-.003	.008	.864
13	.514	.334	.030	.042	.005	-.002	-.008	.925
17	.314	.232	.043	.083	.074	-.002	.024	.770
24	.484	.237	.107	.066	.013	-.004	-.004	.807
26	.431	.156	.040	.060	.016	.003	.002	.708
4	.325	.282	.127	.011	.003	.012	.030	.890
10	.718	.114	.015	.007	.004	.006	-.009	.864
15	.517	.217	.089	.017	-.001	-.001	.013	.853
22	.674	.057	.005	.010	-.002	-.004	.011	.757
28	.380	.059	.229	.025	.007	.013	-.005	.713
5	.421	.187	.099	-.003	.030	.004	.012	.753
14	.584	.086	.104	.010	.017	.003	-.023	.801
18	.604	.261	.052	-.002	.004	.001	.000	.922
19	.526	.097	.050	-.011	.054	-.008	-.015	.727
20	.797	.032	.048	.005	.009	.004	-.006	.895
23*	.464	.285	.106	.010	-.002	.007	-.013	.872
29	.670	.047	.046	-.021	-.024	-.022	-.068	.763
8	.289	.362	.139	.009	-.001	-.003	-.036	.799
6	.731	.102	.086	.011	.007	.007	.007	.951
21	.679	.049	.083	.016	.038	.006	.007	.878
27	.631	.137	.134	.008	.001	.000	.011	.922

*square root transformation.

APPROVAL SHEET

The dissertation submitted by Jack McKillip has been read and approved by the following Committee:

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The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

July 12, 1974
Date

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Director's Signature