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An experimental analysis of

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ability as determinants of effort and performance

by

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION AND REVIEW OF THE LITERATURE

During the past eight years there has been a considerable resurgence of interest in the application of expectancy theory to the area of worker motivation, performance, satisfaction, and vocational choice. Within this brief period, four major theoretical models (Vroom, 1964; Porter & Lawler, 1968; Graen, 1969; Campbell, Dunnette, Lawler, & Weick, 1970) incorporating these notions have appeared in the literature. Attempting to underscore the unique contribution of their particular model, each theorist has employed slightly different terminology, and has emphasized somewhat different components of their model. Nevertheless, the commonalities among the models far outweigh whatever discernible differences exist.

This paper is concerned with these commonalities. More specifically, all four theories claim to explain and predict worker performance by specifying the construction of its motivational antecedents. The relevant variables and the manner in which they combine are the same. Vroom's (1964) statement is not only the earliest of these, but also the most definitive. Consequently, his model will be described in some detail in order to explicate the terms and relationships with which these theories and this discussion deal.

Vroom's Model

Basic to Vroom's job performance model is the recognition that a worker can potentially perform at a variety of output levels (first-level outcomes). The model suggests that associated with each particular performance level is a set of both positive and negative consequences (second-level outcomes). For example, the consequences a welder might associate with extremely high performance might be high pay, rapid promotions, and resentment from his co-workers. Conversely, with low performance, he might expect high co-worker acceptance, more free time in which to socialize, lower pay, and reduced job security. In Vroom's terms then, associated with each first level outcome (job performance level) are a number of second-level outcomes (consequences). Vroom specifies the manner in which these various consequences combine to determine the desirability (valence) of each of the potential performance levels.

The contribution any particular second-level outcome makes to the valence of the first-level outcome is a multiplicative function of two factors, valence and instrumentality. Valence refers to the expected satisfaction (or dissatisfaction) to be derived from an outcome; in the model valence is arbitrarily scaled to take on any value between 10.0 and -10.0. If co-worker acceptance is very important to the individual, the valence of this outcome is high, approaching 10.0. Valence would be zero if a worker were not concerned at all about co-worker acceptance. Conceivably, one could actually desire to be rejected by his peers, in which case the valence of co-worker acceptance would assume some negative value.

The second concept relating second- to first-level outcomes is instrumentality. Instrumentality is an index of the perceived contingency between attainment of a particular performance level and actually receiving the associated second-level outcome. Instrumentality has been scaled from 1.0 to -1.0. A high positive value suggests that a worker feels an outcome will likely be forthcoming if a certain performance level is attained. If it is felt however, that an outcome is not related to performance, instrumentality approaches zero. Finally, if the possibility of receiving an outcome is precluded by performance at a certain level, instrumentality for this outcome will approximate -1.0.

The contribution of any second-level outcome to the valence of a particular first-level outcome can now be represented as the product of that outcome's valence and instrumentality. If pay is highly valent but not perceived to be related to performance (i.e., instrumentality equals zero), then the product will be near zero, and the contribution of pay to the valence of performance level will be negligible. Where co-worker acceptance is positively valent but high performance results in rejection by co-workers (i.e., negative instrumentality), the product of valence and instrumentality will be some negative value. This implies that the valence of performing at that level is actually reduced by the co-worker acceptance outcome. If we sum the products of valence (V2) times instrumentality (I) across all second-level outcomes associated with a performance level, we arrive at a value which reflects the valence of performing at that output level. Symbolically this is represented as $V = V2 \times I$.

Using the above equation, the valence of any performance level may be specified. However, we are not yet in a position to predict the performance level actually chosen by an individual. A worker does not perforce strive to perform at that level possessing the highest valence. Vroom introduces the concept of expectancy to explain this discrepancy.

Expectancy "incorporates the common sense notion that only Don Quixote would reach for an unreachable star (Graen 1969, p. 4)." It is an index of the perceived probability that a given performance level can be attained. If an individual perceives that a highly valent performance level is unattainable because he lacks the requisite skills or abilities, or if environmental obstacles would thwart his intentions, he will not be motivated to perform at that level. Instead, he will expend effort appropriate for a level of performance which he perceives attainable, albeit less valent. Expectancy is phrased in terms of a probability notion, ranging from 1.00, where the individual perceives the attainment of a performance level is assured, to 0.00, where the performance level is viewed as unachievable.

Finally, Vroom contends there is a field of forces impinging on the individual corresponding to each of the potential performance levels. The strength of each force is determined by multiplying the valence of a performance level by its respective expectancy. The performance level having the largest expectancy-valence product exerts the greatest force upon the individual, and consequently is the output level chosen by the individual. This relationship may be expressed as follows: $F=E(V2xI)$.

This account captures the expectancy theory approach to the understanding of worker motivation, which in turn translates through effort, into performance. All four theories cited earlier share the approach outlined above. While each model posits a more or less unique set of additional relationships, all are derived from the basic expectancy approach as has been described.

Before reviewing the more recent literature relevant to these theories, a brief account of the development of these notions might serve to place the present approach in its proper perspective.

Development of Expectancy Theory

Thorndike's (1911) formalization of the ancient hedonistic doctrine in his statement of the "law of effect" provided the impetus for two major theories of motivation, drive x habit theory on the one hand, and expectancy x valence on the other. Hull's (1943) drive x habit theory described behavior as a multiplicative function of habits, S-R bonds established over time via the law of effect, and drive, which resulted from physiological need states.

A somewhat different tact was taken by Tolman (1932) and Lewin (1938). Finding the mechanistic behaviorist's approach to motivation somewhat sterile, Tolman (1932) introduced the "cognitive map" notion, and Lewin conceptualized motivation in terms of expectancy x valence. Although Tolman's ideas were studied using primarily small animals, whereas Lewin's theory dealt exclusively with human behavior, they shared the view that the important determinants of behavior were to be found through investigation of an _internal cognitive representation of the external environment_. This representation took the form of expectancies that certain acts would result in specific outcomes, and differential preference for these various resultant outcomes.

Aside from the terminological differences between Hullian and Expectancy Theory, a marked similarity remains in terms of their implications for behavior. As Porter and Lawler (1968) suggest, one is not "choosing between basically different approaches to motivation, because there is a strong similarity between drive and expectancy theory. Rather, it is a decision that involves trying to determine which of two similar approaches to motivation is most compatible with our thinking about the relationship between job attitudes and job performance" (p. 10).

Several writers have made this decision easier by emphasizing the subtle differences which do exist between the theories (Vroom, 1964; Atkinson, 1964; Porter and Lawler, 1968). First, drive theory is predicated on the establishment of S-R connections. Consequently one is at once concerned with the reinforcement history resulting in the existing S-R bonds. In contrast, expectancy theory is distinctly ahistorical. Rather than deal with learned S-R relationships, expectancy theory focuses upon anticipation, the expectancy-outcome relationships extant at any point in time. The origin of these expectancies is not treated; in this sense it is future, rather than past oriented.

A second distinction between the two approaches concerns the generality of behavior energized by expectancies on the one hand, and drive on the other. Hullian theory views a goal object as a source of general excitement, resulting in a non-directive, pervasive influence on performance. In contrast, expectancy theory argues that anticipation of a valent outcome energizes only those behaviors which are perceived to lead directly to the attainment of the desired outcome.

Finally, the major thrust of drive theory centers around the explanation and prediction of learning, whereas expectancy theorists have more typically focused upon performance. Where drive theorists account for learning as a result of the reduction of physiological drives or secondary reinforcement, cognitive theorists extend the discussion beyond physiological drive reduction, accounting for performance by reference to needs for achievement, esteem, and self-actualization.

With these distinctions in mind, most investigators of work motivation have found the expectancy theory framework preferable to drive theory. The terminology of the former theoretical position lends itself conveniently to discussions of attitudes, the major substance of work motivation. The emphasis of expectancy theory on more or less rational cognitive activity underlying work behavior is consistent with traditional views of a "rational and economic man" (Katz & Kahn, 1966). Important motives like status, achievement, self-esteem, and power are dealt with easily within an expectancy framework. And last, the emphasis on performance rather than learning places the discussion in a context immediately familiar and relevant to the applied science of work behavior.

Since the initial statements of Tolman (1932) and Lewin (1938), expectancy theories have generated research interest in primarily three areas within psychology: experimental, social, and industrial. Dulany's (1961, 1962, 1968) theory of propositional control has provided the major impetus among experimentalists. Here expectancy notions have fairly successfully accounted for a good deal of verbal conditioning data. In social psychology, the bulk of attention has been directed toward explaining attitudes (Peak, 1955; Rosenberg, 1956; Atkinson, 1958). More recently, Fishbein (1967) has introduced a comprehensive statement which formalized expectancy theory in terms which lend themselves readily to the investigation of social psychological variables, i.e., attitudes, norms, attraction, etc. (See Wicker, 1969, or Mitchell & Biglan, 1971, for a comprehensive review of this literature.)

The formal application of expectancy notions in industrial psychology had a somewhat belated start. It was not until 1957, when Georgopoulos, Mahoney, and Jones published, "A Path-Goal Approach to Productivity," that any serious attempt was made to investigate work performance within an expectancy framework. Georgopulas et al. investigated the relationship between productivity and the perception that high productivity would lead to the attainment of desired goals such as pay, co-worker acceptance, and promotions. The findings of this study, conducted in a household appliance manufacturing company, provided substantial support for expectancy theory. Specifically, Georgopulas et al. found higher productivity among those workers who perceived a greater contingency between high performance and the attainment of the goal objects. Secondly, for those individuals who, in addition, indicated a strong preference for the goal objects, the above relationship was even stronger. Thirdly, participants who felt they had considerable freedom to set their own work pace evidenced the strongest expectancy performance relationship.

All of the above findings are exactly what one would predict from Vroom's model, although the model had not at this point in time, been formally stated. In Vroom's (1964) terms, the first finding suggests that as the perceived performance-reward contingency (instrumentality) increases, so does performance. Secondly, as the valence of the associated outcomes or goals increases, performance also improves. Although admittedly a poor operationalization of the expectancy notion, Georgopoulos' et al. third finding suggests that the individual's perception that he can in fact regulate his level of performance is an important determinant of actual performance. This too is specified in Vroom's model.

Shortly after the publication of the Georgopulas' et al. (1957) study, Atkinson (1958) conducted an experimental investigation of some of the relationships elucidated therein. Atkinson ignored the effort-performance contingency (expectancy). Instead he focused upon the effects of valence and instrumentality on performance. College students competed for a monetary prize of $1.25 or $2.50 with a 1/20, 1/3, 1/2, or 3/4 probability of winning. Performance was defined as the number of arithmetic problems correctly solved in a 20 minute session. Performance was higher in the high valence condition, where the $2.50 prize was offered. Contrary to expectancy theory however, an inverted U function described the relationship between performance and instrumentality. The greatest number of problems were solved when the probability of receiving the cash prize was .5 rather than in the .75 condition as expectancy theory would predict. Atkinson suggested this result was due to a decrement in achievement motivation as the probability of success either increased or decreased from maximum uncertainty, i.e., .5. Atkinson concluded however that his results were in the main supportive of expectancy theory.

Both the Georgopoulos et al. and Atkinson studies drew upon expectancy notions to examine performance. However, at this point, no formal theory of work performance had appeared. Rather Lewin's expectancy notions had provided at best a convenient framework from which to examine performance motivation. This lack of formal theory characterized industrial psychology in general, but was particularly true with regard to work behavior. Guion and Gottier (1965) identify this problem succinctly:

> It must be admitted that industrial psychology lacks a general theory of work; it lacks a more specific theory of the relationships of motivational constructs to the behavior of the individual and his job; and it lacks even a substantial body of research explicitly aimed toward the development of such theories. . . . If the problem lies in the lack of relevance of existing theories, then the solution must surely lie in the design of research that will lead to a relevant theory (p. 37).

The studies just described constitute the research that did indeed lead to a "relevant theory." Vroom's (1964) Model was the first formal attempt to synthesize expectancy notions into an explicit theory of work behavior.

Two particularly significant aspects of Vroom's Model should be noted. First he translated expectancy notions into language immediately applicable to the work setting. As a consequence, students of industrial behavior could no longer easily overlook the potential contribution to their field offered by this approach. Secondly, and perhaps more importantly, Vroom's propositions are stated with sufficient precision to permit specific behavioral predictions. This has generated a substantial number of investigations of certain portions of the Model (Hackman & Porter, 1968; Lawler, 1968; Gavin, 1970) as well as studies aimed at testing the entire theory (Galbraith & Cummings, 1967; Graen, 1969; Mendel, 1971). Furthermore, the more recent expectancy models of work motivation (Porter & Lawler, 1968; Graen, 1969; Campbell et al., 1970) are a direct result of the research stimulated by Vroom's Model.

Recent Literature

We are now in a position to examine the literature relevant to the common elements of the four expectancy models of work performance. Each of the four expectancy models of work performance previously cited views a worker's motivation to perform as a function primarily of the interaction of three variables: 1) his perception of the probability that his task-related efforts will translate into effective performance (expectancy), 2) his perception regarding the probability that rewards will be forthcoming given the attainment of some specified performance level (instrumentality), and 3) the anticipated satisfaction to be derived from these rewards (valence).

<u>Valence x instrumentality</u>

Several investigations have dealt exclusively with the valence x instrumentality portion of the model. A typical procedure is to collect questionnaire data regarding the valence and instrumentality of one or more outcomes associated with the dependent variable under study, form the products as specified by the model, and arrive at a predicted performance score for each subject. This predicted value is then correlated with a self-report or external measure of the criterion. With varied success, this procedure has been used to predict racial prejudice (Rosenberg, 1956), job satisfaction (Porter & Lawler, 1968), vocational preference (Sheard, 1971; Wannous, 1971), turnover (Dunnette, Arvey, & Banas, 1970), as well as job performance (Lawler, 1968; Galbraith & Cummings, 1967; Lawler & Porter, 1967; Hackman & Porter, 1968; Spitzer, 1964; Georgopoulos et al., 1957).

Hackman and Porter (1968) had 82 female service representatives of a telephone company indicate the outcomes they expected would result from working hard on the job. They also indicated the level of certainty these outcomes could be obtained by working hard (I) and an estimate of the degree to which workers like or dislike these consequences (V). Combining instrumentality and valence for these outcomes multiplicatively, the investigators were able to predict a composite criterion of work effectiveness ($r=.40$). Similar results using this procedure to predict job performance have been reported by those cited above.

Two issues regarding this portion of the model have been raised. First, there is a controversy regarding the value of weighting instrumentalities by their respective valences. Sheard (1971) and Wannous (1971) both report valence weighting did not improve prediction of student job preference when compared with predictions made using instrumentalities alone. Ewen (1967) and Blood (1971) arrive at the same conclusion with regard to the prediction of job satisfaction. Blood, in a summary of his and Ewen's arguments states:

> Ewen argued that differential weights did not make a difference (or, if you prefer, that "importance" is not "important"). The present argument adds the consideration that when making judgements about the importance of job aspects, Ss provide information that has little relationship to the actual influence of those aspects on an overall evaluation of the job. It is unwarranted to expect people to behave in the methodical and orderly manner necessary to provide data that would support the model of behavior implied by the original properties of the formula. The conception of importance is empirically invalid (Blood, 1971, p. 433).

In defense of Vroom's propositions however, two points are worth noting. First, although Blood makes a general statement about the empirical validity of valence weighting, the data he references include _only_ job satisfaction as the criterion. Thus, he may be correct with regard to that particular dependent measure, but this does not necessarily suggest his argument is valid for other dependent measures with which expectancy theory deals. Secondly, the fact that Galbraith and Cummings (1967), Lawler and Porter (1967), Spitzer (1964), and Georgopoulos et al. (1957) all report data in which valence weights did improve the prediction of performance, suggests Blood's statement is indeed in need of qualification.

The second issue concerns the direction of causality. Do subjects' perceptions of instrumentalities cause performance or are they determined by it? Almost all of the research dealing with these relationships is of a static correlational nature. Consequently, there is a relatively small literature one can draw upon to answer these questions. There are two studies however, relevant to this point. The Atkinson (1958) study described earlier, in which instrumentality and valence were experimentally manipulated, did result in subsequent changes in performance. This suggests instrumentalities cause performance. Unfortunately, Atkinson used objective rather than cognitive measures of instrumentality. To the extent these objective measures failed to correspond to the subjects' subjective instrumentalities, the data do not provide an appropriate test of the Model.

A more direct test of the causality issue was conducted by Lawler (1968). Cross-lagged (Campbell & Stanley, 1963) in conjunction with dynamic correlational analyses (Vroom, 1966) were performed on subjective instrumentality data. Cross-lagged analysis is based on the assumption that if variable X causes variable Y, then changes in X ought to precede changes in Y. In the context of the Lawler study, if instrumentalities cause performance, then instrumentalities measured at the same time as performance ought to correlate lower than with a performance measure obtained at some later date. Employing self-ratings of performance collected contiguously with the instrumentality measure and again a year later, correlations of .43 and .65 respectively resulted. These findings provide further evidence for the notion that performance is in part caused by instrumentalities.

Expectancy -> performance, expectancy -> reward[1]

Aside from translating expectancy notions into a language which attracted the attention of students of work motivation, Vroom's model made yet another contribution. His postulates formally recognized that there are in fact two theoretically and operationally distinct expectancies which contribute to the motivation to perform. The first, which we have just discussed, is the expectancy that performance leads

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[1]The arrow symbol used throughout this discussion signifies that the construct to the left of the arrow leads to or results in the outcome on the right of the arrow.

to rewards (I). The contribution of this cognition to motivation, however, is moderated by the expectancy that effort will lead to performance (E).

The reader need be cautioned at this point. The distinction this writer is making between two bodies of literature, the first dealing with performance-reward contingencies, and the second focusing upon the effort-performance relationship is by no means clean. There is a large number of investigations in which these notions were confounded, i.e., those which have examined the effort-reward contingency directly while ignoring its two components. Nevertheless, the finding of these studies too have provided some insight into the relationships with which this discussion is concerned.

Glass, Singer, and Friedman (1969), although not directly concerned with the effort-performance expectancy, report findings relevant to this issue. A predictable versus non-predictable auditory stressor resulted in subjects in the non-patterned condition reporting a reduced expectancy that effort leads to performance. Following termination of the stressor, subjects were given a task on which to work and their performance recorded. Subjects who had been in the non-predictable condition, and thus had lower effort-performance expectancies, also had poorer scores on the post-treatment task. The authors accounted for this in terms of the "psychic cost of adaptation to an environmental stressor." An expectancy theorist would argue that the reduced effort-performance expectation resulted in lower performance.

In a study of 154 managers from five different governmental and private organizations, Lawler and Porter (1968) found performance positively related to the expectancy that effort would result in reward. Unfortunately, a separate measure of the effort-performance expectancy was not administered. We can only speculate therefore as to the extent the effort-performance contingency alone contributed to the performance variance. Lawler and Porter do however, recognize the need for research on this point:

> The model (Porter and Lawler, 1967) points out that the probability that effort will lead to rewards is a product of the probability that effort will lead to performance and the probability that performance will lead to the reward. Judging from the high correlations found in the present study, it appears that these managers did not tend to distinguish between the probability that effort leads to rewards and the probability that performance leads to rewards. This would indicate that for them the concern about whether effort was likely to result in performance was not a major factor, and that the major concern was whether performance would result in rewards. This is, of course, an inference and may be an artifact of an approach which did not directly ask the manager to estimate the likelihood that effort would result in performance. Future studies are needed to examine this issue directly (p. 133).

Schuster and Clark (1970), in a study specifically designed to test portions of Porter and Lawler's (1968) model, found the effort-performance expectancy an important and identifiable factor in performance motivation.

> In their research, Porter and Lawler found that the more an individual sees his efforts as leading to the attainment of a reward (pay), the more effort he will expend. He first sees his effort as leading to the desired reward, and then proceeds to exert effort which, if role perceptions are accurate, will result in meaningful performance that will in turn lead to the desired reward of pay.
>
> For our survey population, on the other hand, our results led us to conclude that effort is important primarily because it is believed to result in performance. The individual first sees that his performance will lead him to the desired reward. Since he feels that effort expended leads to performance, he will then exert effort which, if role perceptions are accurate, will result in performnce that will attain for him the desired reward of pay.
>
> Porter and Lawler suggested that in a population such as the one we used, where effort is seen to lead to performance, it may be possible to drop effort from the theoretical model. They said: "Unfortunately we did not directly ask the managers to estimate the probability that effort on their part would result in good performance. If it were found in future studies, that this probability was always close to 1.0, then indeed it could be dropped from the model. However, at this point, we still feel it may be relevant in many situations" (p. 88). We agree with Porter and Lawler that effort is relevant, and our research does not indicate that it should be dropped from the model (p. 16).

Largely similar conclusions were reached by Lifter, Bass, and Nussbaum (1971). In addition, they provide a possible explanation for the differential importance ascribed to the effort-performance contingency in the previous two studies. These authors reasoned that effort might contribute more to effective performance at lower managerial levels. This was based on the observation that line supervisors are more directly involved with production than are their supervisors. Consequently the effort expended by a line supervisor is more likely to translate directly into identifiable performance than an equal amount of staff supervisor's effort. Lifter et al. (1971) report two findings which support their hypotheses that managerial level moderates the effort-performance relationship.

In their study of 92 line and 30 staff supervisors, a higher relationship was found between effort and overall job performance for line than for staff supervisors. Furthermore, effort expenditure was actually used as a factor in determining salary increases to a greater extent by managers of line supervisors than by managers of staff supervisors. Since it appears managerial level does moderate the effort-performance relationship, the greater importance ascribed to effort-performance by Schuster and Clark may have been a result of having investigated subjects of a lower managerial level than did Lawler and Porter.

In sum, it is apparent that the evidence relating effort-performance expectancies to performance is equivocal. This is in part due to the fact that an objective effort-performance index has been employed rather than the individuals perception thereof. The issue has been further clouded by a failure to separate the effort-performance from the effort-reward expectancy. The causal role played by the former perception, as well as adequate identification of variables which moderate its effect, remain unclear. The major problem with this literature insofar as it relates to Vroom's model however, has yet to be mentioned.

It may be recalled that Vroom proposes expectancy combines multiplicatively with the valence of performance. More specifically, actual performance is a function of the interaction of the effort-performance expectancy and the valence of some specified performance level (see Vroom, 1964, p. 17-18, Propositions 1 and 2). In the literature just reviewed we see attempts to evaluate expectancy by examining its main effects, when its hypothesized relationship is interactional. The inapplicability of this approach requires no further elaboration.

In order to evaluate the theory appropriately, all variables must be considered simultaneously.[2] In the last body of literature discussed here, the authors have attempted to do so.

Complete tests of the Model: E, I, and V

Galbraith and Cummings (1967) conducted the first investigation in which the stated objective was to test the adequacy of Vroom's job performance model. The correlational

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[2]The reader may refer to Heneman and Schwab (1972) for a more detailed account of this problem.

study was conducted in an operative industrial plant. Valence and instrumentality measures were obtained from each of the 32 subjects for five second-level outcomes: wages, fringe benefits, promotion, group acceptance, and supervisor support. Expectancy was assumed to equal unity since each worker could independently and autonomously regulate his own output. With these data the authors used a stepwise multiple regression procedure to determine which outcomes, if any, predicted performance.

Supervisor support was the only significant variable. The first order interaction of instrumentality and valence for supervisor support was the only variable significantly related to performance. That is, neither valence nor instrumentality alone predicted job performance, but the product of these two variables did. While this one significant effect is consistent with the model, why did the remaining hypothesized interactions fail to occur? Galbraith and Cummings account for this finding by arguing that the remaining second-level outcomes were not dependent on the worker's level of performance. They maintain that the particular organizational structure in which the study was conducted was such that wages and fringe benefits were controlled by union agreements, and promotion was largely a function of seniority. In short, the instrumentality of high productivity for the attainment of these second-level outcomes was extremely low, thereby precluding any significant effects for these variables.

Two points are particularly noteworthy with regard to this study. First, at the outset of the investigation the authors delineated three conditions which must be satisfied if an organizational variable is to be a significant determinant of performance: 1) the outcome must be desired by the employee, 2) the employee must perceive that variation in performance will effect the amount or probability of second-level outcomes, and 3) the organization must be capable of varying the reward component. Unfortunately, supervisor support was the only one of the five outcomes that satisfied all three conditions. Moreover, the authors designated the relevant second-level outcomes, rather than allowing the subjects themselves to indicate the goals for which they performed. Thus, it appears Galbraith and Cummings failed to make any systematic attempt, by interviews, job analysis, etc., to identify the relevant second-level outcomes for the workers from whom the data were collected. Although the authors did report a substantial correlation between the predictor cited above and performance (r=.57), the potential efficacy of the model may well have been severely restricted; the input employed was for the most part inappropriate.

A second important point concerns these authors' treatment of expectancy. They tacitly assumed that expectancy equalled unity in the particular work setting investigated. Even if one were to concede that the objective expectancy was as reported, it is inappropriate to use this index in the model. Vroom (1964, p. 17) emphatically states that it is the expectancy as perceived by the worker that is germane to the model. In the final analysis, one must conclude Galbraith and Cummings failed to provide an adequate test of Vroom's model.

Mendel (1971) attempted a validity extension as well as suggesting a slight modification of Vroom's model. He noted that earlier attempts to determine the validity of Vroom's model were conducted either in actual industrial settings (Galbraith & Cummings, 1967; Hackman & Porter, 1968) or in "experimental simulations" of industrial environments (Graen, 1969). It was argued that there are no intrinsic characteristics of the model which should restrict its utility solely to industrial environments; the model should be an equally powerful tool in virtually any performance setting. To test this notion, a collegiate wrestling team constituted the subject population.

A second purpose was to test a proposed modification of the theory. Mendel and Dickinson (1971) stated that heretofore

> The model has been evaluated in terms of its ability to account for variations in performance. Without exception, the measure of performance pre-

> dicted was derived by some external, often called 'objective' means, e.g., unit output records. The model Vroom espouses however, is distinctly cognitive. Emphasis in all the independent measures is on the perceptions or cognitions of the individual, that is, self-rated valence, self-rated instrumentality, and self-rated expectancy. Hence it is with some trepidation that this author learns that in the quantification of the dependent variable productivity, the perceptions of the focal individual are completely ignored.
>
> Is it not reasonable to view cognitively derived, self-perceived performance as an intervening variable between the motivational base and 'objective' performance? Vroom argues that a worker adjusts his performance to a force impinging upon him to attain a certain level of output. But performance for the individual is defined by his perceptual and cognitive processes. It therefore seems defensible that it is this cognitive index of performance that the worker adjusts to this force, and as a result it is this measure of performance that is in fact predicted by the sizable correlation extant between self and other ratings of this variable (p. 2).

Before looking at the results of this study, two methodological improvements over the Galbraith and Cummings study deserve mention. First, the second-level outcomes used in this study (winning matches, making the varsity, respect of teammates, support from coaches, becoming too tired to study after practice), were defined by the subjects rather than by the experimenter. Secondly, although Mendel felt that expectancy might reasonably equal unity, a measure of the subjects' perceptions of this variable was taken. Thus the two major shortcomings of the Galbraith and Cummings study were avoided here.

When an external index of performance was used (coach-ratings) as the criterion, Vroom's model approached, but failed to reach traditionally acceptable levels of significance. However, the model did predict a self-rating of performance ($R=.65$, $p<.025$). Moreover, the amount of variance explained in the latter case was significantly greater ($p<.01$) than when an external performance rating was used. The author concluded that this finding constituted substantial support for his proposed modification of the theory.

Incontrovertible evidence for the necessity of actually measuring subjects' expectancies was also obtained. When expectancy was deleted from the model, R's of .12 and .14 for coach- and self-rated performance respectively resulted. This contrasts with R's of .32 and .42 for the same two variables when actual expectancy measures were included in the prediction equation. It appears that subjects' perceptions of the effort-performance relationship do not necessarily correspond to reality as defined by a second party, whether the latter be the experimenter or a worker's superior.

One obvious deficiency in Mendel's conclusion must be recognized. It is quite possible that the better prediction of self- versus coach-rated performance is due to differential method bias. Self-rated predictors would logically be expected to correlate higher with self- than coach-rated performance since the former enjoys a common method, whereas the latter does not. The method factor is inextricably confounded in this study, so definitive evidence for the suggested modification has not been provided. At the very least, this question does warrant further investigation.

The Mendel (1971) study probably offers the most complete test to date of Vroom's Model. The findings constitute substantial support for this expectancy theory. The fact that the data were collected in a non-industrial setting makes the findings even more convincing.

The evidence reviewed thus far warrants two broad conclusions. First, both the experimental and correlational data concerning the separate effects on performance of valence, instrumentality, the valence x instrumentality interaction, and expectancy are consistent with expectancy theory in general, and Vroom's model in particular. However, as was pointed out, these findings are only tangentially relevant to Vroom's and the later expectancy models since these models deal with performance as a function of the interaction of the above variables. All of these variables must be considered simultaneously in order to generate data truly relevant to these models.

The second conclusion derives from those correlational investigations just discussed, which have with varying degrees of success, simultaneously considered all of the variables in the model. These studies do offer moderately encouraging support for the kinds of relationships suggested by Vroom.

The obvious next step is the experimental manipulation of all variables in the model within a single paradigm. Only in this way can one justify conclusions regarding the direction of causality, the nature of the interaction, and the relative amount of variation in performance attributable to each of the models' variables or combinations thereof.

Only one attempt to conduct such an investigation is reported in the literature. Arvey and Dunnette (1970) set out to determine if individuals do in fact distinguish between expectancy and instrumentality, and if they do, to establish the nature of the effect these two types of expectancies have on performance. Although the valence of reward was not manipulated, this is the only study reported that has manipulated both expectancy and instrumentality.

The expectancy manipulation involved informing subjects, who were solving math problems in groups of size ten, that on the basis of the number of problems correctly answered in a 20 minute session, either the top two (low E), five (medium E), or eight (high E) of their number would be designated "top performer." Subjects were also told that the "top performer" designates would subsequently have the opportunity to reach into a bowl containing red and white poker chips, selection of a red chip being worth two experimental psychology points. Instrumentality was manipulated by informing subjects that the bowl contained 25% red chips (low I) or 75% red chips (high I). Subjects were also blocked on the basis of math problem-solving ability.

Although much of Arvey and Dunnette's discussion concerned the relevance of their findings for Atkinson's achievement motivation and Locke's goal setting notions, some implications for expectancy theory are discussed. First, Arvey and Dunnette note with particular enthusiasm that as expectancy increased, so did performance. Second, they found that, contrary to expectancy predictions, increases in instrumentality (i.e., performance-reward perception) were <u>not</u> associated with higher performance. Third, and not too surprisingly, they report higher ability subjects actually did perform better. Fourth, no significant interactions resulted for expectancy, instrumentality, and ability. This too is contrary to expectancy theory. Finally, and again counter to expectancy notions, effort did not relate more highly than performance to expectancy and instrumentality.

On the surface, these findings offer little encouragement for proponents of expectancy theory. Upon closer inspection of Arvey and Dunnette's procedure, however, their findings appear uninterpretable. Arvey and Dunnette set out to separate and experimentally manipulate the effort-performance and performance-reward expectancies. But it appears they have really manipulated an _effort-reward_ rather than an effort-performance contingency. Recall that this latter manipulation involved varying the number of subjects, in a group of size ten, that would be designated "top performer." Certainly being designated "top performer" on the basis of performance on a 20 minute math test is a highly rewarding situation. This is especially so when you consider the designations were made in front of the group of peers with whom the subjects competed. Particularly in the high E condition where all but two of the subjects in the group would be "top performers" is the reward component extant. No doubt, for a group of college students performing an intellectual task, being singled out as one of the two group participants with the poorest score reflects more then performance. It is highly punishing (or rewarding) as well. In fact, it is likely that the reward component associated with the "top performer" designation was far greater than the intended reward of "two experimental credits."

If Arvey's findings are reconsidered with this criticism in mind, a very different set of conclusions are warranted. First, he has actually replicated the earlier finding that the effort-reward probability relates to performance. His second finding is consistent with this writer's hypothesis that relative to the "top performer" designation, two experimental credits have little reward value; thus no effect for the performance-reward manipulation resulted. Finally, the failure to obtain an interaction between expectancy and instrumentality is easily explained; neither of these cognitions were manipulated correctly. Hence the need for an experimental analysis of the expectancy theory variables remains.

Statement of Purpose

An experimental approach to the analysis of Vroom's and related expectancy models was adopted a) to determine if the specified three-way interaction does predict performance, b) to compare the efficacy of the Model as an explanatory device for cognitive versus objective performance measures, and c) to determine the nature of the causal relationship between expectancies and performance. Additionally, several variations of and derivations from the Model were examined. Specifically, these were d) the degree of equivalence between effort -> reward and expectancy x instrumentality perceptions, and the implications of the use of each in the Model, e) the value of valence weighting, f) the effect of using cognitive rather than objective ability measures on the predictive power of the Model, and g) the success of the Model as a predictor of effort versus performance.

Hypotheses

The first set of hypotheses are derived directly from the Model and thus represent tests of the relationships thereby specified.

Predictions derived from Vroom's Model

Hypothesis 1: Vroom's Model, i.e., the product of expectancy, instrumentality, and valence predicts effort and performance.

Hypothesis 2: Vroom's Model is a better predictor of effort than performance.

Hypothesis 3: Vroom's Model more accurately predicts effort and performance when instrumentality is weighted by valence than when valence is deleted.

Hypothesis 4: Vroom's Model more accurately predicts performance when the product of expectancy, instrumentality, and valence is multiplied by ability.

Hypothesis 5: The product of perceived expectancy and instrumentality does not correspond to subjects' effort -> reward estimates.

Hypothesis 5.1: Better effort and performance predictions result when the product of expectancy and instrumentality, rather than effort -> reward expectancies are employed in the model.

The hypotheses in the following section are based on the position that Vroom's Model, as a cognitive consistency theory, is more accurately characterized as a predictor of cognitive performance.

Predictions derived from modified model[3]

Hypothesis 6: Vroom's Model is a better predictor of effort and performance when cognitive measures (self-report) are employed as both independent and dependent variables.

Hypothesis 6.1: Vroom's Model is a better predictor of self-ratings of effort and performance than externally derived measures of these constructs.

Hypothesis 6.2: The product of Vroom's Model variables and self-rated ability more accurately predicts effort and performance than when externally derived measures are employed.

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[3]For expository convenience, the term "modified model" is used to describe Vroom's Model when evaluated against cognitively derived measures of effort or performance.

METHOD

Overview

Subjects were required to solve arithmetic problems under one of eight treatment combinations. The design was a 2 x 2 x 2 factorial with two levels of expectancy (.60 and 1.00), two levels of instrumentality (.25 and .75), two levels of reward ($1 and $5), and ability serving as a covariate.

Subjects

Eighty male students enrolled in the Introductory Psychology courses at Iowa State University and Western Kentucky University served as subjects.

Task

After a preliminary training exercise (described in Procedure), subjects in a laboratory setting were asked to solve pairs of equations, and then to apply a decision rule to arrive at a final answer for each equation-pair. There were two successive 20-minute, problem-solving sessions.

Each subject was given three types of materials:

1) a booklet containing 90 pairs of equations. Each equation pair was numbered consecutively and appeared in the following format (see Appendix A):

$$
\begin{array}{lll}
1. & 8X - 4 + 2 = & \\
 & & = \\
 & 9X + 5 - 6 = &
\end{array}
$$

2) a blank IBM Form 517 answer sheet (see Appendix B).

3) a 4"x6" input card with a summary of the decision rule at the top and ten "input values" listed below (see Appendix C).

In order to solve each equation-pair, subjects first had to select the appropriate value from the input card. While an equation booklet contained seventy equation-pairs, the input card listed only ten values with the numeric labels "0" through "9." Therefore, subjects were instructed to reuse the input values as follows. Equation-pairs 1, 11, 21, etc. were to be solved by substituting for X, the input value labeled "1." Likewise, the input value corresponding to the label "0," was to be used to solve equation-pairs 10, 20, 30, etc. In short, subjects had to attend only to the last digit in the equation-pair number, and select the value from the input card with the same numeric label.

Once the appropriate input was selected, subjects were required to substitute this value for X in both equations in a pair. They then had to carry out the indicated arithmetic operations and write down the answers next to the equations in the booklet. At this point, subjects had to apply a decision rule. If the upper answer was larger or equal to the lower answer, they were to subtract the lower from the upper. Conversely, if the lower answer was larger, they were to add the two answers. In this way, a final two-digit number was computed for each equation-pair. Only the last digit in this final answer for an equation-pair was recorded by blackening the corresponding digit on the IBM answer sheet.

Manipulations

Deception was used to manipulate expectancy. In the high expectancy condition, subjects were told that all of the ten values on the input card were correct and thus if they personally carried out the arithmetic operations without error, 100 percent of their answers on the IBM answer sheet would be scored as correct responses. Subjects in the low expectancy condition were informed that only six of the ten inputs were correct, so the best they thought they could do was 60 percent of those equation-pairs solved correctly. Although subjects in both conditions were informed of the percentage of "incorrect inputs," they were not told which of the ten were supposedly in error. Consequently, the only performance maximization strategy was to work each and every problem as rapidly and accurately as possible. In point of *fact, inputs were identical in all conditions; every input would have resulted in a correct response had subjects committed no arithmetic errors.*

Instrumentality was manipulated by informing subjects at the outset of the experiment that the department had provided some funds for payment of subjects, but that these funds were not sufficient to pay all 80 subjects in this experiment. Consequently, a two step process would be used to decide who would receive a cash prize. Subjects were told that if the total number of equations correctly solved by their team fell above the bottom quartile on norms already obtained, they would have a chance to win a cash prize. Subjects in the high instrumentality condition were told that if they fell above the bottom quartile, they could reach into an opaque sack (which they were shown) containing 75% red and 25% white poker chips. If they pulled out a red chip, each partner would receive the cash prize. A white chip meant no cash prize would be awarded. Low instrumentality subjects were given the same instructions except that a red chip meant no cash prize, whereas a white chip won.

Subjects in the high valence treatments were told that the cash prize was $5, while a $1 prize was indicated for subjects in the low valence conditions.

The covariate ability was assessed on the basis of subjects' performance on a pretest which was disguised as a training exercise.

Measures

All subjects completed two questionnaires, the first immediately prior to the onset of the problem-solving session (Appendix D), and a second at the end of 40 minutes of problem solving (Appendix E). Both measured subjects' perceived expectancy, instrumentality, valence, ability, and effort-reward probability. In addition, the post-questionnaire asked subjects to indicate the amount of effort they had actually put forth in solving the equations, how well they thought they personally had actually performed, how well they thought their partner had done, whether they had set any particular goal for themselves at the onset of the session, and whether they would be embarrassed had they not performed well enough to surpass the bottom quartile cutoff.

"Objective" measures of performance and effort were also obtained. Performance was defined as the number of equation-pairs correctly answered by a subject during the sixty minute session. Effort was operationalized as the number of equation-pairs for which the subject had recorded a response, regardless of the precision.

Procedure

A subject sign-up sheet was posted in the psychology building. The study was identified as one concerned with dyadic problem solving. A two-hour time commitment was required; two subjects were allowed to sign up for each time slot. Two experimental participation credits, a minor academic inducement, were awarded for participation.

When both subjects arrived in the laboratory, they were seated at a table and the experimenter read aloud the following instructions:

> In this study we are attempting to simulate certain aspects of a typical industrial work environment. As you know, the behavior of workers in industry, as well as the rewards these workers receive, such as pay, promotions, and so forth, are based in part on the abilities and skills of the individual worker, and in part on pure chance or luck. Moreover, often the behavior of one worker is partially dependent upon the cooperation of one or more coworkers, as would be the case for example, in an assembly line job. It is the influence of these kinds of variables that are of interest in this study. A more detailed explanation will be given to you at the conclusion of this session, roughly an hour and a half from now.

When both subjects indicated they understood what they were to do, the experimenter read the following:

> In order that I may be absolutely certain you understand exactly how you are to solve the equation-pairs, and to obtain an estimate of your ability to solve this type of problem, you will have eight minutes to solve equations exactly as

> you will be doing during the test sessions. Please work as rapidly and accurately as you possibly can. Your goal should be to solve correctly as many of the thirty equation-pairs in eight minutes as you are capable of doing. I will stop you when eight minutes have elapsed.

Both subjects were then given a problem booklet containing thirty equation-pairs, an input card, and an IBM answer sheet. They were instructed to begin.

After eight minutes, subjects were told to stop. Each was then given a blank input card and instructed to transfer his answers for the first ten problems from the IBM answer sheet to the input card. When this was done, the experimenter collected the input cards and a single "instructional" treatment combination was administered to both subjects:

> For the next hour the two of you will be solving equations exactly as you have just done. The hour will be divided into three 20-minute sessions. At the end of the first and second sessions*, I will collect your equation booklet and answer sheet, and give you another set to work during the next 20 minutes. Each booklet will contain 90 equation pairs, more than you will be able to solve in the allotted time.
>
> The two of you will be working as a team, but in separate rooms. At the end of the third session, I will score all the answer sheets and total the number of equations the two of you together have solved correctly.
>
> There is one catch, however. The inputs you will be using to solve the equations are the

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*In order to avoid the increase in performance frequently observed toward the end of a work period (Wyatt, Langdon, & Scott, 1937), subjects were told that there would be three 20-minute sessions when, in fact, there were only two.

answers your partner just recorded on the blank input card. The correct solutions to the equation-pairs you will be solving during the next hour were computed by substituting in for "X" the correct solutions to the equations your partner just solved. What this means, for example, is that if your partner got five of the first ten wrong on the pretest, you will be able to get at most 50% of the equation-pairs you solve correct. On the other hand, if he made no errors, you will get every equation-pair you solve correct as long as you personally do not commit an arithmetic error. I will note the number of incorrect inputs your partner has given you at the top left-hand corner of the input card. You will not know, however, which particular inputs are incorrect. Since you won't know which inputs are incorrect, your best performance maximization strategy is to work each and every equation-pair as rapidly and accurately as possible. How hard you work is entirely up to you. Do not try to second guess the task by recalling your own input responses, for the problems you just solved were of equal difficulty, but the correct solutions were different. Thus, each of you will be working with somewhat different inputs. Do either of you have any questions?

In order to make this a bit more interesting, the department has provided me with some funds to pay subjects. However, these funds are not sufficient to pay all participants. Therefore, I have established performance norms for this task. If your combined score falls above the bottom 25%, as three out of four teams have, you will have a chance to win $10 ($2 in low V condition), to be divided equally between you. If you make the 25% cutoff, and if you try at all you will, one of you may reach into this bag and pull out one chip. The bag, as you can see (subjects shown a bag containing 15 red and 5 white poker chips) contains 15 red and 5 white chips. If you pull out a red chip (white chip in low I condition), I'll immediately give each of you $5 in return for your signature on a receipt indicating you did receive the money. If, however, you pull out one of the five white chips, neither of you will be paid, but of course, you will still receive your two participation credits.

Incidentally, I will tell you your team score, but not how much each of you contributed to that

> score since that might lead one of you to feel inferior. In any event these scores would be meaningless since each of you partially determines your partner's score through the inputs you provide each other.[5]
>
> Are there any questions?
>
> I will now place each of you in a separate room, give you your input sheets and a brief questionnaire to complete. This questionnaire, as you will see, is designed in part to make certain you have understood these rather lengthy and complicated instructions. Please fill out this questionnaire carefully. If you don't understand any of the questions, be sure to ask for clarification. When you have completed the questionnaire, I'll give you the equation booklet and the first 20-minute session will begin.

To discourage random responding to unfinished equations during the closing minutes of each twenty minute session, subjects were relieved of their watches. They were then directed to separate rooms. Meanwhile, the experimenter discretely substituted a standard input card for those previously completed by the subjects. This input card was identical for all subjects except for a number at the top, supposedly indicating the number of incorrect inputs. In the low expectancy condition the number "4" appeared, while a "0" appeared in the high expectancy treatment. The experimenter then entered the first test room, handed the subject what the latter thought were "partner generated inputs," and while

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[5]Subjects were so informed in order to minimize any reward (or punishment) component associated with performance, independent of externally mediated reinforcement.

pointing to the score, announced the number of errors his partner had committed. Experimenter then stated, "Now you understand this means that if you personally make no errors whatsoever during the next sixty minutes, 60% (100% in high expectancy condition) of your answers will be correct, and thus count toward your total team score." The subject was then given the Preliminary Questionnaire to complete. The experimenter repeated this procedure for the second subject.

As soon as both subjects completed their questionnaires, they were given the problem booklet and reminded that the experimenter would return in 20 minutes with another answer sheet and problem booklet.

At the end of the first session, the experimenter entered each test room, collected the answer sheet and problem booklet, and gave the subject a new set. He reminded subjects that he would return in 20 minutes with the third set.

When the second session had ended, the experimenter again entered the room, this time with the Post Questionnaire in his hand. He collected the answer sheet and test booklet and stated: "Now that you have been working at this task for 40 minutes and have gained some experience, I would like you to fill out this questionnaire. It is very similar to the one you already filled out. Try to answer each question as you feel right now, rather than trying to recall your earlier responses. They may, of course, be the same. Take your time and answer carefully. When you have answered all the questions, the third 20-minute session will begin."

When both subjects had completed their questionnaires, they were told the experiment was over. They were debriefed, each paid $3, and sworn to secrecy.

Analyses

All data were converted to deviation scores to eliminate spurious correlations between column means. A Certainty transformation was performed on all cognitive measures in order to reduce the effects of individual differences in response style on the pre- and post-questionnaires (Liu, 1971).

Several preliminary analyses were conducted to assess the effectiveness of the experimental manipulations. Four separate ANOVA's were run on the preliminary self-ratings of expectancy, instrumentality, valence, and perceived effort -> reward probability.

A determination of the adequacy of Vroom's Model as a predictor of effort and performance was made by employing two different strategies. Initially, with the treatment manipulations as design factors, a 2^3 ANOCOV with ability as a covariate was computed on each of the four dependent variates (i.e., cognitive and objective measures of both effort and performance). Subsequently, each of the four dependent variates was regressed on the cognitive measures of all Model variables and their first- and second-order interactions and a partial F-test performed on the predicted 3-way interaction.

A partial F-test was used to determine whether Vroom's Model yields a better estimate of performance when the cognitive measures are multiplied by ability.

The correspondence between effort -> reward estimates and the product of expectancy and instrumentality was determined by a test of significance of the Pearson Product-Moment Correlation (r) between these variables.

Partial F-tests were used to determine whether effort -> reward or the product of expectancy and instrumentality contributed more to the ability of the Model to predict effort and performance. Employing the preceding test, several pairwise comparisons were made to determine whether cognitive or objective measures of both independent and dependent variates result in better prediction (Hypothesis 6).

RESULTS

Check on Experimental Manipulations

The results of the three-way ANOVA on expectancy are shown in Table 1.

Table 1. Summary of the analysis of variance of cognitive expectancy as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	64695.87	10.333**
Instrumentality (I)	1	8757.15	1.399
Valence (V)	1	1647.10	0.263
E x I	1	456.02	0.073
E x V	1	15207.69	2.429
I x V	1	17257.95	2.756
E x I x V	1	599.52	0.096
Error	72	6261.15	
total	79		

**$p<.01$

The experimental manipulation was highly effective in influencing cognitive expectancy ($p<.001$). The mean high and low expectancies were 78.5% and 65.2% respectively.[6] However, it is also evident that cognitive expectancy, while influenced by the objective probability (100% and 60%) nevertheless does differ from the latter. Moreover, inspection of the remaining entries in Table 1 reveals that cognitive expectancy was unaffected by any other experimental manipulation or interaction thereof. Only the expectancy manipulation affected cognitive expectancy.

Table 2 displays the results of the instrumentality ANOVA.

Table 2. Summary of the analysis of variance of cognitive instrumentality as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	404.99	0.447
Instrumentality (I)	1	257644.40	284.225**
Valence (V)	1	414.03	0.457
E x I	1	7527.16	8.304**
E x V	1	1361.26	1.502
I x V	1	684.48	0.755
E x I x V	1	378.46	0.418
Error	72	906.48	
total	79		

**p<.01

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[6]The actual ANOVA was conducted on the Certainty transformed data. Since the tests on both the raw and transformed data were highly significant, the raw score means are reported for ease of interpretability. The respective transformed means are 340.32 and 283.45.

Here too the manipulation was effective. Subjects in the high instrumentality condition reported higher instrumentalities than did those in the low instrumentality condition ($p<.001$). The mean cognitive instrumentalities corresponding to the 75% and 25% objective instrumentality conditions were 69.6% and 27.5% respectively (respective Certainty transformed means were 285.8 and 172.3). The instrumentality manipulation also resulted in a significant expectancy x instrumentality interaction ($p<.01$). Inspection of the means revealed this effect was due to the dominant influence of objective instrumentality over expectancy as a determinant of cognitive instrumentality. Plotted from low to high instrumentality, the positive slope for the low expectancy condition was greater than that for the high expectancy condition.

The final manipulation, that of valence, was also successful. The results of this ANOVA are displayed in Table 3. Subjects in the five dollar condition indicated they valued the cash reward to a greater extent than did subjects in the one dollar condition ($p<.001$). The means were 67.6 and 38.5 respectively (corresponding Certainty transformed means were 300 and 188.7). As was the case with expectancy, cognitive valence was affected exclusively by the valence manipulation.

A final manipulation check was conducted using cognitive

Table 3. Summary of the analysis of variance of cognitive valence as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	16336.75	0.772
Instrumentality (I)	1	871.19	0.106
Valence (V)	1	247752.70	30.202**
E x I	1	5511.18	0.672
E x V	1	8080.22	0.985
I x V	1	11712.67	1.428
E x I x V	1	1729.77	0.211
Error	72	8203.16	
total	79		

**p<.01

effort -> reward probability as the dependent variable. The results of this ANOVA are shown in Table 4.

Table 4. Summary of the analysis of variance of cognitive effort -> reward as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	4820.49	1.134
Instrumentality (I)	1	83526.94	19.652**
Valence (V)	1	70.32	0.017
E x I	1	3794.99	0.893
E x V	1	4636.00	1.091
I x V	1	5.51	0.001
E x I x V	1	154.01	0.036
Error	72	4250.30	
total	79		

**p<.01

The only design factor affecting cognitive effort -> reward probability was the instrumentality manipulation. Subjects in the high instrumentality condition reported higher effort -> reward probabilities than did low instrumentality Ss ($p<.001$). The mean cognitive effort -> reward probabilities for the high and low instrumentality conditions were 60.5 and 36.2 respectively (263.6 and 199 for Certainty transformed data).

The previous finding is particularly interesting in view of the fact that several published studies are predicated on the assumption that effort -> reward probability is isomorphic with the product of expectancy and instrumentality (Hackman and Porter, 1968; Gavin, 1970; Lawler, 1966, 1968; Lawler and Porter, 1967; and Porter and Lawler, 1968). While this assumption appears well justified both theoretically and rationally, the present investigation offers no empirical support to this notion. On the contrary, cognitive effort -> reward probability was solely determined by the instrumentality manipulation.

In sum, while there was considerable error in the subjects' cognitive effort -> performance expectancies ($r=.34$ between objective and cognitive expectancy), and in their cognitive performance -> reward instrumentalities ($r=.88$ between objective and cognitive instrumentality), the results do suggest that subjects differentiate between expectancy and instrumentality (cf. Lawler & Porter, 1967). More importantly, the experimental manipulations of expectancy, instrumentality, and valence were all successful.

Hypothesis 1

The results of the covariance analysis on objective effort and performance are shown in Tables 5 and 6 respectively.

Table 5. Summary of the analysis of covariance of objective effort as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	0.58	0.011
Instrumentality (I)	1	25.44	0.496
Valence (V)	1	10.97	0.214
E x I	1	0.20	0.004
E x V	1	25.97	0.507
I x V	1	6.54	0.128
E x I x V	1	7.01	0.137
Error	70	51.27	

Based on a strict interpretation of Vroom's Model, the second-order interaction should be significant, with no first-order interactions or main effects. However, the analysis did not reveal any significant design factor effects on either objective effort or performance.

Table 6. Summary of the analysis of covariance of objective performance as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	0.59	0.009
Instrumentality (I)	1	25.12	0.378
Valence (V)	1	16.47	0.248
E x I	1	2.68	0.040
E x V	1	27.54	0.415
I x V	1	54.55	0.822
E x I x V	1	3.39	0.051
Error	70	66.38	

Similarly, as is shown in Tables 7 and 8, the covariance analyses did not indicate any significant effects for any of the manipulations on either cognitive effort or performance.

Table 7. Summary of the analysis of covariance of cognitive effort as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	195.23	0.951
Instrumentality (I)	1	271.03	1.320
Valence (V)	1	0.91	0.004
E x I	1	692.66	3.37
E x V	1	50.99	0.248
I x V	1	23.69	0.115
E x I x V	1	572.49	2.787
Error	70	205.38	

Table 8. Summary of the analysis of covariance of cognitive performance as a function of the treatment manipulations.

Source	df	MS	F
Expectancy (E)	1	634.31	2.146
Instrumentality (I)	1	4.87	0.016
Valence (V)	1	40.30	0.136
E x I	1	0.34	0.001
E x V	1	32.88	0.111
I x V	1	65.77	0.222
E x I x V	1	45.56	0.154
Error	70	295.59	

The regression analyses of objective effort and performance on cognitive expectancy, instrumentality, valence, and their first- and second-order interactions offer no support for Vroom's Model. None of the partial F-tests was significant for any of the component variables. Furthermore, contrary to Vroom's Model, the three-way interaction (E x I x V) was not the first of the Model variablesentering a stepwise regression.

When cognitive effort was regressed on all Model variables, a somewhat more encouraging finding emerged. Of the seven Model components on which effort was regressed, the predicted second-order interaction was indeed the first variable which entered the stepwise regression. The amount of variance explained by this single predictor was significant ($r=.24$, $F=4.63$, $df=1/78$, $p<.025$). However, the partial F-test on this interaction when all seven variables were entered did not reach traditionally acceptable levels of statistical significance ($F=1.92$, $df=1/70$, $p<.10$). These results therefore, although somewhat equivocal, are suggestive of the triple interaction predicted by the theory.

Data further indicative of the hypothesized interaction were obtained from the regression of cognitive performance on the Model variables. Again the second-order interaction was the first of the seven predictors to enter the stepwise regression. A significant amount of cognitive performance variance was explained by this interaction ($r=.28$, $F=6.67$, $df=1/78$, $p<.025$).

Unlike the regression on cognitive effort however, the partial F-test on the predicted interaction with all variables entered was significant with respect to cognitive performance ($F=6.58$, $df=1/70$, $p<.025$). Consequently, Vroom's Model is supported as an explanatory device for understanding cognitive performance.

In sum, Hypothesis 1 was confirmed for the cognitive dependent measures, but was not supported for the objective variables.

Hypothesis 2

Hypothesis 2, stating that Vroom's Model is a better predictor of effort than performance, was not supported. Due to the extremely high correlation between the objective measures of effort and performance ($r=.93$), the result could not have been otherwise in the present study. In essence these constructs were not identifiably different.

The failure to support Hypothesis 2 in the case of cognitive effort and performance however, cannot be explained in the same manner since the correlation between these two constructs was considerably lower ($r=.36$). In fact, the model predicted cognitive effort less accurately ($r=.24$) than cognitive performance ($r=.28$), although the difference was not significant ($F=1.02$, $df=1/77$, $p>.05$).

Hypothesis 3

Higher correlations were predicted (Hypothesis 3) between the four dependent measures and E x I x V (Vroom's Model) than with the product E x I without valence weighting. Table 9 presents the correlations relevant to this hypothesis.

The correlation between Vroom's Model and the dependent variables was larger in all four cases. Partial F-tests were

Table 9. Correlations of valence weighted and non-valence weighted models with cognitive and objective effort and performance.

	Cognitive Effort	Objective Effort	Cognitive Performance	Objective Performance
E x I x V	.2375*	.1364	.2817**	.1456
E x I	.1706	.0750	.0502	.1191

*$p<.05$
**$p<.01$

computed only for the cognitive dependent measures however, since neither of the objective dependent variables was significantly related to either model. The partial F-test on cognitive effort was not significant, while that for cognitive performance did reveal that Vroom's Model was a better predictor than the valence deleted model ($F=3.48$, $df=1/77$, $p<.05$)[7] In sum, the data offer weak support for the hypothesized superiority of valence weighting.

Hypothesis 4

The present study revealed no evidence to support Hypothesis 4. The product of Vroom's Model (E x I x V) and

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[7]A one-tailed test was performed.

ability (A) did not more accurately predict performance than did E x I x V alone. As inspection of the relevant correlations in Tables 9 and 11 reveals, in no case did the addition of ability, whether derived objectively or cognitively, increase the correlation with either objective or cognitive performance. In fact, the addition of ability actually attenuated the obtained correlation in all four instances.

Hypothesis 5

The hypothesis that the product of perceived expectancy and instrumentality does not correspond to subjects' effort -> reward estimates was confirmed. The obtained correlation between these two variables was not significant ($r=.18$, $df=79$, $p>.05$).

Hypothesis 5.1

Hypothesis 5.1 stated that better effort and performance predictions result when the product E x I rather than effort -> reward expectancies are employed in the Model. Table 10 displays the correlations of the four dependent variables with each of the two models described above.

Each of the four correlations between the prescribed model (E x I x V) and the dependent variables is considerably

Table 10. Correlations of Vroom's and effort -> reward models with cognitive and objective effort and performance.

	Cognitive Effort	Objective Effort	Cognitive Performance	Objective Performance
E x I x V	.2375*	.1364	.2817**	.1456
Eff->Rew x V	.0137	-.0040	.1224	.0296

*$p<.05$
**$p<.01$

larger than the corresponding relationship with the inappropriate model (effort -> reward x V). Since, as discussed earlier, the correlations between Vroom's Model and the objective measures of effort and performance were not statistically significant, the relationship between E x I x V and these dependent measures was perforce not significantly larger than when effort -> reward was substituted in the Model. Nevertheless, the differences were in the predicted direction for both objective effort and performance.

A comparison of the above two models when the cognitive dependent measures were used produced more definitive results. With cognitive effort as the dependent measure, the resulting correlation with E x I x V was indeed significantly larger than that obtained when the effort -> reward estimate replaced E x I in the Model ($F=4.09$, $df=1/77$, $p<.025$).[8] The difference between the two models with regard to cognitive performance approached traditionally acceptable levels of statistical significance ($F=2.07$, $df=1/77$, $p<.08$).[9] In sum, the evidence lends support to the hypothesis that better effort and performance predictions result when Vroom's Model is operationalized as originally stated rather than substituting effort -> reward estimates in the Model.

Hypotheses 6 and 6.1

Hypothesis 6 stated the general principle that better prediction of effort and performance results when cognitive measures are employed both in the Model and as dependent variates. Two testable hypotheses were derived from this principle. First, the Model is a better predictor of cogni-

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[8]A one-tailed test was performed.

[9]One factor which may have contributed both to the discrepancy between cognitive and objective contingencies and to within treatment variations among subjects is the fact that the subjects serving in the present study were drawn from two relatively diverse college populations. The extent to which Western Kentucky University students differ systematically from those at Iowa State University on dimensions which might affect the outcome of this investigation is unknown. In any case, such differences, while possibly increasing the amount of error variance, definitely broaden the generalizability of the findings.

tive effort and performance than externally derived measures of these constructs. A partial F-test was used to determine whether the Model was a better predictor of cognitive than objective effort. Although the correlation between the Model and cognitive effort ($r=.24$) was larger as predicted, than that with objective effort ($r=.14$), the difference between these correlations was not significant ($F=.48$, $df=1/77$, $p>.05$).

Parallel results were obtained with cognitive and objective performance. Again the correlation between the Model and cognitive performance ($r=.28$) was larger than that with objective performance ($r=.14$), but the difference was not statistically significant ($F=.98$, $df=1/77$, $p>.05$).

Hypothesis 6.2

Hypothesis 6.2 stated that the product of the Model and cognitive ability more accurately predicts effort and performance than does the utilization of externally derived measures of ability. Table 11 displays the correlations between both the objective and cognitive models and the four dependent variables. Because neither of the above models correlates at all with either objective effort or performance (a finding consistent with Hypothesis 6.1), no further significance tests were conducted on these relationships.

Table 11. Correlations of the product of Vroom's Model and cognitive vs. objective ability with cognitive and objective effort and performance.

	Cognitive Effort	Objective Effort	Cognitive Performance	Objective Performance
Ac x E x I x V	.1830	.0052	.2524*	.0133
Ao x E x I x V	.1020	.0128	.1620	.0150

*p<.05

However, the relationships between the two models and the cognitive dependent measures were subjected to further analyses.

Once again the predicted larger correlation resulted between the cognitive model and effort (r=.18), rather than between the objective model and effort (r=.10). However, the difference between the correlations was not significant (F=.25, df=1/77, p>.05).

Precisely the same result was obtained when evaluating the two models against cognitive performance. The correlation with the cognitive model was larger (r=.25) than that with the objective model (r=.16), but the difference between them failed to reach statistical significance (F=.90, df=1/77, p>.05). In sum, although Hypotheses 6.1 and 6.2 were not strictly confirmed, the fact that all four relationships were in the hypothesized direction offers weak support for the position that cognitive rather than objective measures are more appropriate both as Model and dependent variables.

DISCUSSION

The findings of the current study are discussed in the same sequence as their presentation in the Results. The initial comments deal with the implications of the check on treatment manipulation effectiveness, followed by an evaluation of the findings pertaining to the hypotheses. Discussion of the causality issue and the psychometric limitations of evaluations of Vroom's Model concludes this section.

Experimental Manipulations

The overall success of the treatment manipulations demonstrates that Vroom, as well as other expectancy theorists, is correct in his assumption that individuals are aware of the environmental contingencies existing between effort and performance, and performance -> reward. This assumption is germane to a rational model which seeks to explain human motivation in terms of the interactive effects of these contingencies. Yet, the present study also reveals that even in a situation where the actual contingencies were explicitly defined, the subjective representation of these relationships does not precisely parallel the objective probabilities.

The discrepancy described above was particularly apparent with respect to the expectancy manipulation. Although the manipulation was highly successful, the reported expectancies differed markedly from the experimentally defined contingencies. Aside from the attenuation due to the unreliability of the expectancy measure (r=.59), it is possible that this discrepancy is specific to the particular operationalization of the expectancy notion employed in the present investigation. However, this seems doubtful insofar as the contingencies extant in this study were probably far more veridical than those characteristic of the vastly more complex non-laboratory environment.

An alternative explanation for the expectancy discrepancy may have implications which extend beyond the present study. There may be some semantic confusion regarding this concept. Expectancy is defined as the degree to which performance is perceived to be contingent upon effort. This definition may be construed in two ways. On the one hand, one might assume that typically a certain amount of goal-directed effort fails to translate into performance and thus expectancy is always less than unity. Conversely, one might reason that, despite the fact that a certain amount of effort is non-productive, performance remains entirely dependent on the remaining effort, and thus expectancy always equals unity. Given this dual interpretation, the discrepancy between objective and cognitive expectancy may be attributable to differential subject interpretation of the item designed to measure this construct.

A particularly interesting result concerns the effect of the treatment manipulations on the perceived effort -> reward contingency. Rationally one would expect the above variable to be a function of the interaction of the expectancy x instrumentality manipulation. In fact, perceived effort -> reward depended solely on the instrumentality manipulation. Again, one cannot ascertain whether this finding is specific to the present manipulations. Regardless, this result underscores the importance to the Model of measuring expectancy and instrumentality separately, rather than simply measuring effort -> reward. The latter may be only tapping subjective instrumentality, a point to which we shall return when discussing Hypotheses 4 and 4.1.

Hypothesis 1

The failure of the covariance analyses to reveal the hypothesized second-order interaction for any of the dependent variables is disappointing, but not especially damaging to the Model. A major assumption underlying the analysis of covariance procedure is that no differential response exists between subjects exposed to a common treatment. As previously indicated, while all treatment manipulations were significant, considerable within treatment differences were observed in subjects' reports of existing contingencies. Thus, the above assumption was violated.

Furthermore, Vroom's Model explicitly recognizes the existence of individual differences in the perception of environmental contingencies. This recognition is basic to cognitive theories in general, and to expectancy models in particular. The essential components of the Model are reflections of the manner in which an individual perceives his environment. Hence, within a treatment combination, the extent to which any given individual's perceptions of existing contingencies approximated the perceptions held by subjects exposed to different treatments, Vroom's Model itself would not predict significant treatment effects on effort and performance.

In defense of performing the covariance analysis in view of the above arguments, it should be noted that had the predicted second-order interactions been significant, the theory would have been strongly supported under extremely adverse conditions. Since it was not supported, one can justifiably claim that this analysis did not provide a fair test of the Model. In short, the covariance analysis was an expectancy theorist's delight in that it could either overwhelmingly confirm or say nothing about the viability of the model. In the present study the latter was the case!

The non-significance of the regressions of objective effort and performance on the Model are, in contrast, embarrassing to the theory. The subjects' own perceptions, when combined as the Model dictates, failed to predict either objective measure. This writer suggests that the findings demonstrate that the Model does not directly account for externally derived measures of effort or performance. However, proponents of the Model as a predictor of objective measures might legitimately dispute the above interpretation on two grounds.

First, it is probably misrepresentative to argue that the Model twice failed - first as a predictor of objective effort, and second as a predictor of objective performance. The reader will recall that effort was defined as the number of equation-pairs attempted, performance as the number correctly answered. In fact, these two measures, while operationally distinct, were not functionally different. Because of the task employed and the "questionable" definition of effort, the high correlation between these two constructs ($r=.93$) assured the implication for the Model would be virtually identical when evaluated against either dependent measure. Given the validity of this argument, one may find solace in the fact that the Model has failed once, rather than twice!

A more tenable defense for the Model's failure to predict objective measures can be presented. Vroom argues that performance is a function of a number of second-level outcomes, while only one second-level outcome (cash) was considered in the present study. It can be argued that other second-level outcomes were operative, but simply ignored when forming the expressions dictated by the Model. Although in the debriefing session most Ss only indicated they were working for the cash reward, a more rigorous assessment might have revealed other relevant outcomes. Nevertheless, to the extent other outcomes were salient, the Model was not fairly tested.

The above criticism becomes less problematic when considering the regressions of cognitive effort and performance on the Model. The fact that the Model (E x I x V) was the first of seven variables to enter the stepwise regression for both cognitive effort and performance, the fact that the F-values for the above term were significant for both dependent variables, and the fact that the partial F-test with all variables entered was significant for cognitive performance offer strong support for the Model as defined in the present study.

Discussion of effort and performance as distinct variables in the cognitive case is also justified. The correlation between cognitive effort and performance ($r=.36$), even when corrected for the attenuation due to the unreliability of the measures, had less than half of their variance in common.

In view of the confirmation of the Model for the cognitive measures, but not for the objective measures, the argument that the omission of relevant second-order outcomes precipitated the failure of the Model in the objective case is doubtful. Such an omission would not be expected to differentially favor the Model in the cognitive case.

A possible exception to the above statement occurs in the situation where differential method bias operates in favor of the Model evaluated against the cognitive dependent measures. A determination of the existence of differential method bias was therefore made in a post hoc analysis. Employing a procedure devised by Joreskog and Gruvaeus (1970), the multi-trait, multi-method correlation matrix was factor analyzed.[10] As is shown in Table 12, there was actually slightly more method bias in the objective than in the cognitive measures.

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[10]The 12 x 12 correlation matrix was composed of six traits (ability, expectancy, instrumentality, valence, effort, and performance), each measured by two methods (objective and cognitive).

Table 12. Factor analysis of multi-method, multi-trait correlation matrix: Factor matrix.

	General	Traits A	E	I	V	Ef	P
1	0.418	0.136	0.0	0.0	0.0	0.0	0.0
2	0.321	0.0	0.880	0.0	0.0	0.0	0.0
3	0.136	0.0	0.0	0.992	0.0	0.0	0.0
4	0.172	0.0	0.0	0.0	0.635	0.0	0.0
5	0.368	0.0	0.0	0.0	0.0	0.352	0.0
6	0.215	0.0	0.0	0.0	0.0	0.0	0.421
7	0.551	0.485	0.0	0.0	0.0	0.0	0.0
8	-0.052	0.0	0.427	0.0	0.0	0.0	0.0
9	0.062	0.0	0.0	0.944	0.0	0.0	0.0
10	0.245	0.0	0.0	0.0	0.781	0.0	0.0
11	0.712	0.0	0.0	0.0	0.0	0.213	0.0
12	0.082	0.0	0.0	0.0	0.0	0.0	0.209

Table 12. (Continued).

	Methods Cog	Obj
1	0.153	0.0
2	0.282	0.0
3	0.172	0.0
4	0.516	0.0
5	0.225	0.0
6	0.225	0.0
7	0.0	0.642
8	0.0	0.173
9	0.0	-0.030
10	0.0	-0.157
11	0.0	0.669
12	0.0	0.533

Substantially more method variance is present in the objective measures of effort and performance (36%) than in the cognitive determinations of these variables (5%). The obtained correlations of the Model with cognitive effort and performance relative to the amount of method bias present in the dependent measures reveal that the relationship between the former variables cannot be attributed solely to method bias.

Furthermore, as is shown in Table 13, the correlations of both cognitive effort and performance with objectively defined E x I x V are larger than those obtained for the preceding factor with objective effort and performance.

Table 13. Correlation matrix of cognitive and objective determinations of the variables effort, performance, and E x I x V.

		Effort		Performance	
		Cog.	Obj.	Cog.	Obj.
E x I x V	Cognitive	.2367	.1315	.2807	.1420
	Objective[1]	.1595	-.1110	.1066	-.0713

[1]The variable E x I x V objective is the design coding of the ANOVA factor E x I x V.

Thus, even when the objective dependent measures enjoy a method in common with the Model, the cognitive measures of effort and performance are still predicted better. In sum, the results reported in Tables 12 and 13 lend strong support to the conclusion that the Model's superior prediction of cognitive rather than objective effort and performance is not simply an artifact of differential method bias.

Hypothesis 2

The reader will recall that the hypothesis that the Model better predicts effort than performance was based on the fact that the theory is intended to explain motivation. Effort is regarded as a more direct measure of motivation than is performance, since the latter is also moderated by ability and role perceptions (Porter and Lawler, 1968).

The failure to confirm this hypothesis for the objective dependent measures has already been explained. The definition of objective effort in the present study was such that its correlation with objective performance was so large that there was almost no unique effort variance to explain. This fact, of course, reflects not on the Model, but rather on the failure to validly define and measure objective effort in this study.

Non-confirmation of the hypothesis for cognitive effort and performance is more difficult to explain. The intercorrelation between these variables was not so large that confirmation of the hypothesis was precluded. Although it is only speculation, in this writer's opinion the lack of reliability of the single-item measure, combined with the inherent ambiguity of the effort notion, resulted in low construct validity for this variable. A more definitive interpretation awaits further refinements in the definition and measurement of cognitive effort.

Hypothesis 3

Although the data generated in this investigation did not offer overwhelming support for valence weighting, the valence weighted model resulted in slightly higher correlations with all four dependent measures. The increase in the amount of cognitive performance variance explained by the weighted model was statistically significant. These findings are consistent with Vroom's Model and cast doubt on the position that valence weighting should be discontinued (Blood, 1971; Sheard, 1971; Wannous, 1971; and Ewen, 1967).

Furthermore, there is reason to believe that valence weighting was less important in the present experiment than might be expected in a less artificial context. Subjects were led to believe they would be performing a very monotonous task for sixty minutes. They were then asked to indicate the valence of either a one or five dollar reward.

This procedure, according to Festinger (1961) can result in an inflated evaluation of the valence of the one dollar relative to the five dollar reward. Insofar as this dissonance effect occurred, the effectiveness of the valence manipulation was reduced, and the increment in explanatory power of the valence weighted model was attenuated.

Hypothesis 4

Contrary to speculation, the product of Vroom's Model and ability, whether the latter was measured objectively or cognitively, did not increase the predictability of either cognitive or objective performance. The failure to confirm this hypothesis probably reflects less on the theory than on the measures of ability employed.

As can be observed in Table 12, the loadings of both the cognitive and objective ability measures on the ability factor were much smaller than the corresponding loadings of any of the other measures on their respective factors. It appears neither measure of ability had adequate construct validity. Consequently, multiplying Vroom's Model by either ability measure simply increased the amount of error in the predictor.

Hypotheses 5 and 5.1

Since several studies designed to test Vroom's Model measured the subjects' perceived effort -> reward linkage rather than expectancy and instrumentality separately, the presumed equivalence of these two approaches was examined. As hypothesized, effort -> reward estimates were not isomorphic with the product of perceived effort -> performance and performance -> reward. Vroom's Model therefore has not been assessed in those purported tests of the Model which failed to explicitly form the product of perceived expectancy and instrumentality (Gavin, 1970; Goodman et al., 1970; Hackman & Porter, 1968; Lawler, 1968, 1966; Lawler & Porter, 1967; and Porter & Lawler, 1968). The findings of these studies may have relevance for expectancy theories in general, but they cannot be offered as either support or disconfirmation of Vroom's propositions.

Given the non-equivalence of the two methods of measuring perceived effort -> reward, the next logical question was: does incorporation in the Model of the value obtained from one method rather than the other result in superior prediction of effort and performance? Hypothesis 5.1, a deduction made from Vroom's Model, predicted that better estimates of effort and performance result when the product of expectancy and instrumentality, rather than perceived effort

-> reward, is utilized in the Model. This hypothesis was confirmed.

Two implications of the above finding should be made explicit. First, the importance of the specific method employed to measure two rationally equivalent constructs is underscored. The particular method used may have significant effects on the outcome of an investigation, especially in a cognitive model which emphasizes individual differences. Second, the present study demonstrates that of the two distinct models (E x I x V and Effort -> Reward x V) reported in the literature, Vroom's Model results in more accurate effort and performance prediction.

Hypotheses 6, 6.1, and 6.2

These hypotheses were based on the proposition that the explanatory power of the cognitive model is enhanced when exclusively cognitive measures are utilized as both independent and dependent variates. The test of the hypothesis that the Model better predicts cognitive than objective effort and performance was not strictly confirmed. The partial F-tests on the increase in Model variance explained when cognitive in addition to objective dependent variates were used did not satisfy conventional criteria of statistical significance. Nevertheless, it is of importance to note that both for effort and performance, the correlations with the cognitive measures were larger than with the objective. Moreover, the reader may recall that the results relevant to Hypothesis 1 allowed the conclusion that the Model does predict cognitive effort and performance, while a similar statement for the objective measures was not supported. A strict interpretation of the data places the writer in the seemingly contradictory position of stating that a correlation which is significantly larger than zero is, at the same time, not significantly greater than a correlation which is not significantly different from zero. The veracity of this conclusion is evident when one compares the null hypotheses corresponding to the experimental hypotheses.

In sum, the findings do allow for interpretation. They are suggestive of the superiority of the cognitive model. The real issue now becomes why the cognitive model results in better prediction.

Mendel (1971) suggested that it is misleading to indicate that expectancies predict objective performance. Actually expectancies predict cognitive performance which, due to effective feedback systems in most situations, highly corresponds to objective performance. Let us examine the implications of the findings of the present study in light of this position.

Subjects were not given any feedback regarding their performance during the problem-solving sessions. They were not told the number of equation-pairs they had solved correctly, nor were they given any indication of normative performance from which they might tacitly estimate their relative standing. This fact, in conjunction with the rather unusual task the subjects were given, defined an uncommonly ambiguous performance situation. Consequently, subjects' appraisals of their own performance had to be made in a situation relatively devoid of the customary external cues. The non-significant correlation obtained between cognitive and objective performance ($r=.21$) supports this contention.

In contrast to earlier research, the present investigation defined an environment in which substantial discrepancies existed between cognitive and objective performance. It thus provided an unusually good opportunity to address the question of which dependent measure the Model really predicts. The confirmation of the Model for cognitive, but not for objective performance strongly supports the position that expectancy models predict an internal estimate of performance. Previous successful predictors of objective performance were very likely caused by the correspondence of objective performance to its cognitive counterpart.

Although, as predicted, the product of the Model variables and cognitively, rather than objectively derived ability measures increased the correlation with cognitive effort and performance, again the difference was not significant. This finding does not merit elaboration in view of the lack of construct validity for either measure of ability. Further investigation is necessary in order to discover which determination of ability more improves the Model's predictive power.

Expectancies Cause Performance

While not addressed in the form of a specific hypothesis, the experimental paradigm employed in the present investigation affords conclusions regarding the causal relationships between expectancies on the one hand and effort and performance on the other. Manipulation of expectancy, instrumentality, and valence resulted in subsequent changes in cognitive effort and performance. The minimal amount of feedback to subjects regarding their effort and performance reduced the likelihood that these variables were in turn affecting adjustments in the Model variables. The stability of the subjects' reported expectancies from pre- to post-measures gives support to the preceding contention. Hence, an assumption implicit in all prior research on expectancy models is herein experimentally validated; expectancies cause performance.[11]

Psychometric Limitations of Expectancy Model Evaluation

A few general comments are warranted regarding the statistical analysis used to determine the validity of the Model. Because Vroom postulates that it is an interaction of several variables that determines performance, the appropriate test of the Model must assess the degree to which the hypothesized interaction makes an independent and significant contribution to the explanation of performance variance beyond that of the additive (main) effects of the component variables (Darlington, 1968). Merely demonstrating a significant relationship between performance and the product of E x I x V does not represent confirmation of the Model. Convincing evidence for the preceding interaction is obtained when, with all main effects and interactions included in the regression equation, the partial F-test on the hypothesized interaction is statistically significant. When this occurs, as it did in the case of cognitive performance, the interaction is accounting for variance which is not explained by any

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[11]The author wishes to acknowledge the contribution of Leroy Wolins for defining the problem and its ramifications for an evaluation of Vroom's Model.

of the remaining additive or multiplicative combinations of the Model variables.

A very difficult interpretative problem exists however, when significance for the predicted interaction is not obtained. In this event, though no support for the Model is provided, the evidence cannot be forthwith regarded as disproof of the theory.

The problem resides in the psychometric limitations of the cognitive measures.[12] There exist three sources of variance which can potentially contribute to an individual's obtained score on each measure: a) his true score on that construct, b) a scale factor, and c) error. The error does not constitute a major difficulty given the validity of the assumption that error is randomly and independently distributed. However, the scale factor is a property of the instrument itself. It contributes systematic bias to our measures; its magnitude is typically unknown. Consequently, when products of the cognitive variables are formed, the scale factors also receive non-zero weights in the expression defining the combined variables. Thus, when the Model fails to operate as specified, the problem may be that the interaction term has

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[12]The writer does not intend to discount the cross-lagged and dynamic correlational evidence of this causal relationship provided by Lawler (1968).

not been correctly operationalized, rather than that the theory is invalid.

Although the general problem is not limited to the present theory, it is particularly salient here for two reasons. First, the variables which must be measured are cognitive. This fact severely limits the variety of measurement strategies one might employ to tap the constructs. In practice, some type of paper and pencil attitude questionnaire is invariably used. To the extent scale factors have a significant influence on observed scores whenever questionnaires are administered, the problem is especially difficult to circumvent. Second, the theory hypothesizes that it is a three-way interaction that explains performance. Consequently, the number of potential sources for contamination of the interaction is larger relative to a theory which specifies fewer variables or less complex interrelationships as performance determinants. This differential influence of scale factors when measuring the cognitive variables may indeed explain the varied success Vroom's Model has enjoyed in prior research, as well as the lack of progress in refinement of the theory during the past eight years.

The above problem can, in one sense, be interpreted as a general criticism of Vroom's Model. Empirical verifiability is a major criterion of a good theory (Underwood, 1957). Yet, to the extent that the influence of scale factors in our cognitive measures escapes both quantification and control, the theory is not strictly testable.

In defense of formulations such as Vroom's, it can be argued that the complexity of the behavior for which an explanation is sought might reasonably demand a complex theoretical model, i.e., the actual relationships among the behavioral determinants may be complex. We must not dogmatically avoid researching behavior, or a theory which seeks its explanation simply because our measurement technology at a particular point in time does not permit unambiguous research conclusions. Undoubtedly, much can be learned from imperfect tests of a theory's validity, while at the same time providing impetus for the development of more sophisticated evaluative techniques.

The reality of the present research bespeaks this writer's position relative to the above issue. More important however are the implications of this position in conjunction with the recognition of the measurement problem previously discussed for the interpretation of the results obtained in the present investigation. The reader may have noticed that with regard to several hypotheses, results which approximated, but did not reach conventional levels of statistical significance, were interpreted nevertheless as evidence supporting the related hypotheses. This support is justified on several grounds. First, in view of the scale factor problem, the partial F-tests employed represent extremely conservative tests of the hypotheses. Second, in those instances where non-significant partial F-tests were regarded as support for an hypothesis, the actual probability of obtaining an F of that magnitude on the basis of chance alone was extremely small. Third, frequently the hypotheses were evaluated with respect to several different dependent measures, all of which revealed data consistent with the conclusions drawn. In short, our confidence in a conclusion is greater when it is based on several tests, each of which suggests an unlikely result on the basis of chance alone. This is especially so when we consider that the probability of the simultaneous occurrence of several unlikely events (due to chance) is much lower than that of each individual event. Finally, throughout the potential efficacy of the Model was undermined insofar as outcomes other than the cash reward were motivating task performance, but for the sake of experimental simplicity, were not considered in the present study.

CONCLUSIONS AND IMPLICATIONS

Conclusions relevant to three major issues concerning Vroom's Model were reached in the present study. Most important is the finding that the three-way interaction of expectancy, instrumentality, and valence specified by the Model has some validity as a description of the motivational antecedents of performance. Next, the Model actually explains cognitive performance, not objective performance as heretofore advertised. Finally, the assumption that expectancies cause performance was validated.

Several secondary issues were also elucidated. It is apparent that effort -> reward expectancies are not equivalent to the product of expectancy and instrumentality. Moreover, the Model has considerably less explanatory power when effort -> reward expectancies are employed. As prescribed by the Model, valence weighting does enhance the ability of the theory to explain performance. Last, with reference to the inadequate measurement of ability, no information was obtained regarding the advisability of incorporating ability, whether measured cognitively or objectively, into the Model.

The pragmatic implications of these findings do not require extensive elaboration. At the very least, performance motivation may be understood in terms of the interaction of those variables specified by the Model. The evidence for a causal relationship between the Model variables and performance offers the possibility of substantial control over the latter. In addition, the suggestion that the Model predicts cognitive rather than objective performance underscores the importance as well as the manipulative potential of variations in the performance feedback system.

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APPENDIX A

EQUATION BOOKLET

1) 7X + 7 + 2 =
=
5X - 2 - 7 =

2) 4X + 8 - 2 =
=
7X - 8 + 0 =

3) 7X + 0 + 7 =
=
1X - 3 - 5 =

4) 6X - 0 - 5 =
=
7X - 6 + 0 =

5) 3X - 7 + 2 =
=
9X - 5 + 7 =

6) 6X + 5 - 9 =
=
3X - 3 - 9 =

7) 9X + 4 - 5 =
=
9X - 5 + 8 =

8) 4X - 6 + 3 =
=
6X + 6 - 5 =

9) 4X + 3 - 2 =
=
5X - 2 + 6 =

10) 6X + 6 + 5 =
=
1X + 0 - 2 =

11) 2X - 9 - 0 =
=
9X - 0 + 7 =

12) 3X - 6 + 2 =
=
3X - 0 - 0 =

13) 1X - 5 - 3 =
=
9X + 7 - 4 =

14) 5X - 5 - 5 =
=
6X + 7 - 7 =

15) 4X + 5 + 9 =
=
6X + 7 - 4 =

16) 1X - 1 - 0 =
=
4X - 3 + 7 =

17) 4X - 1 + 9 =
=
2X + 2 + 9 =

18) 7X + 0 + 6 =
=
5X + 7 - 1 =

19) 2X - 2 + 5 =
=
8X - 3 - 2 =

20) 8X + 8 + 6 =
=
4X + 6 - 2 =

21) 7X - 0 + 4 =
=
9X - 0 - 4 =

22) 3X + 6 - 3 =
=
8X - 8 - 8 =

23) $5X - 5 + 3 =$; $5X - 7 - 0 =$; $=$

24) $8X + 4 + 7 =$; $4X + 1 + 9 =$; $=$

25) $1X - 4 - 5 =$; $3X - 2 + 0 =$; $=$

26) $7X + 7 + 2 =$; $5X + 2 + 8 =$; $=$

27) $1X - 0 - 9 =$; $9X - 7 + 1 =$; $=$

28) $1X + 8 + 6 =$; $9X - 0 + 6 =$; $=$

29) $9X - 7 + 6 =$; $3X - 5 - 5 =$; $=$

30) $2X - 2 - 6 =$; $4X + 5 - 4 =$; $=$

1) 8X - 0 + 4 =
8X + 8 + 8 =
=

2) 2X - 0 + 2 =
9X + 6 + 1 =
=

3) 9X - 6 - 2 =
5X - 7 - 8 =
=

4) 3X - 7 + 1 =
9X + 3 - 5 =
=

5) 3X - 0 + 0 =
8X + 4 + 8 =
=

6) 3X + 2 - 9 =
7X - 8 + 4 =
=

7) 3X - 3 + 9 =
6X + 2 - 3 =
=

8) 7X + 3 + 9 =
9X + 3 + 3 =
=

9) 5X - 2 - 6 =
8X - 8 - 2 =
=

10) 5X - 9 + 7 =
6X - 1 + 4 =
=

11) 6X - 1 - 0 =
1X - 6 + 2 =
=

12) 3X - 4 + 3 =
3X - 9 - 9 =
=

13) 8X - 8 - 9 =
4X - 9 + 5 =
=

14) 4X - 6 - 2 =
6X - 5 + 2 =
=

15) 4X - 9 - 5 =
8X + 9 - 1 =
=

16) 1X + 7 - 8 =
8X + 2 - 1 =
=

17) 1X - 8 - 8 =
9X + 8 - 9 =
=

18) 9X + 8 - 3 =
4X - 2 + 8 =
=

19) $4X + 2 + 8 =$
$8X - 3 + 6$ =

20) $4X - 6 + 8 =$
$7X - 8 + 8 =$ =

21) $5X + 0 + 6 =$
$7X - 6 - 3 =$ =

22) $8X + 4 - 3 =$
$3X - 4 - 5 =$ =

23) $6X - 8 + 6 =$
$4X + 4 - 2 =$ =

24) $5X - 4 - 9 =$
$7X + 3 - 0 =$ =

25) $3X + 1 - 5 =$
$2X - 7 - 3 =$ =

26) $7X - 1 - 2 =$
$7X + 7 - 8 =$ =

27) $9X + 3 - 6 =$
$8X + 4 + 1 =$ =

28) $5X + 6 - 6 =$
$8X - 4 - 7 =$ =

29) $6X + 9 - 6 =$
$2X - 2 + 7 =$ =

30) $6X - 1 - 2 =$
$8X - 5 - 2 =$ =

31) $1X + 8 + 8 =$
$1X + 8 - 0 =$ =

32) $2X - 5 - 5 =$
$1X + 5 + 6 =$ =

33) $1X - 3 - 0 =$
$4X + 6 + 4 =$ =

34) $5X + 0 - 6 =$
$3X - 0 + 7 =$ =

35) $2X - 1 + 5 =$
$7X - 4 - 7 =$ =

36) $3X - 8 + 3 =$
$9X - 2 - 6 =$ =

37) $5X - 5 + 3 =$ $=$
$2X - 9 + 3 =$

38) $4X - 9 + 1 =$ $=$
$8X - 8 + 1 =$

39) $4X - 9 - 1 =$ $=$
$2X - 8 + 2 =$

40) $5X - 0 - 4 =$ $=$
$4X - 9 - 5 =$

41) $6X - 3 + 9 =$ $=$
$8X + 7 + 1 =$

42) $5X - 3 - 2 =$ $=$
$8X - 8 - 2 =$

43) $9X + 9 + 4 =$ $=$
$2X - 8 - 0 =$

44) $7X + 7 - 8 =$ $=$
$3X + 6 + 8 =$

45) $3X + 1 - 0 =$ $=$
$4X + 5 - 3 =$

46) $1X - 4 + 4 =$ $=$
$9X - 5 + 8 =$

47) $9X - 1 + 6 =$ $=$
$6X - 4 - 6 =$

48) $9X - 4 - 9 =$ $=$
$4X + 5 - 9 =$

49) $1X + 2 - 3 =$ $=$
$7X + 5 + 2 =$

50) $6X - 2 - 4 =$ $=$
$7X + 3 + 1 =$

51) $3X + 0 + 3 =$ $=$
$5X - 2 - 2 =$

52) $2X - 1 - 7 =$ $=$
$4X + 9 - 0 =$

53) $8X - 6 - 6 =$ $=$
$4X - 2 - 1 =$

54) $4X - 5 + 6 =$ $=$
$5X + 0 - 8 =$

55) $3X + 8 + 3 =$

$=$

$9X + 4 - 9 =$

56) $6X + 5 - 3 =$

$=$

$2X + 6 - 9 =$

57) $1X - 0 + 6 =$

$=$

$1X + 5 + 1 =$

58) $8X + 6 + 1 =$

$=$

$4X + 9 + 4 =$

59) $4X - 4 + 6 =$

$=$

$7X + 3 - 8 =$

60) $7X + 6 + 8 =$

$=$

$9X + 1 + 8 =$

61) $1X - 6 + 3 =$

$=$

$2X - 8 - 4 =$

62) $2X - 7 + 9 =$

$=$

$5X + 4 + 4 =$

63) $7X + 6 + 5 =$

$=$

$9X + 0 - 6 =$

64) $5X - 3 - 6 =$

$=$

$8X + 9 - 4 =$

65) $1X + 0 - 9 =$

$=$

$2X - 5 - 1 =$

66) $6X + 3 + 6 =$

$=$

$4X - 8 + 9 =$

67) $2X - 3 + 9 =$

$=$

$2X - 5 + 6 =$

68) $6X + 8 - 7 =$

$=$

$5X + 4 + 6 =$

69) $1X - 8 - 6 =$

$=$

$8X + 9 + 0 =$

70) $2X - 9 + 8 =$

$=$

$9X + 7 - 0 =$

71) $2X - 9 + 8 =$

$=$

$6X + 8 - 7 =$

72) $5X + 4 + 6 =$

$=$

$4X - 8 + 9 =$

73) 6X + 3 + 6 =
1X + 0 - 9 +
=

74) 8X + 6 + 1 =
1X + 0 - 8 =
=

75) 8X + 9 - 4 =
9X + 0 - 6 =
=

76) 4X + 9 + 4 =
1X + 5 + 1 =
=

77) 2X - 5 - 1 =
7X + 3 + 1 =
=

78) 7X + 6 + 8 =
4X - 4 + 6 =
=

79) 2X - 3 + 9 =
2X - 1 - 7 =
=

80) 9X + 1 + 8 =
7X + 3 - 8 =
=

81) 2X - 5 + 6 =
4X + 9 - 0 =
=

82) 2X - 7 + 9 =
1X - 6 + 3 =
=

83) 1X - 8 - 6 =
4X - 5 + 6 =
=

84) 5X + 4 + 8 =
2X - 8 - 4 =
=

85) 8X + 9 + 0 =
5X + 0 - 8 =
=

86) 5X - 3 - 6 =
7X + 6 + 5 =
=

87) 6X + 5 - 3 =
3X + 8 + 3 =
=

88) 8X + 9 - 4 =
9X + 0 - 6 =
=

89) 2X + 6 - 9 =
9X + 4 - 9 =
=

90) 9X - 3 + 4 =
5X - 4 - 3 =
=

APPENDIX B

ANSWER SHEET

ISU 104

NAME ____________________ DATE __________ AGE _____ SEX _____ DATE OF BIRTH __________

LAST FIRST MIDDLE M OR F

SCHOOL ________________ CITY ________________ GRADE OR CLASS ________ MAJOR ________________

NAME OF TEST OR QUESTIONNAIRE: ____________________

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is appropriate, blacken the corresponding space on this sheet with a No. 2 pencil. Make your mark as long as the pair of lines, and completely fill the area between the pair of lines. If you change your mind, erase your first mark COMPLETELY. Please make no stray marks; they may be scored erroneously.

IDENTIFICATION NUMBER

103

1	0	1	2	3	4	5	6	7	8	9
0	0	1	2	3	4	5	6	7	8	9
3	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

1	0	1	2	3	4	5	6	7	8	9		2	0	1	2	3	4	5	6	7	8	9
3	0	1	2	3	4	5	6	7	8	9		4	0	1	2	3	4	5	6	7	8	9
5	0	1	2	3	4	5	6	7	8	9		6	0	1	2	3	4	5	6	7	8	9
7	0	1	2	3	4	5	6	7	8	9		8	0	1	2	3	4	5	6	7	8	9
9	0	1	2	3	4	5	6	7	8	9		10	0	1	2	3	4	5	6	7	8	9
11	0	1	2	3	4	5	6	7	8	9		12	0	1	2	3	4	5	6	7	8	9
13	0	1	2	3	4	5	6	7	8	9		14	0	1	2	3	4	5	6	7	8	9
15	0	1	2	3	4	5	6	7	8	9		16	0	1	2	3	4	5	6	7	8	9
17	0	1	2	3	4	5	6	7	8	9		18	0	1	2	3	4	5	6	7	8	9
19	0	1	2	3	4	5	6	7	8	9		20	0	1	2	3	4	5	6	7	8	9
21	0	1	2	3	4	5	6	7	8	9		22	0	1	2	3	4	5	6	7	8	9
23	0	1	2	3	4	5	6	7	8	9		24	0	1	2	3	4	5	6	7	8	9
25	0	1	2	3	4	5	6	7	8	9		26	0	1	2	3	4	5	6	7	8	9
27	0	1	2	3	4	5	6	7	8	9		28	0	1	2	3	4	5	6	7	8	9
29	0	1	2	3	4	5	6	7	8	9		30	0	1	2	3	4	5	6	7	8	9
31	0	1	2	3	4	5	6	7	8	9		32	0	1	2	3	4	5	6	7	8	9
33	0	1	2	3	4	5	6	7	8	9		34	0	1	2	3	4	5	6	7	8	9
35	0	1	2	3	4	5	6	7	8	9		36	0	1	2	3	4	5	6	7	8	9
37	0	1	2	3	4	5	6	7	8	9		38	0	1	2	3	4	5	6	7	8	9
39	0	1	2	3	4	5	6	7	8	9		40	0	1	2	3	4	5	6	7	8	9
41	0	1	2	3	4	5	6	7	8	9		42	0	1	2	3	4	5	6	7	8	9
43	0	1	2	3	4	5	6	7	8	9		44	0	1	2	3	4	5	6	7	8	9
45	0	1	2	3	4	5	6	7	8	9		46	0	1	2	3	4	5	6	7	8	9
47	0	1	2	3	4	5	6	7	8	9		48	0	1	2	3	4	5	6	7	8	9
49	0	1	2	3	4	5	6	7	8	9		50	0	1	2	3	4	5	6	7	8	9
51	0	1	2	3	4	5	6	7	8	9		52	0	1	2	3	4	5	6	7	8	9
53	0	1	2	3	4	5	6	7	8	9		54	0	1	2	3	4	5	6	7	8	9
55	0	1	2	3	4	5	6	7	8	9		56	0	1	2	3	4	5	6	7	8	9
57	0	1	2	3	4	5	6	7	8	9		58	0	1	2	3	4	5	6	7	8	9
59	0	1	2	3	4	5	6	7	8	9		60	0	1	2	3	4	5	6	7	8	9
61	0	1	2	3	4	5	6	7	8	9		62	0	1	2	3	4	5	6	7	8	9
63	0	1	2	3	4	5	6	7	8	9		64	0	1	2	3	4	5	6	7	8	9
65	0	1	2	3	4	5	6	7	8	9		66	0	1	2	3	4	5	6	7	8	9
67	0	1	2	3	4	5	6	7	8	9		68	0	1	2	3	4	5	6	7	8	9
69	0	1	2	3	4	5	6	7	8	9		70	0	1	2	3	4	5	6	7	8	9

APPENDIX C

INPUT CARDS

In an equation-pair, if the upper answer is larger or equal to the lower, subtract the lower from the upper. If the lower answer is larger, add the two answers together.

0 of the inputs below are INCORRECT

0) 3	1) 2
2) 1	3) 7
4) 6	5) 8
6) 4	7) 0
8) 2	9) 5

In an equation-pair, if the upper answer is larger or equal to the lower, subtract the lower from the upper. If the lower answer is larger, add the two answers together.

4 of the inputs below are INCORRECT

0) 3	1) 2
2) 1	3) 7
4) 6	5) 8
6) 4	7) 0
8) 2	9) 5

APPENDIX D

PRELIMINARY QUESTIONNAIRE

PRELIMINARY QUESTIONNAIRE

Please answer each of the questions below thoughtfully and carefully. If any questions are the least bit unclear, ask the experimenter for clarification before attempting an answer.

1. I believe that the total number of equation-pairs I will be able to solve correctly during the next hour is ? % determined by the amount of effort I personally put forth. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
not at all determined					partially determined					entirely determined

2. Assuming our team does make the cutoff and therefore gets to reach into the poker chip bag, I believe our chances of pulling out a cash winning chip are ? out of 100. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
no chance at all					possible					absolutely certain

3. I believe the probability that I will actually receive the cash prize is ? % determined by the amount of effort I put forth during the next hour. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
not at all determined					partially determined					entirely determined

4. On the scale below, place an "x" at a point which best reflects the degree to which you value the cash prize offered in this experiment.

1	10	20	30	40	50	60	70	80	90	99
not at all valued					moderately valued					very highly valued

5. I believe my ability to solve equation-pairs is greater than ___?___ % of the psychology students who participate in this experiment. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
much less					average ability					much greater

---

6. Consider the total amount of effort you could possibly put into solving the equation-pairs. What per cent of this maximum effort do you expect you will actually put forth during the next hour? On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
least effort possible					moderate effort					most effort possible

---

7. Do you intend to try for any particular goal or score? Yes_____ No_____

---

8. If you checked "yes" in response to question 7, what is your goal? ______
____
____.

APPENDIX E

POST QUESTIONNAIRE

FOLLOW-UP QUESTIONNAIRE

1. I believe the total number of equation-pairs I have been able to solve correctly thus far has been _?_ % determined by the amount of effort I personally have put forth. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
not at all determined					partially determined					entirely determined

2. Assuming our team has performed well enough to make the cutoff and therefore gets to reach into the poker chip bag, I believe our chances of pulling out a cash winning chip are _?_ out of 100. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
no chance at all					possible					absolutely certain

3. I believe the probability that I will actually receive the cash prize is _?_ % determined by the amount of effort I put forth during the equation solving sessions. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
not at all determined					partially determined					entirely determined

4. On the scale below, place an "x" at a point which best reflects the degree to which you value the cash prize offered in this experiment.

1	10	20	30	40	50	60	70	80	90	99
not at all valued					moderately valued					very highly valued

5. Consider the total amount of effort you could possibly have put into solving the equation-pairs during just the last session. What per cent of this maximum effort would you say you actually have put forth? On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
least effort possible					moderate effort					most effort possible

---

6. I believe my ability to solve equation-pairs is greater than ? % of the psychology students who participate in this experiment. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
much less					average ability					much greater

---

7. Relative to the second-session performance of other participants, I believe the number of equation-pairs I solved correctly during the last session places me at the ? percentile. On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
many fewer					average number					many more

---

8. If it was extremely important to you to have solved as many equation-pairs during the last session as was humanly possible, how many more equation-pairs do you think you could have solved? On the scale below, place an "x" at a point on the scale which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
no more					half again as many					twice as many

9. On the scale below, place an "x" at a point which best reflects your feeling about the number of equation-pairs you solved correctly during the last session.

1	10	20	30	40	50	60	70	80	90	99
poor performance					average performance					excellent performance

---

10. Have you been trying to attain any particular goal or score? Yes____ No____.

---

11. If you checked "yes" in response to question 10, what is your goal? ______

____

____.

---

12. If your team does not make the cutoff, will it embarrass you? Yes____ No____.

---

13. Relative to yourself, how well do you think your partner has performed? On the scale below, place an "x" at a point which best reflects your feeling.

1	10	20	30	40	50	60	70	80	90	99
much poorer					about the same					much better
