THE EFFECT OF TASK UNCERTAINTY ON PERFORMANCE IN A GOAL SETTING ENVIRONMENT

A Dissertation

Presented to

the Faculty of the College of Business Administration

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

James B. Stinson

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Bell & Howell Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

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APPROVED:

Janet A. Meade, Associate Professor
of Accountancy and Taxation

Arthur J. Francia, Professor
of Accountancy and Taxation

Wynne Chin, Associate Professor
of Decision and Information Sciences

James Phillips, Professor
of Management

Richard Scamell, Professor
of Decision and Information Sciences

Jerry Strawser, Interim Dean
College of Business Administration

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Reviews of goal setting research consistently have documented broad support for the basic proposition that specific, difficult goals lead to higher performance than easy, general or do-best goals (Latham and Yukl 1975b; Locke, Saari, Shaw, and Latham 1981; Earley, Connolly and Ekegren 1989; Locke and Latham 1990). Examples include Stedry and Kay (1966) and Locke (1967b) in psychology; Ivancevich (1977) and Ivancevich and McMahon (1982) in management; and Otley (1978), Chow (1983), and Fatseas and Hirst (1992) in accounting.

However, Locke and Latham (1990) offer a variety of possible design and measurement shortcomings as reasons for reported deviations from anticipated results. Others, most notably Hirst (1987), suggest that the theory may still be incomplete. In particular, Hirst identified task uncertainty as a condition which, within a goal-setting context, might affect task performance.

This study employed a laboratory experiment to test Hirst's proposition. A fully computerized word search task was used to manipulate the two primary elements of task uncertainty, task repetitiveness and task openness, in combination with goal difficulty. Task performance was the dependent variable, measured in points for words found. Subjects earned cash by accumulating points and for reaching a production goal.

The findings supported the proposition that task uncertainty affects task performance. The mechanisms of ability and task strategy, especially an appropriate strategy, were found to be important factors. Subjects in the low task uncertainty treatment group acquired greater task knowledge and selected appropriate strategies more often than the subjects in the high task uncertainty treatment group. However, the results did not support the hypothesis that an interaction between task uncertainty and goal

setting affects performance. Although goal commitment significantly affected strategy choice and intensity of effort, neither goal commitment nor intensity of effort were found to directly affect performance. Goal commitment did not significantly affect duration of effort, and duration of effort had only a moderate effect on task performance. Overall the results of this study provided evidence that task uncertainty affects performance and that individuals can respond to task uncertainty by working smarter rather than harder.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

The purpose of this study is to examine the effect of task uncertainty on performance in the presence of goal setting. The role of budget data in the evaluation of performance and the determination of rewards has received substantial and extensive attention in the accounting literature (Kren and Liao 1988, Imoisili 1989). At the organizational level, profit planning in the form of financial budgets and longer range strategy decisions has long been an important feature of the business landscape. At lower levels, departments and individuals frequently are asked to perform, and be evaluated, according to goals set in the budgetary process.

Background

After decades of investigation by researchers in psychology, management and accounting, goal setting has become established as one of the most consistent and successful models of work performance (Earley, Connolly and Ekegren 1989). Tests of the goal setting model have been numerous and varied. Taken as a whole, the literature has demonstrated that specific and difficult goals, if accepted, lead to higher levels of performance than easy, general or "do your best" goals. Reviews of the goal setting research consistently have documented broad support for that basic proposition (Latham and Yukl 1975b; Locke, Saari, Shaw, and Latham 1981; Locke and Latham 1990).

Not only have the results been consistent, they also have extended across a broad spectrum of settings, participants, and tasks. Researchers in psychology, management science, and managerial accounting have conducted a wide range of studies linking goals with improved task performance. Examples include Stedry and Kay (1966) and Locke (1967b) in psychology; Ivancevich (1977) and Ivancevich and McMahon (1982) in management; and Otley (1978), Chow (1983), and Fatseas and Hirst (1992) in accounting. Summarizing goal setting research, Locke and Latham (1990) report that 91 percent of 393 studies using 88 different tasks provided support (292 studies) or contingent support (66 studies) for goal setting theory as of that date.

Nevertheless, there appear to be boundaries beyond which goal not have the expected positive effect on performance as evidenced by the 35 studies (9 percent) listed as unsuccessful by Locke and Latham (1990). In some circumstances goal setting may even be detrimental. Huber (1985), for example, found that individuals performing a heuristic computer maze task were *less* effective if they had a specific, difficult rather than a general goal for how quickly to find their way out of a the maze. For single trial tasks, Weed and Mitchell (1980) also failed to find performance differences attributable to goal setting. Their results suggest that goal setting effects might not accrue for one-time efforts such as special projects, custom production, research, etc.

A number of other exceptions to the results predicted by goal setting theory also have been found. Although the apparent contradictions in no way invalidate theory, they do suggest that further research may reveal special situations for which the results of traditional goal setting might not be realized. This study investigates one of those situations.

Motivation for the Study

The purpose of this study was to investigate a condition, task uncertainty, for which goal setting may not yield the results suggested by theory. The theoretical model to tested in this study was proposed in the accounting literature by Hirst (1987), who suggested that the level of task uncertainty may interact with goal setting to affect the outcome of task performance. Elsewhere in the accounting literature, this issue had been investigated only rarely in field studies (e.g., Hirst 1983, Kren 1992), included infrequently in laboratory studies (e.g.,Young 1985, Bamber and Snowball 1988), and discussed moderately in theoretical papers (e.g., Hirst 1981, Hayes and Cron 1988, Bownell and Dunk 1991). Similarly, few studies in psychology and management have explicitly incorporated consideration of task uncertainty (e.g., Victor and Blackburn 1987, Weingart 1992). Notable exceptions have been the attempts to reconcile the conflicting results of the Hopwood (1972) and Otley (1978) investigations of the effect of management evaluation styles on subordinate performance by appealing to task uncertainty (Brownell 1982, Brownell and Hirst 1987, Dunk 1989, Abernathy and Stoelwinder 1991, Kaplan and Mackey 1992).

In summary, there is no evidence of a direct test of the effect of task uncertainty, as defined by Hirst, on performance in the accounting, psychology, or management literatures. Accordingly, the primary research question addressed by this study was whether task uncertainty and goal setting interact to affect task performance as hypothesized by Hirst. In addition, but with no less importance, the specific mechanisms by which task uncertainty and goal setting operate on performance were investigated.

Overview of the Study

This study utilized a laboratory experiment to test Hirst's theoretical proposition. The experimental task was designed to be performed entirely on a personal computer. The selection of the design was guided by a combination of factors. First, the task selected allowed for strong manipulation and control of the variables of interest. As will be discussed in more detail later, Hirst defined task uncertainty, not in the usual terms of probability, but instead in terms of the characteristics of the task. The computer provided an opportunity to manipulate those characteristics while simultaneously controlling for elements outside the theory.

Second, the data produced were measured and recorded entirely by the computer, with precision, and without involvement by the experimenter. As will be described in more detail later, subjects received a disk upon arrival at the laboratory, proceeded to a separate room with a computer to perform the experimental task, and returned the disk when they were finished. The only contact with the experimenter was at check-in and check-out.

Finally, using the computer made the results of the study more contemporaneous to an environment increasingly dominated by automation. Previous studies have almost exclusively utilized more traditional manually performed tasks.

Following the lead of Hirst, the study hypothesized that task performance would be affected by task uncertainty, and in particular by the interaction between task uncertainty and goal setting. Beyond these basic propositions, the study also investigated the mechanisms believed to be activated by task uncertainty.

The results provide evidence that uncertainty affects task performance. Ability, strategy choice, and whether or not the strategy choices were appropriate for individual subjects all were found to be important mechanisms by which task uncertainty operates. However, the findings do not support the hypothesis that task uncertainty and goal setting interact to affect task performance. Furthermore, neither effort nor goal difficulty were found to be a major performance differentiation factor in this particular investigation.

Organization of the Paper

A summary review of three foundational theoretical frameworks precedes a description of Hirst's theoretical proposition. Those frameworks are goal setting theory, expectancy theory, and achievement motivation theory.

Next, the experiment designed to test Hirst's theory in the laboratory is described, followed by an analysis of the data and a discussion of the results. The paper concludes with some preliminary thoughts on directions for future research.

Chapter II

THEORETICAL FRAMEWORKS

Locke and Latham (1990), two key architects of the goal setting framework, provided an exhaustive and thorough review of the development of goal setting theory over the last several decades. Hirst's thinking on the effects of task uncertainty on performance draws from goal setting theory. In addition, traces of two other complementary (and sometimes competing) theoretical paradigms can be detected beneath Hirst's work: Vroom's expectancy theory and Atkinson's achievement motivation theory. Although each can be viewed as posing an alternative challenging notion of how motivated performance occurs, a more appropriate view for this study is to view them as complementary and overlapping. A brief summary of each theoretical framework follows.

Goal Setting Theory

The basic premise of goal setting theory is that goals are immediate regulators of human action on work tasks. Goal setting theory postulates that (1) challenging goals result in a higher level of output than easy goals, (2) specific goals produce higher performance than no goals or "do your best" goals, and (3) behavioral intentions regulate choice behavior (Locke and Latham, 1990; Chowdhury, 1993). Locke, et al. (1981), followed by Locke and Latham (1990), emphasize that the products of goal setting theory are contingent upon the individual being committed to the goal.

Clearly defined, challenging goals also are believed to result in the formation of relevant task strategies necessary to attain the targeted level of performance. Underlying these premises are the assumptions that the individual has the motivation, the requisite task ability, and the resources necessary to perform the task and put forth the effort necessary to accomplish it. Knowledge of task results in the form of feedback serves as a regulator of effort and strategy during task performance.

It is important to distinguish between goal difficulty and task difficulty. A task is a piece of work to be accomplished. A goal is the object or aim of an action. Goal difficulty specifies a certain level of task proficiency measured against a standard, whereas task difficulty refers to the nature of the work to be accomplished (Locke and Latham, 1990, p. 26). For example, composing a symphony would be a more difficult task than composing a letter because it requires more complex and extensive skills, talents and knowledge. Writing five symphonies in a lifetime would be a more difficult goal than writing only one, which also could be expected to require requires more complex and extensive skills, talents and knowledge.

A second goal dimension is intensity, which refers to the scope and integration of the goal setting process, the effort required to form the goal, the place of the goal in the individual's goal hierarchy, the degree to which the individual is committed to the goal, and the importance of the goal. Goal intensity should not be confused with effort intensity, which is the amount of effort the individual expends to complete the task. Most research on goal intensity has focused on goal commitment, although the intensity of the goal setting process has received some investigative attention.

As will be described in more detail later, this study manipulated goal difficulty, while attempting to control for task difficulty and measure goal commitment. Other than through randomized acquisition of subjects and random assignment of treatments, no attempt was made to manipulate or measure the elements of goal intensity.

Goal Difficulty

The first aspect of goal setting theory asserts that there is a positive relationship between goal difficulty and subsequent task performance. A number of empirical findings demonstrate this function, including Campbell and Ilgen (1976); Rockness (1977); Chow (1983); and Locke, Chah, Harrison and Lustgarten (1989) to name a few. In all cases the relationship is linear except when subjects reach the limit of their abilities at very high levels of goal difficulty. Several meta analyses and enumerative studies have been conducted of research designed to test the relationship between goal difficulty and performance (e.g., Chidester and Grigsby 1984; Latham, et al 1981; Mento, Steel, and Karren 1987; Tubbs 1986; Wood, Mento, and Locke 1987). The combined rate of successes and contingent successes quite impressively was above 90 percent.

A second core aspect of goal theory is that specific quantifiable goals, when viewed as challenging but achievable, lead to greater performance than goals which are not specific. Non-specific goals are vague and nonquantified. They are expressed as do your best, work at a moderate pace, work as hard as you can, or not expressed at all. This does not, however, mean that a goal is completely absent. If there is literally no goal at all, subjects would do nothing and the comparison with other goal conditions would be of little or no theoretical interest (Locke and Latham 1990).

To the contrary, no expressed goal actually implies a do-best situation. Despite being nonquantified, do-best in turn implies a high level of motivation because most people will try to do well, especially in laboratory conditions (Orne 1962). In fact, subjects often will establish their own internal quantified goal in order to do their beset. Because it would be relatively trivial to compare the effects of specific, difficult goals with goals implying a moderate to low level of motivation such as work at a moderate pace or work at a slow pace (although such comparisons occasionally have been made), most studies of nonquantified goals compare specific, difficult goals with do-best or implicit do-best goals (no expressed goal). The meta analyses and enumerative reviews of studies comparing difficult goals with easy goals also examined studies comparing specific, difficult goals with do-best goals. Again the combined rate of successes and contingent successes was in excess of 90 percent.

As the collective evidence has demonstrated, the goal difficulty-performance relationship is quite robust. The explanation offered for the goal difficulty effect is that, assuming the goals are accepted, hard goals lead to greater effort intensity and persistence of effort than easy goals. The evidence further suggests that individuals work harder and longer to achieve a difficult goal because the personal satisfaction received is greater than the satisfaction that accrues from achieving an easy goal.

On the other hand, goal theory remains vague as to the range and level of difficulty that are sufficient to affect performance. It does seem clear that the larger the range, the higher the chances of obtaining a significant difference. However, the goal difficulty effect also depends on the level of goal commitment (discussed in the next section). If subjects are committed only to their goals, and stop working when they reach them, then a small range of goal difficulty can produce significant results. Goal difficulty effect also assumes that the individual possesses the ability required to have at least a reasonable chance of achieving the goal. It does not predict significant differences if the goal is practically unattainable. Thus, when attempting to manipulate goal difficulty, the researcher must attempt to present the subjects with a goal that is truly hard but not impossible. Unfortunately, goal theory does not provide much in the way of guidance.

Nevertheless, the theory of goal difficulty has demonstrated what has been described as a "remarkable consistency of results --- as consistency that has held up for a period of many years" (Locke and Latham, 1990, p. 39). The findings to date clearly indicate that the harder the goal the better the performance, given that the individual has the requisite ability and knowledge.

Goal Commitment

It is axiomatic that true commitment to a goal requires that the individual must genuinely try to achieve it. In field settings, noncommitment to organizational goals is a well-known phenomenon which results in a variety of dysfunctional behaviors such as output restriction or resistance to change. Goal commitment, therefore, is of practical as well as theoretical importance.

Although theorists initially attempted to distinguish goal commitment from goal acceptance, such a distinction has not proved to be empirically useful. Goal acceptance refers specifically to the agreement to pursue goals that have been assigned, while goal commitment is a broader term that refers to the pursuit of any goal regardless of the source, whether self-set, participatively set, or assigned. Thus, goal acceptance currently is viewed as a subset of goal commitment. Consequently, quite often the terms are used interchangeably. The generic term goal commitment is used throughout this study even though, as will be described in detail later, experimental performance goals were assigned.

A precondition for discovering factors that affect goal commitment is the ability to measure it. While some have suggested that goal commitment is an accept-reject dichotomous decision, the evidence suggests otherwise. Erez and Zidon (1984) showed that subjects can detect degrees of commitment as a continuous variable and that it can be measured with direct questioning. Subsequently, Hollenbeck, Klein, O'Leary, and Wright (1988) developed a set of four questions that formed a single factor with an alpha value of 0.88. As will be described later, this study utilized that four-item direct measurement of goal commitment.

Numerous empirical studies have shown significant relationships between performance and goal commitment as long as there was sufficient variability in the degree of commitment.[1] These include Earley and Kanfer (1985); Erez (1986); Erez and Arad (1986); Erez, Earley, and Hulin (1985); Hollenbeck, et al (1989); Ivancevich and McMahon (1977); Kernan and Lord (1988); and Latham, Erez, and Locke (1988) to name a few. In summary, both theory and empirical research suggest that goal commitment enhances subsequent task performance.

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[1] Failure to demonstrate the effect of goal commitment on performance most often occurred when the goal was too easily achieved.

There are several identifiable factors underlying the commitment-performance relationship. According to Locke and Latham (1990), the integrating principle behind the efficacy of these factors is that they lead the individual to believe that trying to achieve the goal is important. Also, these factors help reduce or eliminate any conflict that might exist between the goal in question and other goals. From among the several identified factors, those directly relevant to this study are discussed next.

Authority. Most goal setting research has focused on the effects of assigned goals by asking the subjects simply to try for a specific level of task performance. Overwhelmingly, the subjects tried to do what was asked of them by the researcher (Latham and Lee 1986). Studies that measured personal goals after goals were assigned have shown that the two are highly correlated. Oldham (1975) found supervisory legitimacy to be significantly related to the intent to work hard in a laboratory experiment that utilized assigned goals. Thus it seems that people usually, though not always, choose to comply with authority figures.

Legitimate authority exists in both field and laboratory settings (Locke and Latham 1990), which may account for the high degree of generalization of results found between the two settings (Latham and Lee 1986). Most employees accept that supervisors and managers have both the right and the responsibility to direct the activities of subordinates as part of the employment agreement. Evidence suggests that physical presence may enhance the effect of authority. For example, Ronan, Latham, and Kinne (1973) discovered that logging crews were more productive when supervisors remained present after assigning goals. Crews whose supervisors did not remain on the job were less productive.

Trust. Trust in authority is another element that is important for goal commitment. In a study of tire-tread layers in England and the United States, Earley (1986) found that English workers exhibited greater commitment when the rationale for the goal was explained by the union steward than when it was explained by the supervisor. There was no differential between the two sources in the U.S. sample. Earley argued that the English trusted the union leadership more than management. Similarly, Podaskoff and Farh (1989) found that normative performance information had the greatest effect when the source of the information was trusted.

In the laboratory, the experimenter is viewed as the authority figure. An experiment, by its very nature, is a situation in which subjects, who are almost always volunteers, arrive at the laboratory with a reasonable willingness to do as they are instructed. Although in most experimental situations contact with the experimenter is purposely minimized, there is every reason to believe that subjects trust that they will have a reasonable opportunity to do what is expected of them and that they will not be asked to do anything harmful, immoral or illegal.

Competition. Several studies have found that competition improves performance when compared with no competition. Competition can be promoted directly or indirectly. It can be effected in any number of ways --- by telling subjects that their performance is being evaluated, by giving them feedback in relation to group norms, by posting performance scores so that they can compare themselves with each other, and so on. For example, Chung and Vickery (1976) provided feedback on a clerical task in relation to the average performance of other group members; Mithchell, Rothman, and Liden (1985) gave subjects group norms on a labeling task; and Shalley, Oldham, and Porac (1987) told some of their subjects that their performance on a toy-assembly task would be compared with that of others. Mueller (1983) specifically tested the hypothesis that competition can increase performance if it leads to the setting of and/or commitment to high goals. In all cases, the competitive groups performed better than those in the non-competitive treatments.

Competition in this study was manipulated directly. Although subjects were allowed to believe that they were competing with other subjects, the role of the competitor actually was performed by the computer. The competitive element is explained in more detail in the description of the experiment presented later.

Publicity. Several studies suggest that public commitment to goals has a greater effect than private commitment. In a study by Hayes et al. (1985) students answered questions from the graduate record examination after setting goals that were either held in private or announced publicly by the experimenter. The goal levels of the two groups were not significantly different, but the performance of the public goal group was significantly higher than the private goal group.

Hollenbeck et al. (1989) specifically measured the effects of public and private goals on goal commitment as well as subsequent task performance. Subjects in the public goal condition gave their name and goal for a course grade to other subjects within the same treatment as well as to one other significant person. Those in the private condition did not reveal their course grade goals. The results showed a significant difference in goal commitment in the public group relative to the private group, as well as a significant effect of commitment on subsequent performance independent of goal level.

This study did not specifically manipulate goal publicity. In fact, it can be argued that goals were held in private since the entire experiment was performed with a computer. However, results of a computerized task study of budget participation, budget emphasis, and information asymmetry by Radtke and Stinson (1999) suggest that subjects may suspect that information maintained by computer actually is not held in private despite instructions to the contrary. Thus, because the current study was conducted entirely by computer in a setting that at least gave the appearance of connectivity, subjects may or may not have believed that their goals were not revealed. Because publicity was not of particular interest in this study, no manipulation check was performed. The issue of the effect on goal setting and goal commitment of the perceived public availability of private information stored by computer may be worthy of further investigation.

Monetary incentives. An incentive pay scheme often is used to encourage greater effort to meet or exceed a predetermined level of performance. It is known that meaningful incentives/rewards can be powerful motivators of performance (Locke et al 1981). Locke, Feren, McCaleb, Shaw, and Denny (1980), for example, found that individual monetary incentives increased worker performance by a median of 30 percent. Numerous studies have examined the effect of monetary incentives on performance in conjunction with goal setting. Positive effects of contingent pay schemes have been found by Pritchard and Curtis (1973), London and Oldham (1976), Campbell (1984), Schunk (1984), and Huber (1985).

Negative effects also have been discovered. Das (1982), using a hole-drilling task, found that incentives combined with goals and feedback led to no higher performance than goals and feedback alone. Kleinbeck (1986) found that monetary incentives did not add to performance on a complex task compared with goals and feedback alone. Monetary incentives combined with self-monitoring and goals were no more effective than self-monitoring and goals alone in an experiment on student study time by Mercier and LaDouceur (1983). Using a word-finding task similar to the one in this study, Phillips and Freedman (1988) found that goals plus bonuses for goal achievement produced better performance than no goals or bonuses, while goals only did not. However, since the goal only condition was not significantly different from the goal and bonus condition, the effect of the bonus can be considered insignificant.

Awasthi and Pratt (1990) studied the effects of monetary incentives on effort and decision performance using a series of typical accounting decisions as their experimental task. While the monetary rewards induced the subjects to increase their levels of effort and spend more time on the decision problems, it did not increase their overall levels of performance. The extra time spent on task apparently failed to help them apply the decisions rules correctly. Using a letter arrangement decoding task, Fatseas and Hirst (1992) discovered that assigned goals had a dominating effect on performance over medium to high levels of goal difficulty regardless of type of compensation (fixed-pay, piece-rate, or budget-based). Performance-contingent pay (budget-based) pay schemes had an additive effect on performance when the level of the assigned goal was low but a negative effect when the goal was perceived to be impossible. The highest performance resulted from using incentive-based compensation when the budget (assigned goal) was relatively low (80 percent achievable).

In general, the positive effect studies had larger payments to subjects than the negative effect studies, suggesting that the materiality of the incentive payment is crucial.

Further, Mowen et al. (1981) investigated the interaction between goal difficulty and incentive level. They found that an incentive-based scheme that awards a bonus for goal (budget) achievement was effective for moderate goals, but not for difficult or unreachable goals.

In summary, most studies suggest that bonus pay for moderate goals is effective, but not when goals are very difficult or impossible to reach (Locke and Latham 1990, p. 143). When goals are hard to achieve or unachievable, pay for performance rather than pay for goal success appears to be advisable to prevent the goals from being rejected.[2]

Mindful of these propositions, along with the previously noted uncertainty about how hard a hard goal should be and what is a sufficient range between easy and hard, the current study attempted to incorporate a material incentive payment for achievement of both the easy and challenging goal treatments. The pay scheme included both a piece-rate component and a bonus component to approximate compensation systems often encountered in practice. The details of the compensation scheme are described later.

Very few of the goal and incentive studies actually measured goal commitment, so it can only be inferred that a commitment effect was involved. Locke and Latham (1990, p. 143) suggest a different approach: "Another possibility is that a different type of commitment measure might work better, such as questions asking subjects to indicate their degree of enthusiasm for the goal." Following their guidance, goal commitment was measured in this study by directly questioning the subjects using an instrument developed by Hollenbeck et al. (1989).

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[2] Rejection of hard goals does not seem to occur in the absence of incentives. As noted by Locke and Latham (1990, p. 143), subjects' mental set can change from "succeed or receive nothing" under a bonus only system to "get as close as possible" with no bonus.

Task Complexity

Wood (1986) defined task complexity in terms of three dimensions: component complexity (the number of task elements), coordinative complexity (the number and the nature of the relationships between the task elements), and dynamic complexity (the number and types of elements and the relationships between them over time). Figure 1 presents a detailed taxonomy of task complexity. Wood, Mento, and Locke (1987) related the complexity of the tasks to the size of the goal setting effect obtained in 125 goal setting studies. Their meta-analysis confirmed that task complexity served as a significant moderator of the goal setting-performance relationship. Although the effects were significant for both simple and complex tasks, the average effect size was substantially larger for the simpler tasks. Strategies, plans, and tactics play a more important role in determining performance for complex tasks than they do for simpler tasks (Chesney and Locke 1988). This is because the number of alternative strategies for simple tasks is more limited and they are more evident. Consequently, the effort induced by goals leads more directly to task performance on simple tasks than it does on complex tasks. More complex tasks require decisions about how and where to allocate effort.

Earley, Connolly, and Ekegren (1989) along with Huber (1985) have found evidence that specific, challenging goals may not produce better performance than do-best goals --- and may even result in poorer performance --- on unfamiliar, complex, heuristic tasks when there is pressure to perform immediately. These conditions seem to cause an increase in the incidence of the selection of inappropriate or suboptimal strategies.

Figure 1

Task Complexity Taxonomy

1. Component complexity: refers to the number of distinct acts and information cues that are inputs to a task product. This can be broken down into two parts:

   a. The number of acts required to complete a task, where an act is a complex pattern of behavior with some identifiable purpose (e.g., lifting, reading).
   b. The number of information cues that must be attended to and processed in order to make the judgment needed to complete a task.

2. Coordinative complexity: refers to the nature of relationships between task inputs (i.e., acts and information cues) and task products. Several different aspects of the relationship between task inputs will impact on coordinative complexity, including the following:

   a. Sequencing of acts required to complete a task, specifically the number of precedence relations between the required acts for a task.
   b. Form of the relationships between task inputs and task products. In manual tasks this relates to the physical coordination required in the performance of different acts, either simultaneously or in quick succession. In cognitive tasks the equivalent forms of complexity include the integration of cues in judgments and simultaneous processing of information from different sources of decision making.
   c. Strength of association between task inputs and task products (i.e., the predictability of the effects of acts and the predictive validity of information cues).
   d. Time allowed for performance of a task. This will influence the speed at which acts must be performed and information processed.

3. Dynamic complexity: changes in the acts and information cues for a task. As such, dynamic complexity represents different levels of the various types of component and coordinative complexity for a single task at different points in time. These changes can be analyzed in terms of

   a. Continuity of the change over time (i.e., whether the change is a single discontinuous event or continuous).
   b. Predictability of the change when it is continuous.

Source: Locke and Latham 1990, p. 308 from Wood 1986.

It is important to distinguish between task complexity and task uncertainty. As described above, task complexity has to do with the number, nature, and relationships of the task elements. Task uncertainty, as defined by Hirst and described in greater detail later, has to do with the repetitiveness of the task and influences external to the task. A complex task can have high or low uncertainty. So too can a simple task. As described later, the experimental task in this study was designed to permit the manipulation of task uncertainty while holding task complexity as constant as possible. Task strategies are discussed next.

Task Strategies

Task strategies are broadly defined. According to Locke and Latham (1990, p. 87), "task strategies are conscious or deliberate action plans motivated by goals." The development of task strategies involves the creation of task-relevant action plans for attaining goals. Although strategy development is motivated by goals, the mechanism itself is essentially cognitive. It involves skill development and application, as well as problem solving.

When confronted with a goal, individuals usually initiate a thought process of determining how to go about achieving the goal. If the task is simple or familiar, action plans may be developed rather quickly. If the task is new, difficult, complex, or near or beyond the ability of the individual, then action plans may not come to mind so easily. Task strategies are classified as indirect goal mechanisms because the discovery and/or selection of new task strategies, especially correct ones, is not automatic.

Numerous studies have shown that individuals do attempt to develop task strategies on their own when given a performance goal. Adam (1975) found evidence that die casting workers elevated the operating speed of their machines to increase production after receiving performance goals. Das (1982) showed that when given a goal and provided with feedback, subjects would devise various efficiency strategies for a hole drilling task such as prearranging the order of the holes and combining hand motions. In a study involving a complex task, Campbell and Gingrich (1986) found that computer programmers were more likely pursue a strategy of seeking information from their supervisors about how to write the programs when given goals. Likewise, Chesney and Lock (1988) demonstrated that subjects participating in a complex management simulation game were led to develop various strategies when given performance goals, as were the subjects who listed uses for common objects in a study by Earley and Perry (1987). Finally, Klein, Whitener, and Ilgen (1988) found that subjects with the most specific and challenging goals developed the most effective strategies for a computer game task.

Several studies have examined the interaction of goals with assigned, chosen, or primed strategies. Earley and Kanfer (1985) found that subjects allowed to select both goal and strategy performed better than subjects given either goal choice or strategy choice only. Earley, Wojnaroski, and Prest (1987) found that while strategy information and goals had an effect on planning and effort respectively, their was no evidence of an interaction effect on task performance. In the study by Earley and Perry (1987) cited previously, subjects were provided strategy information indirectly in a priming process. They were either told which strategy to use or they were asked to perform a cover task that would induce them to use the same strategy the other group was told to use. They then performed a task that was either facilitated, inhibited, or not affected by the primed strategy. When the primed task was appropriate, hard goal subjects performed better than subjects with goals of doing their best. When the primed strategy was not appropriate, do-best subjects did better than hard goal subjects. Thus, the effect of the primed strategy on the performance of subjects with challenging goals depended on the match between the strategy and the task. A second experiment, which added a no-priming condition, replicated the results of the first. In addition, priming was found to be more effective for difficult goals than no-priming when the strategy was appropriate. The opposite was true when the strategy was inappropriate. Similar results have been found by Neale, Northcraft, and Earley (1987) and Earley, Northcraft, Lee, and Lituchy (1990).

The probability of goal achievement increases if the chosen strategy is appropriate for the task/goal combination. For example, a faculty member with the goal of obtaining tenure should be mindful of the quality of research that is required. Producing a long list of articles in lower level journals would not likely result in goal attainment if publication in top journals is expected. When relevant strategies are not developed, the increased motivational opportunity provided by goals probably will not be translated into effective performance.

If strategies provide crucial linkage between goals and performance on tasks, the factors that lead to the development of appropriate and inappropriate strategies are important. Although a set of factors and how they affect strategy choice has not been fully defined, several studies have shown that the nature of goals themselves can affect the quality of strategies selected. Earley, Connolly, and Ekegren (1989) found that untrained subjects working on a complex task with do-best goals performed better than those with specific hard goals, a result counter to what goal setting theory predicts (absent consideration of task complexity). Subjects with hard goals were more likely to frequently switch task strategies, whereas those with do-best goals tried fewer strategies and switched less often. Kanfer and Ackerman (1988) found similar results. Wood, Bandura, and Bailey (1990) found no strategy or performance differences between specific, difficult and do-best goals on a complex task. On the other hand, Campbell (1984) found that subjects with specific, hard goals tended to select poor strategies in a management simulation. Finally, in a study by Bandura and Wood (1990), subjects who were assigned easy goals used better strategies than those assigned hard goals, but there was no significant difference in performance between the two groups. On the whole, it appears then that specific, challenging goals may encourage subjects to scramble to find a strategy that will get immediate results, whereas those with easy, do-best, or learning goals are more likely to use a systematic approach to strategy discovery and selection (Locke and Latham, 1990).

Thus the evidence suggesting linkage between strategies, goal setting and task performance is somewhat mixed. Locke and Latham (1990) offer three interrelated factors that can be hypothesized to explain why the usual goal-setting results did not emerge or emerged in reverse. First, the tasks were complex and heuristic; thus subjects had to learn the best strategy to use to achieve the desired level of performance. Second, the subjects had no prior experience or training at the task; thus they had no proven strategies or problem-solving processes to rely on. Third, subjects with specific, hard goals felt pressure to perform well immediately. There was no announced opportunity to learn or experiment. Hard goal subjects may therefore have had tunnel vision, focusing more on obtaining immediate results rather than developing the best strategy for performing the task.

Locke and Latham (1990, p. 106) hypothesize that "the usual goal setting findings and relationships will occur to the degree that one or more of the disrupting features are absent." They suggest that future studies should separate the effects of these factors, using different versions of the same task. This study attempts to eliminate or control for all three factors.

In summary, task strategies have an indirect effect on performance because they do not occur automatically. Absent the factors noted above, appropriate strategies seem to enhance performance more when combined with challenging goals than when combined with easy or do-best goals. The evidence also suggests that as tasks become more complex, suitable strategies also become more complex and also more important in regulating performance. Effort, which is a direct factor affecting performance, is discussed next.

Effort

Goal setting scholars, especially those in psychology, view goal setting primarily as a motivational mechanism. The concept of motivation is used to explain the effect of three direct mechanisms by which goal setting is believed to operate. According to Locke and Latham (1990), the three mechanisms are effort, persistence, and direction. They correspond to the three attributes of motivated action: arousal (intensity), choice (direction), and duration. Goals affect arousal by regulating the intensity of effort the individual expends on the task, and they affect duration by leading the individuals to sustain their actions until the goal is achieved. Goals affect choice by directing attention to goal-relevant activities and away from non goal-relevant activities.

Simply put, intensity of effort identifies how hard an individual is willing to work, duration of effort identifies how long someone is willing to work, and direction of effort identifies the focus of that work. These three mechanisms are considered to have a direct effect on performance because once an individual has a goal and chooses to act on it, they are brought into play more or less automatically. Individuals know that to reach a goal they must exert effort, persist over time, and pay attention to what they are doing relative to what they want to achieve. Strategy, while somewhat related to direction, identifies how smart the individual is willing to work. As noted previously, strategy formulation is considered to be an indirect goal mechanism because it not believed to occur automatically.

Intensity of Effort. Many researchers have found evidence that goals affect effort expenditure. Some studies have used tasks requiring physical effort in which ability or capacity was held constant. These tasks include the arm ergometer (Bandura and Cervone 1983, 1986), jumping (Erbaugh and Barnett 1986), elbow flexion (Nelson 1978), weight lifting (Ness and Patton 1979), and bicycle riding (Roberts and Hall 1987) among others. All of these studies showed that subjects with specific difficult goals performed better than those with easy goals, do-best goals, or no goals. Because ability or capacity were controlled, performance was a measure of effort.

Another group of studies found the rate of performance to be a linear function of goal difficulty. These investigations typically used cognitive tasks. In cases where the tasks were sufficiently simple to preclude significant differences in task strategies, the results can be inferred to be caused by differences in effort. Examples in which the effects of specific hard goals were compared with easy goals include an addition task (Locke and Bryan 1969), brainstorming (Garland 1982), anagrams (Sales 1970), and reaction time (Locke et al. 1970). Results of comparisons of specific hard goals with do-best goals have been similar. Bryan and Locke (1967) found that subjects with specific hard goals performed at a faster rate on an addition task than subjects with do-best goals, as did Bandura and Schunk (1981) using a subtraction task.

A third group of studies solicited self-reported subjective ratings from subjects as measures of effort. The results of the Bryan and Locke (1967) study noted previously also found that subjects with specific hard goals, in addition to performing better, reported exerting more effort than those with do-best goals. Sales (1970) found the same results using a physiological indicator (heart rate), actual work rate, and subjective effort ratings. Cannon-Bowers and Levine (1988) found that subjects given harder goals reported exerting far more effort than those with more easily achievable goals. Earley, Wojnaroski, and Prest (1987) obtained similar results when comparing the effort ratings of subjects given difficult goals with those using do-best goals, which was replicated in a field study of goal setting in two organizations. Earley, Northcraft, and Lituchy (1990) found the same results in a simulated stock investment experiment.

The convergence of evidence from these different types of investigations points to the inescapable conclusion that specific hard goals tend to affect performance by increasing the intensity of effort expended on the task. Only Bavelas and Lee (1978) have found otherwise. In their study, subjects with easy goals worked at the same rate as those with hard goals. According to Locke and Latham (1990), however, this result is not surprising because (a) subjects were denied feedback about the difficulty of the goal with respect to their practice period performance, (b) they apparently were denied feedback during the experimental trial, and (c) they worked at the task for only one trial. Further, Bavelas and Lee disclaimed their more relevant finding of a linear relationship between goal level and performance because the hard goal subjects worked longer than the easy goal subjects. As will be discussed in the next section, this is precisely what goal theory predicts. Goals affect the duration of effort as well as the intensity.

Duration of Effort. A second element of effort is duration (also known as persistence). Duration of effort is work maintained over time. The nature of the effort can be physical, mental, or both. Typically it is measured in the form of time spent working or the equivalent, such as the number of attempts to successfully perform a task (Locke and Latham 1990). Therefore, an ideal study would allow for the choice of how much time (or trials) to spend on task. This is particularly challenging to the experimenter, who is limited by the amount of time that can be expected from subjects in the laboratory.

Duration of effort should not be confused with intensity of effort. It is not unusual for duration and intensity to be inversely related. Individuals often work less intensely if they know the effort is to be sustained over a long period. On the other hand, they may exert considerable effort for a short duration. Of course, various degrees of both may be combined depending on the individual and the task. Thus, intensity and duration are best considered alternative but not mutually exclusive ways of applying effort.

Several studies have shown that specific challenging goals result in longer duration of effort than other types of goals. Bavelas and Lee (1978), cited earlier, found that subjects with harder goals worked longer than those with less difficult goals. Cannon-Bowers and Levine (1988), also cited earlier, found that subjects with harder self-set goals spent more time on task than did those with easier goals. Although there was no performance difference, Huber (1985) found that subjects with difficult goals worked longer to solve a computer maze than subjects with easy, moderate, or do-best goals.

Rather than measure performance, Kirsch (1978) directly measured time spent on task. Subjects with challenging goals spent more time exercising than did those with no goals. Similarly, Sales (1970) discovered that subjects with difficult goals spent more time working and less time resting than did subjects with easy goals. In an earlier study, Bryan and Locke (1967) found that subjects with easier goals worked at a slower pace than subjects with hard goals. Hall, Weinberg and Jackson (1987) showed that subjects would compress a hand dynamometer than longer if they were given specific difficult goals rather than do-best goals.

Persistence also can be psychological as well as physical. Huber and Neale (1987) found that subjects engaged in a bargaining task were less willing to compromise if they were working toward hard goals than if given easy or do-best goals. Neale, Northcraft, and Earley (1987) studied the effects of goals on contract negotiations. They found that subjects with challenging goals spent more time completing contracts, although they actually completed fewer total contracts.

Direction of Effort. Regardless of the level of intensity and the length of duration, effort must be directed toward some activity. Goals produce two directional effects which are relatively automatic (Locke and Latham 1990). First, they provide orientation toward goal-relevant activities and materials and away from irrelevant ones. Second, they activate stored knowledge, skills, and experience that are perceived as being relevant to the task.

Most of the studies that have investigated the directive effects of goals have used prose learning tasks (Locke and Latham 1990). Rothkopf and Billington (1975) found that students who were given specific goals for what was to be learned from a prose passage learned more about the goal relevant material than those who were given general goals or no goals at all. Reynolds, Standiford, and Anderson (1979) obtained similar results with a similar experiment that prompted learning in a more indirect way. Additional research by Rothkopf and Billington (1979) found that that the eye movements of subjects with specific learning objectives were more frequent and that fixations on goal relevant text material was longer. To quote Locke and Latham (1990, p. 93), "This is as clear proof as one could hope for that goals influence direction of attention."

The evidence that goals affect attention direction has not been confined to verbal tasks. For example, Terborg and Miller found (1978) found that subjects with quality goals for an assembly task checked completed production for quality more frequently than did those subjects with quantity goals only or no goals at all.

Individual Differences

Because goal setting is a theory of motivation, it would seem that goals would not necessarily affect every individual in the same way. Although several variables have been examined in this regard, individual differences as moderator variables have been relatively unexplored. Thus, their effects on performance remain somewhat cloudy.

One of the more obvious factors that could affect performance is the personal ability of the individual. Other factors include demographic variables such as education, race, gender and job tenure, as well personality variables such as need for achievement, need for independence, locus of control, and behavior type.

Ability. It is axiomatic that a person cannot achieve a goal without the ability to perform at the required level. Thus it can be expected that performance increases with increasing goals up to the limit of the ability of the individual and then tends to level off. With subjects working to achieve a wide range of goal levels, including goals far beyond their capacity, Locke (1982) found a curvilinear relationship between goal level and performance, with performance leveling off at higher goal levels. The relationship between goal level and performance was .82 ($p < .001$) for goals that ranged from easy to difficult and .11 (not significant[3]) for goals approaching impossible and beyond. Bavelas and Lee (1978) and Locke, Frederick, Buckner, and Bobko (1984) found similar results.

The relationship between ability and performance exhibited the opposite pattern. In Locke's study noted above, the correlation between ability and performance was .13 (not significant) for easy-to-difficult goals and .55 ($p < .001$) for goals in the difficult-to-impossible range. The relationship between performance and easy-to-difficult goals was low because subjects were instructed to stop working when their goal had been achieved. No such constraints were imposed on subjects with difficult-to-impossible goals. Again, Locke, Frederick, Buckner, and Bobko (1984) replicated this finding. Thus, under these restrictions, goals and ability are moderators for each other. Similarly, Locke, Mento, and

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[3] The specific p value was not reported; however, p values reported elsewhere in the paper implied a significance threshold of $p = 0.05$.

Katcher (1978) found higher ability-performance correlations for subjects with moderate and difficult goals than for those with easy goals. However, the relationship for the easy goal condition was substantial because subjects were not instructed to stop working upon reaching their goals.

While there is a significant goal-ability interaction for a wide range of goal levels, there also is tenable, but weaker, evidence of an interaction for a narrow range of goal levels. Battle (1966) found that the combination of high self-set goals and high ability added a significant increment to performance beyond the additive effects of the two individual variables. Examining four other studies for the same interaction effect, Locke (1965) found only one of significance. However, goal setting had a larger effect on subjects with high ability than it did on subjects with low ability, and ability had a greater effect on subjects with hard goals than it did on subjects with easier goals. Nevertheless, significant effects were observed for subjects with low goals because they were not instructed to stop working upon reaching their goals.

Cessation of work upon goal achievement has been described as an artifact in the literature. Such a description can be misleading, however, because continuation of work beyond achievement of an easy goal actually becomes what can be termed an easy-goal-plus condition (Locke and Latham 1990). Instructing subjects to terminate work efforts when the goal is reached is justified when the research focus is on the effect of the goal, but often does not match situations outside the laboratory. As will be described later, this study included an incentive designed to be sufficiently attractive such that subjects might abandon or significantly reduce production after reaching the goal. However, to better correlate with actual working conditions, subjects were allowed to continue working beyond goal achievement.

Figure 2 summarizes the effect of the goal difficulty-ability interaction on performance. The general shapes of both the low ability and high ability graphs are curvilinear because performance tends to level as goal difficulty approaches and exceeds the personal ability of the individual. This shows that the goal difficulty effect on performance operates only for goals within the low to high range and does not apply when goals become impossible. It also is evident that the effect of ability on performance is greater at high-to-impossible goal levels than it is at low goal levels. However, as noted previously, this assumes that subjects with reachable goals discontinue working when they reach them. Finally, the goal difficulty effect is stronger for individuals with high ability than it is for those with low ability within the moderate to high goal range. This is shown by the difference in the slope of the two ability curves in that range. This study afforded the opportunity to examine the goal difficulty-ability interaction, although it was not the primary focus of the investigation.

A number of studies have examined the effects of demographic variables, particularly education, and job tenure. Other demographic variables of interest have included age, gender, race[4] and a variety of personality variables. The demographic variables relevant to this study are discussed next.

Education. There are no theories for the effect of education as a moderator of goal setting, nor is there any consistent evidence suggesting that any should exist. Goal

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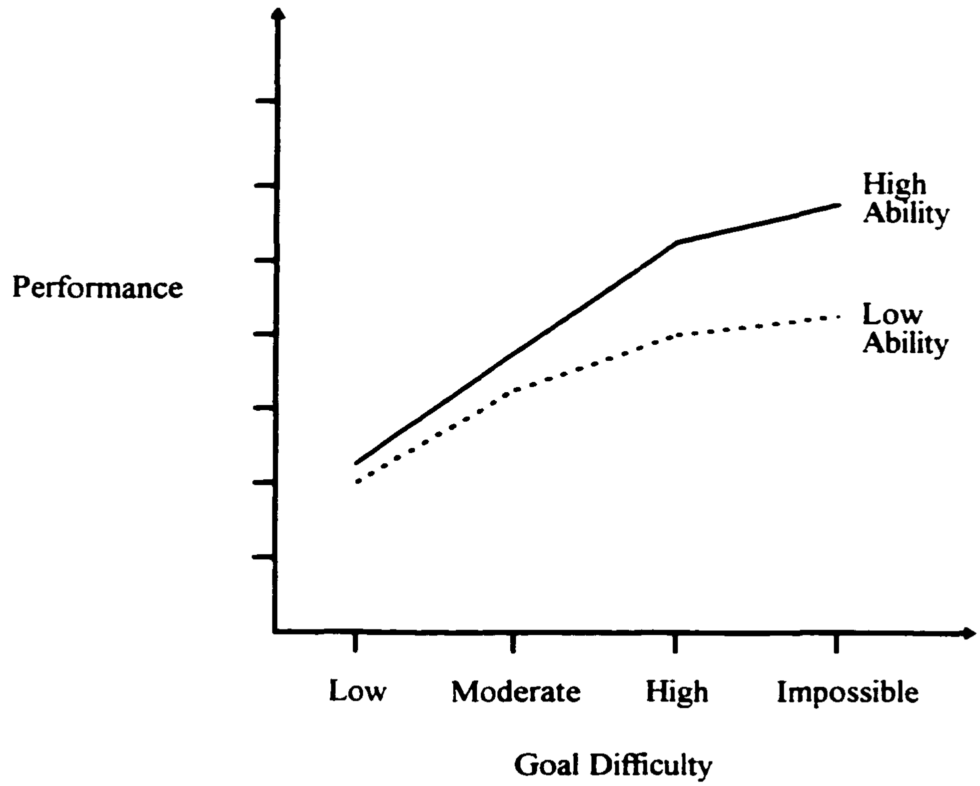
[4] Very limited research has produced no conclusive evidence that race is a mediator of goal setting. Race data were not collected for this study.

Figure 2

The Goal Difficulty-Ability Interaction



Source: Locke and Latham 1990, p. 208.

setting appears to be effective for individuals of all levels of education, ranging from relatively uneducated loggers (Latham and Yukl, 1975) to highly educated scientists and engineers with advanced degrees (Latham et al., 1978). Ivancevich and McMahon (1977) found that perceived goal challenge was significantly related to performance for electronics technicians with twelve or more years of education. In contrast, goal clarity and feedback (the literature on the effect of feedback on performance will be discussed in greater detail later) significantly affected performance only for technicians with fewer than twelve years of education. Education did not moderate the effects of goal setting in field experiments of loggers (Latham and Yukl 1975) and typists (Latham and Yukl 1976). Similarly, Steers (1975) found no moderating effect of education on the goal setting activities of supervisors.

Job Tenure. The evidence on the effect of job tenure as a moderator variable is mixed. Steers (1975), Latham and Yukl (1976), and Invancevich and McMahon (1977) found no moderating effect. In their study of government employees, Latham and Marshall (1982) found no main interaction effect for supervisor job tenure or public sector work experience. Dachler and Mobley (1973) found no significant relationship between goals and performance for individuals with less than two years of employment, but they did find a significant relationship for those with more than two years of employment. Their explanation for this difference was that more experienced employees have more accurate perceptions of their chances of achieving various levels of performance and of the related contingencies. Work by Earley, Lee, and Hanson (1989) provided and exception. They found evidence of an interaction between goal setting and job tenure that affected performance. Goal setting enhanced the performance of all employees except those with complex jobs and limited experience. Locke and Latham (1990) used these results to suggest that individuals with limited experience on complex jobs may not have had sufficient time to develop the task strategies required to implement their goals.

Age. A very limited number of studies have directly examined the role of age as a moderator of goal setting. The evidence that has been gathered has not shown a significant relationship among age, goal setting, and performance. Ivancevich and McMahon (1977) did not find age to be related to goal setting or performance. A few studies, such as Rosswork (1977), have found goal setting to be effective for a wide variety of age groups.

Gender. Relatively few studies have examined the role of gender in goal setting. There have been no significant findings that gender is a moderator of the goal setting-performance relationship. In studies by Steers (1975) and Latham and Yukl (1975, 1976) it has been shown that goal setting significantly increases the performance of both males and females.

Personality Variables. The relationship among goal setting, performance, and a variety of personality variables, including need for achievement, need for independence, and locus of control, has been the subject of several research efforts. Because none of these variables is measured or manipulated in this study, a brief discussion is provided as background information only.

Steers (1975) found that for those with high measures of need-for-achievement performance was related to goal specificity and feedback, but not to participation in goal setting. Low need-for-achievement individuals, however, performed better when they were allowed to participate in the goal setting process. The evidence suggests that those high in need-for-achievement perform best when provided feedback on progress toward assigned goals, while those low in need-for-achievement perform best when they have some influence on setting their own goal. Singh (1972) reported that high need-for-achievement students set higher goals for themselves over repeated trials of a mathematical clerical task than subjects measuring low in need-for-achievement. Similarly, Yukl and Latham (1978) found that high need-for-achievement subjects set higher performance goals than did low need-for-achievers when both groups were allowed to participate in the goal setting process.

Kernan and Lord (1988) reported that high need-for-achievers were more committed to their goals and performed better with participative goal setting than low need-for-achievers. Hollenbeck, Klein, O'Leary, and Wright (1988) found significant correlations between goal commitment and need-for-achievement. Hollenbeck, Williams, and Klein (1989) found that high need-for-achievement subjects were more committed to their goals than were those low in need-for-achievement, especially if goals were self-set.

A moderating effect has not been found by most studies examining need for independence. In an early study, French, Kay, and Meyer (1966) did find evidence suggesting that goal commitment was greater among employees who demonstrated a high need for independence when participation was increased. However, additional support for a moderating effect of need for independence has not materialized. For example, Latham and Yukl (1976) found that need for independence did not moderate the effect on performance of either assigned or participatively set goals. Dossett et al. (1979) found no moderating effects of need for independence in the field and Latham, Steele, and Saari (1982) also failed to find moderating effects in the lab.

Researchers generally have not found locus of control to be a significant moderator variable. For example, neither Latham and Yukl (1976) nor Dossett et al. (1979) discovered a moderating effect of locus of control on performance. Similarly, Latham et al. (1982) found no moderating effect in the laboratory, nor did Latham and Marshall (1982) with their field study. On the other hand, Latham and Yukl (1976) found that internals set more difficult goals than externals. In the accounting literature, Brownell (1981, 1982) reported that a laboratory experiment and a field study both found that locus of control affected the budgetary participation-performance relationship such that internals performed better with high levels of participation and externals performed better with low levels. It is possible that the budgeting environment affected the relationship is some way, possibly because either environmental uncertainty or task uncertainty was not present in the other investigations.

Feedback

As previously indicated, goal setting is one of the most well established and robust findings in the literature. In addition, the positive effects of feedback, or knowledge of results of task performance, also is a well established finding. In fact, the relationship between goals and feedback is a complex one such that neither is very effective in the absence of the other (Locke and Latham 1990). Locke et al (1981) and Locke and Latham (1990) reported that the positive effect of knowledge of results is a well established, if not one of the best established, findings in the psychology literature. An integration of numerous studies points to an unequivocal conclusion: feedback must be combined with goals to increase task performance; neither goals nor feedback alone is sufficient.

With respect to feedback, goals are a mediator (Locke, Cartledge, and Koeppel, 1968). They are one of the key mechanisms by which feedback is translated into action. With respect to goals, feedback is a moderator. Goals regulate performance more reliably when feedback is provided than when it is withheld (Locke et al. 1981). Thus, goals and feedback are interdependent.

Goal Setting as a Mediator of Feedback. A mediator is a mechanism that accounts for, in whole or in part, the effects of another variable. For example, effort is one of the variables that causes performance to be greater at higher levels of goal difficulty. Effort, therefore, is a mediator of the relationship between goal difficulty and performance.

As noted by Balcazar, Hopkins, and Suarez (1986), feedback does not always increase performance by itself. To be effective, feedback requires goal setting as a conduit through which it affects performance. Upon receiving feedback, the individual will form a value appraisal in the form of an emotional response (Locke and Latham 1990). The strength of emotion will depend on the degree of the discrepancy between the goal and the performance and the importance to the individual. If required, corrective actions, in the form of more or less goal commitment, more or less exerted effort, changes in strategy, etc., would follow. Without a goal there would be no basis for the emotional response. The goal can be formally set as a part of an external process or it could be internally set informally by the individual (e.g., a self imposed do-best goal).

If goal setting is a mediator of feedback, there should be at least a reduced effect on performance when goal setting in response to feedback is prevented compared to when it is allowed. Furthermore, when feedback does lead to improved performance, it must be shown that the effect is reduced when goal setting among subjects is statistically or experimentally controlled. According to Locke and Latham (1990), the studies that tested these propositions found results consistent with the mediation hypothesis.

A few studies have actually prevented goal setting by subjects given feedback or prevented differential goal setting by subjects in feedback and no feedback conditions. For example, Locke (1967) conducted an experiment in which treatment groups either received feedback or did not while either pursuing specific, hard goals or do-best goals on an addition task. Subjects were provided with knowledge of their results at the end of each of five trials. Goal setting was prevented by varying the lengths of the trials such that scores on the trials were not comparable (as will be described later, task non-repetitiveness is an element in Hirst's theory of task uncertainty). A significant goal effect on performance was found for the specific, hard goal treatment, but the results produced no significant feedback effect and no interaction. A subsequent study by Locke and Bryan (1969), in which trial lengths were more irregular and easy goals replaced do-best goals, replicated these findings. According to Locke and Latham, these findings suggest an explanation for studies that did not find any effect for feedback alone on performance (Locke and Latham 1990, p. 181): "In such cases one can presume that no goals to improve performance had been set or accepted in response to or along with the feedback." They further indicate that studies finding significant effects for feedback alone probably did so because feedback motivated the subjects to set their own goals to improve their performance.

Feedback as a Moderator of Goal Setting. A moderator is a variable that affects the relationship between two other variables. It may or may not have a direct causal effect. For example, commitment is a moderator of the relationship between goals and performance.

Feedback is another moderator of the goal-performance relationship. According to Locke and Latham (1990), the first investigator to show the moderator effect by fully separating goal setting and feedback was Erez (1977). Using a number comparison task, she provided knowledge of results to half of her subjects in an initial work period before they set goals for a second period. The other group set goals in the absence of feedback. In the second period, there was a significant relationship between goals and performance only for the subjects who had been provided feedback.

In a field study of electricity consumption, Becker (1978) compared the behavior of families with high versus low goals and feedback versus no feedback. Families without feedback did not know how much electricity they were using, while families with feedback were provided with quantitative consumption information three times each week. Only the families with hard goals plus feedback consumed less energy than the control group. They also outperformed (i.e. consumed less energy) all the other groups, which did not differ significantly from each other. Strang, Lawrence, and Fowler (1978) obtained essentially the same results in a laboratory setting using an arithmetic task.

An exception was found in an experiment by Strang (1981). One treatment group set difficult goals while the second group worked toward do-best goals on a reaction time task. Although neither group received feedback, the hard goal group outperformed the do-best group. The results suggest the possibility that there is an energizing effect of goals on simple tasks that does not depend on performance feedback. As noted by Bandura (1988) and found in Banudra and Cervone (1983), goals can have an anticipatory, feedforward effect on the first trial of a task or work period. Thus goals can have an influence on performance before any formal feedback is received by the individual. Subsequent feedback allows adjustments in response to the new information.

At what point feedback should be provided is another issue. In some studies feedback has been provided just before the setting of goals. In other studies goals were assigned and feedback was given to subjects during their performance so they could regulate their effort as required by the goal. According to Locke and Latham (1990, p. 192), feedback should be provided both before and during performance: "Ideally it seems preferable to supply knowledge of results both before performance (here is how you did on the practice or warm-up trials) and during performance such as between trials (here is how you are doing thus far)."

As described later, this study provided feedback information both before and during the performance period. Feedback about practice period results was provided continuously in real time throughout the practice period and summarized at the end of the practice period immediately before goal assignment and the performance period. Feedback about performance period results was provided continuously in real time throughout and summarized at the conclusion of the performance period.

In summary, goal setting seems to have little effect on performance when feedback is withheld. If feedback without goal setting also is ineffective as discussed earlier, then it follows that the combination of goal setting with feedback would be more effective than either alone. This combination is the subject of the next section.

Goal Setting and Feedback Combined. Numerous studies have been conducted comparing goals plus feedback with either goals alone or feedback alone. Overwhelmingly, the combination of goals plus feedback has been more effective in promoting performance than either alone (Locke and Latham 1990, p. 192). For example, Ivancevich and McMahon (1982) found that engineers performed better on several measures using self-feedback and goals than they did using feedback without goals. Bandura and Cervone (1983) used their ergometer task to find that the combination of goals and feedback led to better performance than either alone or neither. Likewise, Das (1982) found that goals plus feedback led to higher output on a hole drilling task than either alone.

A number of studies have used time series designs to test the combined effects of goal setting and feedback in which one element was introduced after a baseline period and the other was added later. The simultaneous introduction of both elements, followed by a subtraction of one, also has been used. Other designs both added and subtracted elements. Examples include the Chhokar and Wallin (1984) study of machine shop workers, the Fellner and Sulzer-Azaroff (1985) study of paper mill workers, and the Anderson et al. (1988) study of hockey players. These are but a few of the many investigations that have shown the positive effects of using goal setting and feedback together instead of either alone. The results are consistent with those conducted with non-time series designs.

The characteristics of feedback appear to be important. Earley (1986, 1988) and others have found that specificity of feedback affected task performance, either directly or through its effect on task planning. Specific feedback allows the individual to better regulate effort because it provides more information about progress toward the goal than does vague or general feedback. It also may provide more useful information about the direction of activity, including appropriateness of task strategies. Specific feedback does not guarantee that the best strategies will be chosen, but it does provide better information on which to base the selection (Locke and Latham 1990, p. 203). As will be discussed later, the Hirst theory tested by this study specifically includes a possible effect of task uncertainty on strategy choice. The evidence also suggests that delayed feedback was better than immediate feedback, and that factual (impersonal) feedback is more effective than more evaluative (personal) feedback.

Summary

Goal setting findings are among the most well established and robust in the literature. Many studies provide empirical support for the goal-setting hypothesis. The evidence is strong that specific, difficult goals lead to higher performance than easy or do-best goals as long as the goal is not impossible.

The evidence also strongly suggests that goal setting operates primarily through the direct mechanisms of goal commitment and the direction, intensity, and duration of effort. Not surprisingly, the effort induced by goals leads more directly to task performance on simple tasks than it does on complex tasks.

Goal setting also operates indirectly by influencing task planning and the selection of appropriate task strategies. Monetary incentives generally have been found to increase the power of goal setting, although under some circumstances there can be a neutral or even a negative effect. Finally, the evidence is very strong that goal setting requires feedback to be fully effective.

As noted by Chowdhury (1993), however, the goal-setting research stream fails to provide a comprehensive theoretical structure for the findings (see Tubbs 1986 for a meta-analysis of 87 goal setting studies). Hirst offers task uncertainty as an additional element of the theoretical framework. Hirst's theory will be described after brief descriptions of two other foundational theories, expectancy theory and achievement motivation theory, both of which are linked to goal setting theory and Hirst's proposition.

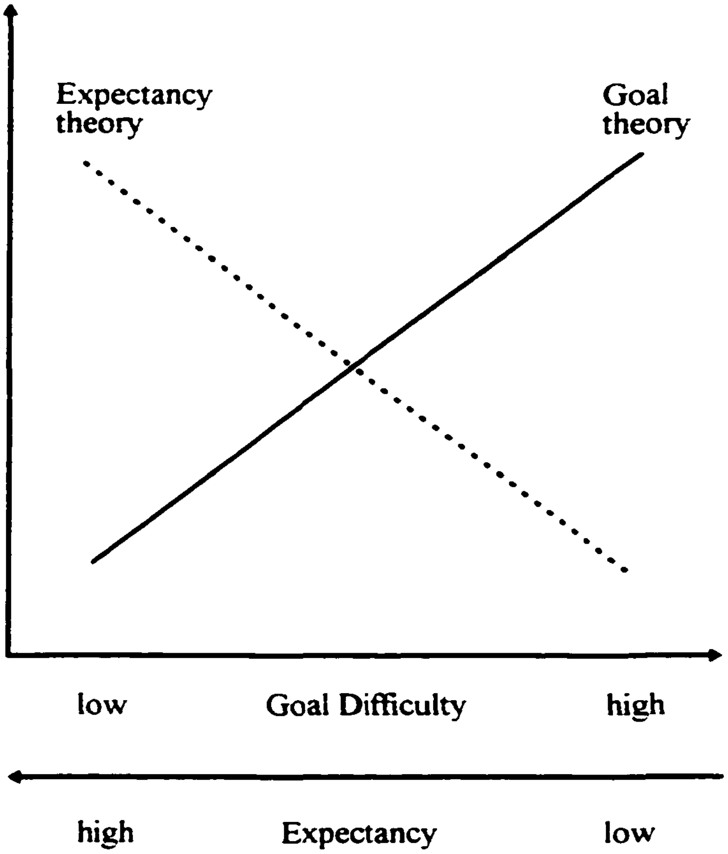
Expectancy Theory

As discussed previously, the evidence supporting goal theory suggests convincingly that there is a positive linear relationship between goal difficulty and task performance, as long as the goal does not approach impossibility. Because difficult goals are harder to achieve than easier goals, there will be a negative linear relationship between expectancy of success and performance across goal levels.

In contrast, expectancy theory (Vroom, 1964) proposes that there is a positive linear relationship between expectancy of success and performance because choices are affected by perceived chances of performing well on a task. Clear evidence supporting Vroom's assertion has been found (Campbell and Pritchard 1976, Mitchell 1974). These two seemingly contrasting theories are represented graphically in Figure 3. The expectancy theory components are described next.

Figure 3

Predicted Expectancy-Performance Relationships I for Goal Theory and Expectancy Theory



Source: Locke and Latham 1990, p. 64.

Expectancy Theory Components

The basic postulate of expectancy theory is that task performance (P) is a multiplicative function of motivation to perform (M) and ability to perform (A) expressed as P = f (M x A). Motivation, in turn, is a multiplicative function of expectancy (E), valence (V), and instrumentality (I), so that M = f (E x V x I). Expectancy refers to the individual's subjective probability that effort will lead to a given level of performance, whereas instrumentality is a subjective correlation indicating that the same performance level will be associated with certain outcomes. Valence refers to the desirability of each of the outcomes associated with the given performance level.

One implication of expectancy theory that has considerably influenced subsequent theorizing is the idea that the desirability of a reward and the individual's estimate of how likely it is that the reward will be obtained constitute equally important motivators of action (Chowdhury 1993). Because expectancy of task success is likely to diminish as the level of an externally assigned goal is increased, expectancy theory often has been interpreted to imply that motivation and task performance decrease (increase) monotonically. Although the Hirst proposition of the effect of task uncertainty does not specifically include any direct reference to expectancy theory, it is not unreasonable to suspect that increases (decreases) in task uncertainty could decrease (increase) the individual's subjective probability (E) that a particular intensity and duration of effort will lead to a given level of performance.

Reconciliation of Goal Theory and Expectancy Theory

Early attempts to reconcile the apparent conflict between goal theory and expectancy theory, such as Locke et al. (1981) and Mento et al. (1980), suggested that expectancy, along with valence and instrumentality, directly affected goal choice rather than performance. Goals were thought to directly affect task performance by mediating the relationship between the three expectancy theory variables and performance. It is clear that expectancy and instrumentality do affect goal choice and goal commitment (Klein 1988, Locke and Latham 1990). However, expectancy also affects performance after controlling for the effect of goals (Klein 1988; Locke, Frederick, Lee, and Bobko 1984; Wood and Locke 1987).

It also has been noted that many of the studies of expectancy and goal setting may have been affected by methodological artifacts. Mento et al. (1984) and Locke and Shaw (1984) point out that expectations of success may be correlated with ability. Mento et al. further noted that many studies have included inadequate measurements, or no measurements at all, of goals, goal acceptance, and valence. Furthermore, feedback was not always provided and expectancy measures did not always assume maximum effort. With all of these artifacts eliminated, some investigators have found significant effects of expectancy on performance, while others have not. Thus, the conflict between goal theory and expectancy theory remains.

Locke and Latham (1990) suggest two avenues of reconciliation. The first is based on distinguishing between within-group and between-group analysis as suggested by Garland (1984). The second is based on using a different measure of expectancy than usual.

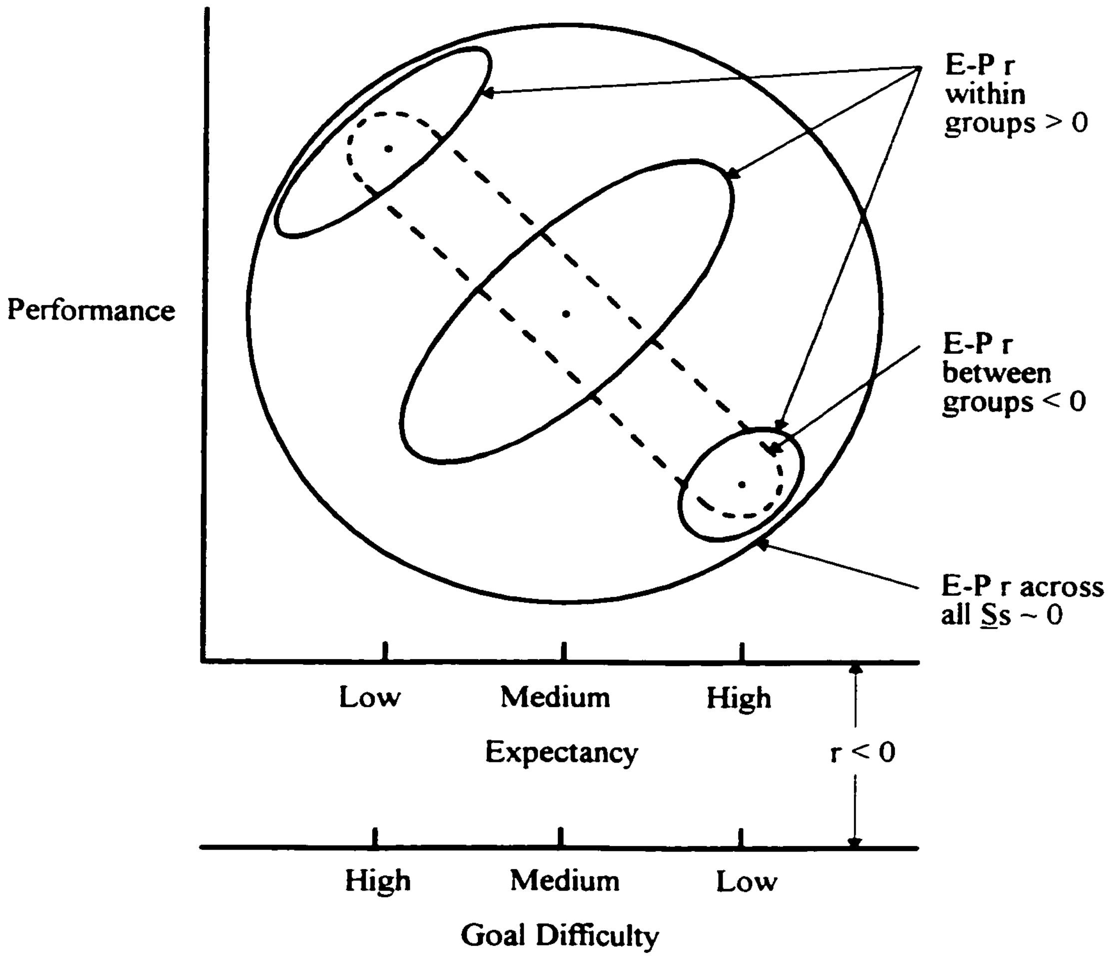
Within-group vs. Between-group Analysis. The typical goal-setting research design asks groups of subjects to rate their expectancies of achieving the goals assigned to them. Each subject reports the expectancy of reaching only one assigned performance goal. Because different subject groups are assigned different goals, their expectancies relate to different performance levels. Consequently, although each subject rates the expectation of goal attainment, its meaning differs from group to group. The subjects actually are rating the expectancies of different task performance outcomes. Thus, the negative relationships found previously between expectancy and performance in goal-setting research were artifacts of confounded levels of analysis (Locke and Latham 1990, p. 65).

Figure 4 shows the relationships between expectancy of goal achievement and performance for a hypothetical experiment involving three groups of subjects (Locke, Motowidlo, and Bobko 1986). One group has a high performance goal, one has a medium goal, and one has a low goal. Each subject rates the probability of achieving only the one assigned goal. Expectancy and goal difficulty, along the abscissa, are negatively correlated because subjects with easier goals have more chance of attaining them than subjects with harder goals. Also, the between-group correlation (dashed line oval) between expectancy and performance is negative. Higher performing (higher goal) groups have lower expectancies than do lower-performing (lower goal groups). The focus of this analysis is on group-level data (i.e., the three group means).

On the other hand, Garland's (1984) key insight was that the within-group correlation between expectancy and performance (solid ovals, all made with respect to the

Figure 4

Single Goal Expectancy-Performance Relationships
When Expectancy is Measured with Respect to Assigned or Chosen Goal Level Only



Source: Locke and Latham 1990, p. 65 from Locke, Motowidlo and Bobko 1986.

same goal level) tends to be positive. This within-group relationship may appear as a main effect for expectancy, or there may also be an interaction between goals and expectancy if the various within-group correlations differ from each other sufficiently. Both Garland (1984) and Locke, Frederick, Lee, and Bobko (1984) found higher correlation in the medium- and hard-goal groups than in the easy goal group, who almost can be assured of reaching their goal. In Figure 4, this is depicted by the wider ranges of the ovals for the medium- and hard-goal groups relative to the easy-goal group. Finally, the overall correlation using all subjects in all groups tends to be relatively low as shown by the large solid circle. This is because the within-group and between-group correlations are opposite in sign and tend to cancel each other. As a consequence, expectancy-performance correlation across all subjects in goal setting studies tends to be small and/or nonsignificant (Mento et al. 1980).

Tubbs, Boehne, and Dahl (1993) suggest that work motivation researchers should consider the nature of the two distinct approaches. They argue that a within-persons analysis is more faithful to Vroom's (1964) expectancy-valence theory while also incorporating the greater specificity provided by achievement motivation theory (described later). The across-persons approach differs in the nature of expectancy and valence constructs, the existence and relevance of the motivational force constructs, and the nature of the relation examined between motivational judgments and outcomes.

An Alternative Measure of Expectancy. A second approach to resolving the conflict between goal setting theory and expectancy theory is to use Bandura's concept of self-efficacy as a measure of expectancy (Bandura 1977, 1986). Self-efficacy is a key element of Bandura's social learning or social-cognitive theory. It is defined as an individual's judgment of "how well one can execute courses of action required to deal with prospective situations" (Bandura 1982, p. 122).

Self-efficacy is closely related to expectancy but is broader in scope. It is based on the assessment of all personal factors that could affect future performance, such as past performance, ability, adaptability, capacity to coordinate skilled sequences of actions, resourcefulness, etc. Self-efficacy is significantly and positively related to future performance, and sometimes even more so than to past performance. In practice expectancy measures probably are at least partially equivalent to self-efficacy measures because when asked to rate their chances of succeeding at a task, individuals may include not only their estimates of the degree to which effort will produce performance but also their belief in their total capability to perform at a certain level (Locke and Latham 1990).

However, in contrast to the typical goal setting or expectancy study, self-efficacy usually is measured in two dimensions against a wide range of performance levels instead of just one. These two dimensions are magnitude and strength. Magnitude involves yes or no answers to each designated performance level, and strength involves a rating by the subject of the degree of certainty of reaching each level. The total number of yes answers and the mean certainty rating across all performance levels are used as predictors.

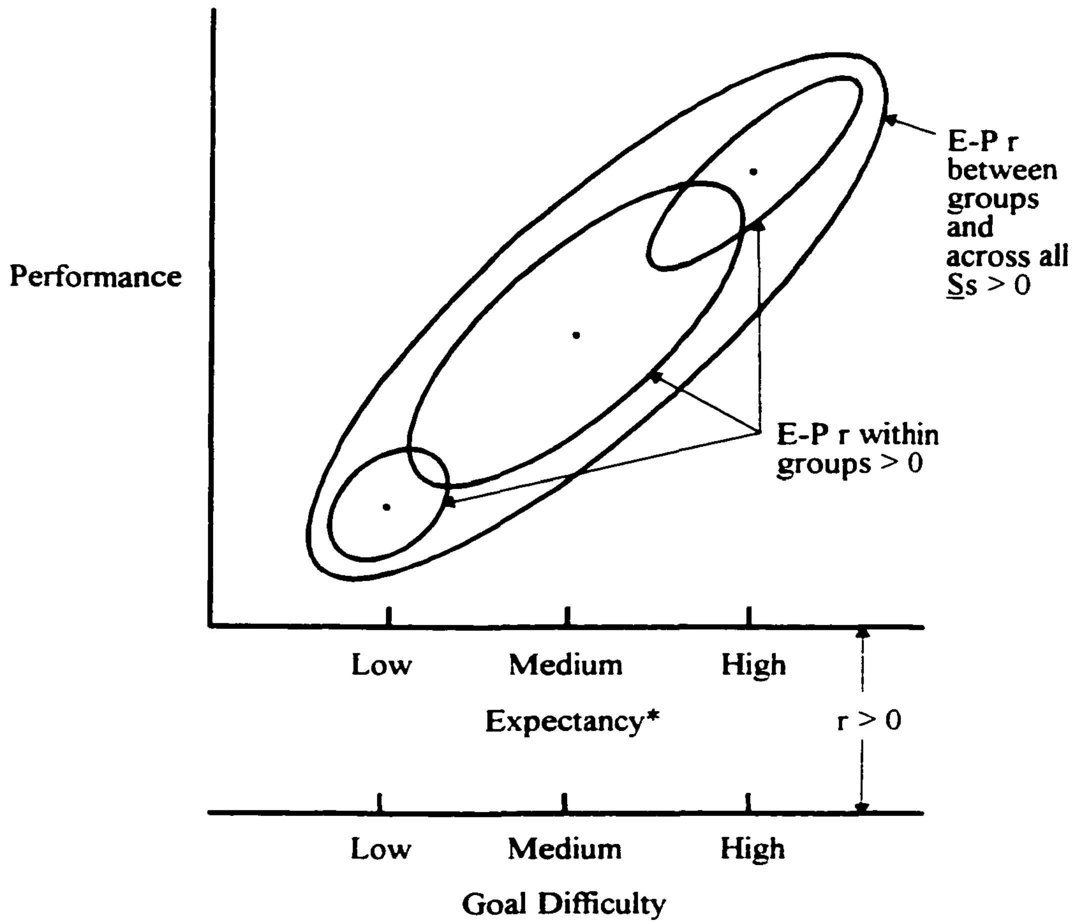
Expectancy ratings, which can be measured in the same way, are most nearly equivalent to the strength measure. Each subject subjectively rates the likelihood of reaching each of several levels of performance. The variable of performance expectancy is computed as the sum or average of all the expectancy estimates from each individual. In other words, expectancy is the probability of obtaining all levels of performance and not just the chosen (or assigned) level. Thus, the overall expectancy ratings by subjects in each goal group across the same outcomes is obtained. Compared with the traditional case, the goal-expectancy correlation is reversed: the high-goal subjects have the highest overall expectancy ratings, and both goals and expectancies relate positively to performance. This holds for self-set and assigned goals. Those with higher self-efficacy tend to set higher goals for themselves. Individuals who receive higher assigned goals will have higher self-efficacy as a result of the assignment (Locke and Latham 1990).

Figure 5 shows the relationship of goals and self-efficacy to performance within and between groups. Goal difficulty and self-efficacy or expectancy are correlated positively instead of negatively. Thus, the between-group relationships of both goal level and expectancy to performance will be positive. The within-group relationships between expectancy and performance will continue to be positive as shown previously in Figure 4. Since both the between- and within-group correlations are in the same direction, the overall relationship of expectancy to performance across all subjects is positive. Several studies provide support for theses patterns (e.g., Locke, Frederick, Lee, and Bobko 1984; Wood and Locke 1987).

Causal Links Between Goals, Self-efficacy, and Performance. The three-way relationship between self-set (as opposed to assigned) goals, self-efficacy or expectancy, and performance is shown in Figure 6. Self-efficacy directly affects the level of the goal chosen and independently affects performance as well. There also is a main effect of self-set goals on performance. The weighted mean correlations are based on the results of thirteen studies (N = 2,285) which measured each of the three relationships (Locke and Latham 1990, p. 70). All used self-efficacy measures or the equivalent. The result of

Figure 5

Multiple Goal Expectancy-Performance Relationships
When Expectancy or Self-Efficacy Is Measured with Respect to
Multiple Goal or Performance Levels



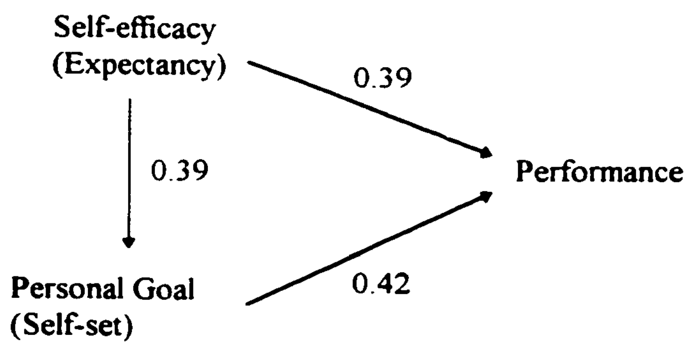
*Measured in terms of attaining all goal or performance levels.

Source: Locke and Latham 1990, p. 69 from Locke, Motowidlo and Bobko 1986.

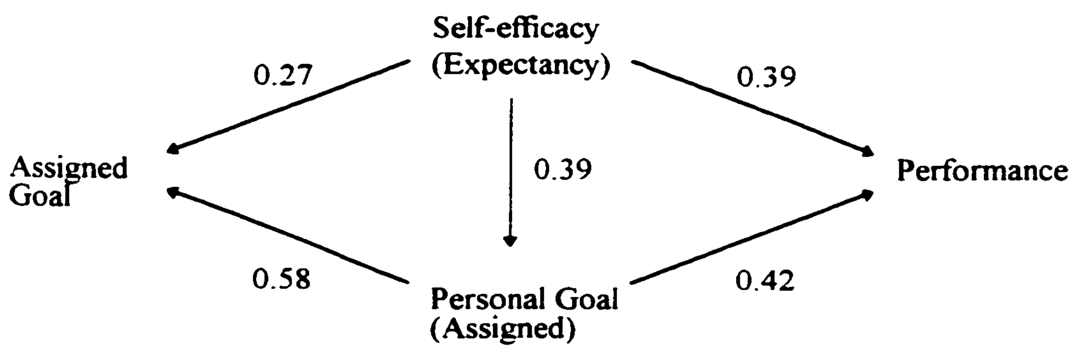
Figure 6

Relationships Between Goals, Self-Efficacy, and Performance

a. Self-Set Goals



b. Assigned Goals



Source: Locke and Latham 1990, p. 70, 72.

adding assigned goals to the model is shown in Figure 6b. The weighted mean correlations for self-efficacy, personal goals, and performance are the same as those shown in Figure 6a. Note that assigned goals affect personal goals, and that they can affect self-efficacy even before performance has occurred. Meyer and Gellatly(1988) found evidence indicating that assigned goals convey normative information by suggesting what level of performance the individual could expect to attain. In their first study, assigned goals affected norms that affected self-efficacy. In turn, self-efficacy affected personal goals and performance. Early and Lituchy (1989) also found evidence supporting the model in Figure 6b.

In summary, assigned goals and self-efficacy both affect performance in two ways. Assigned goals affect personal goals and self-efficacy. Self-efficacy affects personal goals and performance. The joint effect of goals and self-efficacy on performance indicates that performance is affected not only by the level of what an individual is attempting to do but also by how confident the individual is of being able to succeed. The chances of someone being committed to a hard goal should be higher when self-efficacy for a task is high as opposed to low. Accordingly, Bandura (1986, 1988) has demonstrated that self-efficacy plays a major role in maintaining commitment to a course of action, especially when setbacks, obstacles and failures must be overcome.

Factors Affecting Self-Efficacy. Bandura (1986) proposed four categories of determinants of self-efficacy: enactive mastery (actual performance or beliefs about performance), modeling, persuasion, and physiological feedback. In an investigation of enactive mastery, Bandura and Schunk (1981) found evidence that proximal goal setting had a greater positive effect on self-efficacy, persistence, and performance on an arithmetic task than did distal goal setting or no goals. Using a brainstorming task, Locke, Frederick, Lee, and Bobko (1984), along with Earley (1986) also found self-efficacy to be related to past performance. Hollenbeck and Brief (1987) found that actual ability based on a pretest had the highest association with a rating of task-specific ability. Podsakoff and Farh (1989) also found self-efficacy to be related to ability. Success in achieving goals is another form of enactive mastery. Mossholder (1980) found that subjects who succeeded in reaching a specific, challenging goal on an assembly task rated themselves more competent at the task than those who failed (of course those who succeeded performed better). Although low-goal subjects succeeded more often, they actually reported lower self-efficacy because they felt less able to attain higher levels of performance than those with high goals. Also, subjects working toward specific goals rated themselves lower than those with do-best goals. This suggests that subjects with vague goals are more likely to allow themselves the benefit of the doubt since the standard of success is not as well defined as it is with specific goals.

Although the evidence is limited, role modeling has been shown to have some effect on self-efficacy. Weiss and Rakestraw (1988) found that the level of performance of a videotaped role model affected the self-efficacy and performance of subjects performing a card sorting task. However, the effect dissipated over time as actual task performance experience was acquired. Similar effects of task experience were observed by Bandura and Wood (1989). Although goal setting was not involved, Gist, Schwoerer, and Rosen (1989) found that role modeling was more effective in raising self-efficacy than using standard instruction to teach subjects how to use computer software. Their results suggest that self-efficacy is an important mediator between training and skilled performance.

Persuasion is another determinant of self-efficacy. Garland and Adkinson, (1987) found that self-efficacy was increased by issuing an encouraging statement prior to the performance of an object-listing task. Meyer and Gellatly (1988) showed that providing normative information about the performance of other similar individuals also increased self-efficacy. Bandura and Wood (1989) found that subjects who were told that the outcome of a management simulation task was highly controllable had greater self-efficacy, set higher goals, and used more appropriate strategies than those who were told that task performance was not easily controllable.

Earley (1986) obtained results showing that when relevant task strategy information accompanied assigned goals, the self-efficacy of manufacturing workers increased above those who were provided only an explanation of why the goal was important. Locke, Frederick, Lee, and Bobko (1984) found that providing task strategy training produced greater self-efficacy than not providing training. Schunk (1984) found that the combination of goals and incentives led to higher self-efficacy and performance than either one alone. Note that these effects on self-efficacy would be classified as enactive mastery if the strategies affected the performance. If, on the other hand, the effects occurred before performance improved, they would be classified as a form of persuasion.

While the explanation of why task strategy information raises self-efficacy is relatively obvious, the reasons for the reciprocal relationship found by Bandura and Wood (1989) and Wood, Bandura, and Bailey (1990) are not. In those studies, subjects with high self-efficacy selected more appropriate task strategies than did subjects with low self-efficacy. Locke and Latham (1990) speculate that high self-efficacy individuals may believe that they use better methods of discovering and selecting strategies, while those low in confidence may be doing more guessing or random trial and error. Thus, when they perform well they may simply feel lucky and not really in control of the situation; when they perform poorly, they may believe that their random search did not produce a viable strategy.

Finally, Earley (1988) found that employees in the magazine industry had greater self-efficacy when their performance feedback was received directly through their computer terminal rather than from their supervisor. Receiving feedback from the computer was associated with higher trust in the feedback. As described later, this study provided feedback immediately and directly to each subject through the computer.

Valence

Several studies of valences, goals, and performance have produced mixed results. For example, Locke and Shaw (1984) and Matsui et al. (1981) found positive effects of valence on performance, while Garland (1985) and Meyer and Gellatly (1988) found negative effects. In an attempt to resolve the issue, Mento and Locke (1989) examined the relationship between valences (satisfaction of achieving a performance level), goals, and performance. Using both between- and within-subject designs, they found a strong negative relationship between assigned goal level and mean valence across all performance levels. Valence also is related negatively to performance. Thus, subjects assigned high goals expected to derive less satisfaction from every performance level than did those with medium goals. Subjects with medium goals expected to derive less satisfaction than subjects with easy goals.

The relationship between anticipated satisfaction and performance for three hypothetical goal levels is shown in Figure 7. Although previous research had suggested that valence related positively to goal choice, goal commitment, and task performance, the negative relationships between goal level, valence, and performance actually make sense if it is recognized that goals are standards of performance adequacy in addition to targets to achieve. If an individual does not use a goal as a standard for performance it is not a real goal or the individual is not truly committed to it. High standards means not being satisfied with less than high performance. To be satisfied, subjects with difficult goals must achieve a higher level of performance than subjects with easy goals.

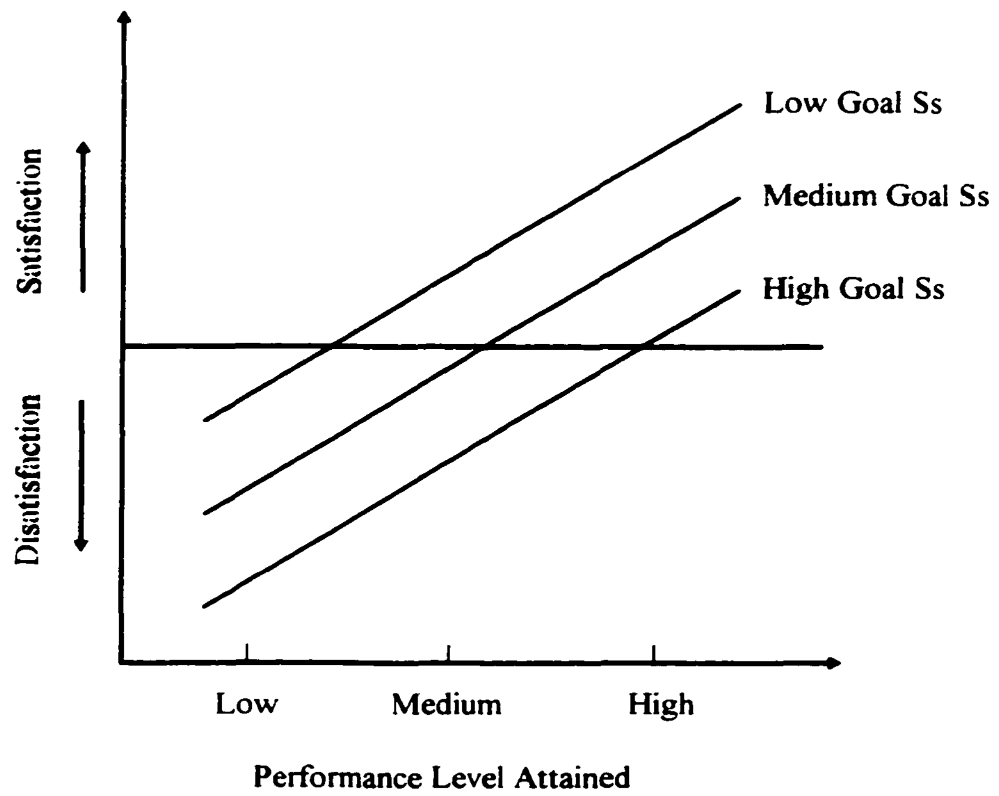
A valence function measured in terms of expected satisfaction when no incentives are offered for performance can be called the achievement valence function (Locke and Latham 1990). The achievement valence function within any given goal level is positive; the higher the performance relative to the goal, the higher the appraisal of that performance. This means that individuals prefer to exceed their goals rather than fail to achieve them. Raising the goal shifts the valence function to a higher plane such that the individual must do more for less satisfaction.

Instrumentality

The studies that have found positive relationships among valence, goal level, and performance have measured the attractiveness of a single outcome (Locke and Shaw

Figure 7

Valence Functions for Subjects at Three Goal Levels



Source: Locke and Latham 1990, p. 78.

1984) and the instrumentality of different levels of performance in attaining various outcomes (Matsui et al. 1981). Following the latter approach, Mento and Locke (1989) used factor analysis to find that all of the following four factors were instrumental in leading their subjects to attempt to attain assigned goals: (1) they were following instructions (obedience), (2) they wanted to improve their skills (skill), (3) trying for goals gave them a sense of achievement (achieve), and (4) they wanted to prove themselves to be competent, persistent, etc. (prove-self). Furthermore, some of the factors were endorsed differentially as a function of goal level. The instrumentality ratings for the skill, achievement, and prove-self factors were positively associated with goal level, but the instrumentality rating for obedience was not. Thus, whereas the achievement (self satisfaction) valence function correlated negatively with goal level, the instrumentality functions for three out of four factors correlated positively with goal level.

These relationships appeared in the absence of any extrinsic incentives. In many actual organizational settings high performance typically is associated with better outcomes of various types (e.g., monetary compensation, bonuses, non-monetary recognition, promotions, career development opportunities, job security, etc.) than low performance. Thus, the goal level-instrumentality relationship should be quite strong when individuals are rewarded for performance.

From an expectancy theory point of view, then, two kinds of forces can result in exertion of greater effort to achieve difficult goals than to achieve easy goals. "Hard goals, on the one hand, require people to accomplish more in order to attain self-satisfaction and, on the other hand, are associated more with beneficial outcomes than easier goals" (Locke and Latham 1990, p. 81).

Summary

Goal theory and expectancy theory are in full agreement, rather than in conflict, regarding the relationship of expectancy to performance (Locke and Latham 1990, p. 85). Expectancy and performance are positively related within any given goal group. Self-efficacy and/or overall expectancy of performing well are positively associated with goal level and performance , both within and across goal groups. Self-efficacy affects goal choice, while both self-efficacy and personal goals affect performance. Assigned goals facilitate performance by influencing both self-efficacy and personal goals. Achievement valence is negatively associated with goal level and performance because harder goals require better performance to attain self-satisfaction. However, difficult goals are more instrumental in achieving valued performance results than easier goals.

Achievement Motivation Theory

According to Atkinson (1958), the arousal of motivation to perform a task is equivalent to the expected positive utility of the consequences. The term motivation designates the activated state of the person which occurs when the cues of a situation arouse the expectancy that performance will lead to an incentive for which the individual has a motive. The arousal of motivation to avoid performance is equivalent to the expected negative utility of the consequences. The resultant motivation, which is expressed directly in performance, is a summation of motivation to perform and motivation to not perform.

Achievement Motivation Theory Components

The relationship between the subjective probability estimate of success at a task and the consequent motivation for the task can be expressed mathematically as

$$T = m\,[P_s - (P_s)^2]$$

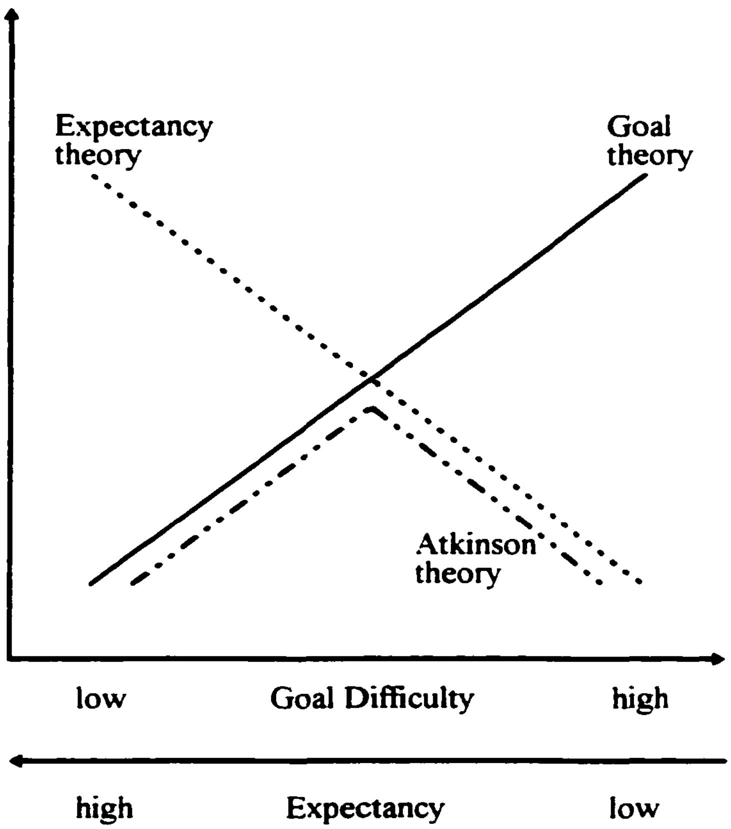
where T represents the resultant motivation to perform or avoid the task, m represents the difference between the motive to achieve success and the motive to avoid failure, and P_s represents the individual's subjective probability of success. For positive values of m, T is maximized when $P_s = 0.5$. In other words, individuals are motivated mostly by goals set at levels corresponding to intermediate difficulty and their motivation decreases as the perceived difficulty approaches certainty of achievement or impossibility. For negative values of m, the situation is reversed.

In contrast to goal theory and expectancy theory, achievement motivation theory proposes that the relationship between probability of success and performance is curvilinear, with the highest level of performance occurring at moderate levels of probability or expectancy. Figure 8 is a comparison of achievement motivation theory with goal theory and expectancy theory (i.e., achievement motivation theory has been added to Figure 3).

According to Locke and Latham (1990), the conflict between goal theory and achievement motivation theory has not been easy to resolve because Atkinson's inverse -U function (depicted as an inverse-V in Figure 8) has proved difficult to replicate. One problem with the theory is the numerous intervening variables that are possible. Many studies have not found support for it, and those that did used objective probabilities of

Figure 8

Predicted Expectancy-Performance Relationships II
for Achievement Motivation Theory, Goal Theory and Expectancy Theory



Source: Locke and Latham 1990, p. 64.

success rather than subjective probabilities. Furthermore, results are greatly affected by including in the analysis data indicating how hard the subjects were trying to succeed.

Even in those conditions when the curvilinear relationship between motivation and performance does appear, it seems to be a highly complex and contingent one involving a variety of factors. Those factors include the degree of difference between the desire to achieve success and the desire to avoid failure, the extent of multiple incentives to perform well, the perceived difficulty of the task, and the extent to which task performance leads to the achievement of the goal. In sum, "neither the curvilinear relationship between probability of success and performance, nor that between motivation (as measured by trait or stress measures) and performance, is a very robust or replicable phenomenon" (Locke and Latham 1990, p. 83). The probable reason for the dearth of replication is that trait measures, especially projective trait or motive measures, are so far removed from action and so much in the periphery of consciousness that their influence is easily dominated by situationally specific, conscious factors such as goals and self-efficacy (Locke and Henne 1986).

Summary

Achievement motivation theory proposes that the motivation to perform is a function of the difference between the motives to achieve success and avoid failure in combination with the individual's subjective probability of success. It has be argued that the curvilinear model does not predict experimental results reliably. The primary reason for this failure is that the model omits numerous factors that intervene between the announcement of an objective probability of success and actual performance (goals, self-efficacy, beliefs about what is required for success, etc.).

Although achievement motivation suffers from significant omissions, it is not completely without relevance in this study. The link between achievement motivation theory and Hirst's theory (described next) is the effect of task uncertainty on the individual's estimate of subjective probability of goal achievement.

Hirst's Theory of Task Uncertainty

Data from a meta-analysis of 125 studies by Wood, Mento, and Locke (1987) indicate that goal setting is significantly related to performance, but that there is sufficient unexplained variance in the strength of these relationships across studies to warrant investigation of potential moderators. Hirst (1987) added task uncertainty to the set of potential moderating variables that might affect the relationship between goals and task performance.

Building on the work of Thompson (1967), Hirst defined task uncertainty along two dimensions: task repetitiveness and task openness. Hirst's main hypothesis "is that the effect of setting specific, difficult budget goals on task performance depends on the level of task uncertainty" (Hirst 1987, p. 774). Specifically, setting goals will be less effective in promoting higher task performance when task uncertainty is high than when task uncertainty is low.

As discussed previously, goals often are used to affect motivation, behavior, and task performance. One type of goal of particular interest to accounting practitioners and researchers is the budget. Consistent with the description of direct goal mechanisms discussed previously, Hirst states that "two characteristics that have received special attention are the specificity and difficulty level of budget goals" (Hirst 1987, p. 774). Specific budget goals are expressed in quantitative terms (e.g., sell x units of product y), whereas nonspecific goals are expressed in more qualitative terms (e.g., sell as many units of product y as possible; i.e., a do-best goal). Goal difficulty is described as the level of performance required to achieve a goal, being moderately difficult if the goal is set at the average level of performance for a given task. Chow (1983) states that goals that are above average are considered difficult, while goals that are below average are labeled easy, and that specific, difficult budget goals lead to higher performance than specific moderate, specific easy, or general goals. These statements are consistent with the goal setting literature as reviewed earlier.

Accounting researchers have relied on the psychology literature to predict and interpret the effects of setting budget goals (e.g., Ronen and Livingstone 1975, Kenis 1979) for two valid reasons. First, the types of goals are similar across both fields (Hirst 1987, p. 775). As Hirst explains, a potential difference between the goal-setting research in accounting and psychology is that accounting studies tend to focus on financial (budget) goals while psychology studies often focus on non-financial, physical goals. However, several accounting studies have used non-financial, quantitative goals (e.g., Rockness 1977; Chow 1983) and a number of psychology-based studies have used financial budget goals (e.g., Ivancevich 1977; Ivancevich and McMahon 1977; Campbell 1984; Chesney 1985; Campbell and Gingrich 1986).

This common ground is broadened when it is recognized that budget goals can be expressed in both physical and financial terms (Heitger, Ogan and Matulich 1992). The budgetary process includes the development of projections for the major elements of the financial statements. Essential to the development of those financial projections are expectations for the underlying physical activities. Consequently, budgets usually include both monetary and non-monetary information (Hirsch and Louderback 1992). According to Heitger, Ogan and Matulich (1992, p. 290), "a budget is most useful when all plans are reduced to the common measure of money and units of output and input." Thus, setting non-financial goals is central to the budgetary process. This is the bridge between psychology and management research on the one hand, and the accounting literature on the other.

Hirst encouraged caution by citing the suggestion of Naylor and Ilgen (1984) that surprising little attention had been paid to the process by which goal setting promotes performance, especially the examination of moderating variables that can limit the extent to which goal setting has a positive effect on performance. An investigation of moderator variables has the potential to identify conditions under which goal setting may not have a positive effect on task performance, and knowledge about moderator variables could have practical implications for designers and managers of goal setting programs. Although the review of the literature presented earlier shows that some variables affecting the goal setting-performance relationship have received research attention in the interim, task uncertainty has yet to be well investigated even now.

Before moving to a description of the model, it is worth remembering that task uncertainty and task complexity are not synonymous. The effects of goal setting on performance have been studied across a wide variety of tasks with a wide range of complexity. In general, the magnitude of goal effects on performance decreases as task complexity increases (Wood, Mento, and Locke 1987). On simple tasks, goals affect performance in a more direct manner by activating one or more of the direct goal mechanisms described previously (direction, intensity, and duration of effort). The indirect mechanisms of problem solving and the development of task-specific strategies are less important. As tasks become more complex, problem solving and the development of relevant task strategies become more important and the direct mechanisms become relatively less effective.

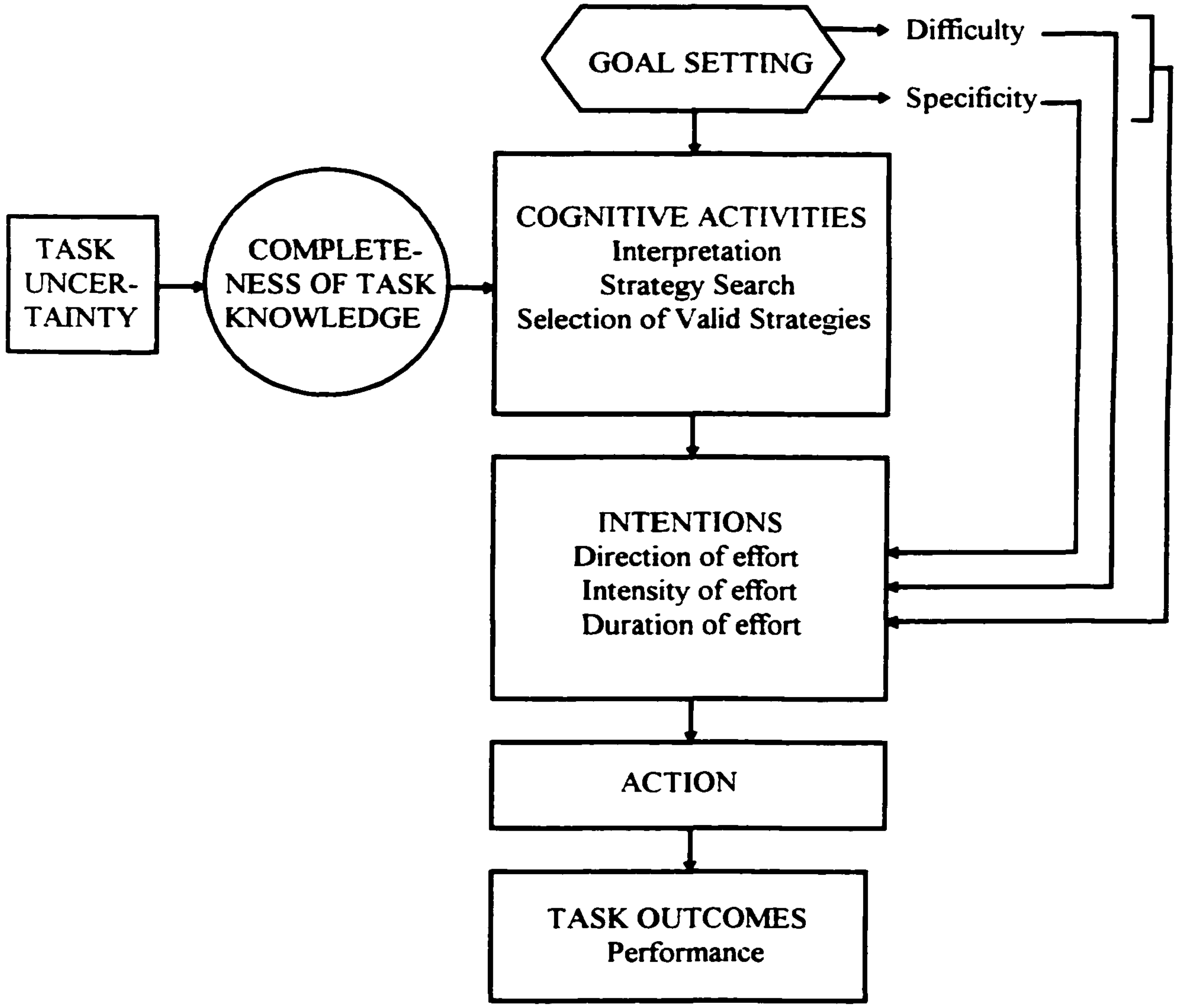
Hirst proposed that both the direct and the indirect goal mechanisms also are affected by task uncertainty. This current study attempted to manipulate the components of task uncertainty to measure their effects on task performance, while holding task complexity constant (see Figure 1 for a taxonomy of task complexity). A task of moderate complexity was selected so that both the direct and the indirect mechanisms would be operative.

The Model

Figure 9 is a diagram of Hirst's model. The model incorporates the direct and indirect mechanisms by which goals affect task performance. Commitment to specific, challenging goals generally have been found to focus the direction of effort on the activities necessary to accomplish the goal, as well as to elevate the intensity of effort for a longer period of time. Specific, challenging goals also trigger the cognitive activities

Figure 9

The Hirst Model of the Effects of Task Uncertainty on Task Performance



Source: Hirst 1987, p. 776.

necessary to search for and select valid strategies (an indirect mechanism) for goal attainment.

These mechanisms assume that individuals know what actions are necessary and relevant for goal achievement. Using the words of Hirst, "In terms of (the model), the four mechanisms are conditional on the accurate interpretation of goals and the effective search for, and selection of, valid actions plans" (1987, p. 777). The argument that follows, upon which Hirst's theory is based, is that "significant difficulties may arise in performing these cognitive activities when task uncertainty is high" (1987, p. 777). Consequently, it is hypothesized that task uncertainty affects the relationship between goal setting and task performance.

Hirst defines goal setting as "setting specific, difficult budget goals" (1987, p. 774). Therefore, by implication, not goal setting occurs when goals are specific and moderate, specific and easy, or of the do-best type. The complete absence of goals is not required. In fact, as discussed previously, there is evidence that when individuals are not assigned or asked to set goals they will set their own internally.

As shown in Figure 9, task uncertainty affects the cognitive activities involved in strategy development (an indirect mechanism) by affecting the completeness of task knowledge. The ability to discover or create appropriate task strategies bears on the direction, intensity, and duration of effort. It is reasonable to conjecture that task uncertainty could affect any or all three of these mechanisms directly. It also is reasonable to expect that task uncertainty may have some differential effect on performance under high and low goal difficulty conditions.

Two propositions are central to the argument that task uncertainty affects the relationship between goal setting and task performance. First, task uncertainty is assumed to have a negative effect on completeness of task knowledge. For example, anyone who has attempted to assemble for the first time an item of even moderate complexity begins with incomplete task knowledge. Even if the instructions are carefully studied, the assembly process often can be quite different from what was anticipated. Second, the positive effects of goal setting are conditional on the completeness of task knowledge, as shown in Figure 9. It is hypothesized that incomplete task knowledge will inhibit the ability of the individual to find strategies relevant to the successful completion of the task. Consequently, the individual may develop a set of incomplete, inefficient, or inappropriate task strategies.

Both dimensions of task uncertainty, repetitiveness and openness have implications for the acquisition of task knowledge. The dimensions of task uncertainty are described next.

Task Uncertainty

Building on Thompson (1967) and following his earlier work (Hirst 1981), Hirst defined task uncertainty along two dimensions, repetitiveness and openness:

> Repetitiveness refers to the frequency with which the focal task is performed, and openness refers, in organizational settings, to the extent to which a task is affected by events of stimuli external to the focal organization and to tasks performed by others in the focal organization. Tasks that are both non-repetitive (repetitive) and open (closed) to "significant" outside influence are referred to as high (low) uncertainty tasks (Hirst 1987, p. 777).

Repetitive tasks provide more opportunities to develop task knowledge than do non-repetitive tasks. Complete task knowledge becomes more critical as goals become more specific and more challenging. Task knowledge includes information about products of the task, actions to produce the products, and the relationships (e.g., spatial, temporal, cause-effect) among actions and products. Knowledge about other factors may be important as well, such as props and rewards. As uncertainty varies across tasks, it is not unreasonable to expect that task knowledge also could vary.

Task knowledge is developed during the performance of repetitive (low uncertainty) tasks as individuals learn which strategies and actions are most effective for the completion of the task. At the extreme, if a task is to be performed only once, learning opportunities are minimal at best. Even if the individual attempts to apply experiences from prior tasks that appear to contain some similarities, the strategy selection process still is likely to be flawed. Although the opportunity to develop task knowledge is not equivalent to the actual acquisition of task knowledge, it is reasonable to expect a positive relationship between these variables. If so, there also is likely to be a positive (negative) relationship between task repetitiveness (nonrepetitiveness) and completeness of task knowledge.

As tasks become more open to stimuli external to the focal organization, the actions of others will influence the ability of the individual to achieve desired levels of task outcomes. Modeling these influences, and therefore incorporating them into strategies and actions, is difficult because the actions of others often are difficult to observe and sometimes entirely unobservable. If so, information cues may be limited such that knowledge about these outside influences may be restricted or unavailable. According to

Hirst, "The inability to model the actions and influences of others causes knowledge about the consequences of own actions to be incomplete" (1987, p. 777). Furthermore, because some consequences of own action may be unobservable and/or unknown, the difficulty of modeling is compounded (March and Olsen 1976). Consequently, there is likely to be a negative relationship between task openness and the completeness of task knowledge as the inability to model a task constrains knowledge acquisition. This is important because, as discussed next, the positive effects of goal setting are likely to be conditional on the completeness of task knowledge.

The Completeness of Task Knowledge

The completeness of task knowledge can affect all three cognitive activities --- task interpretation, search for strategies, selection of strategies --- that must be performed if goal setting is to have a positive effect on task performance. It seems reasonable to expect that an individual could have difficulty interpreting the task, searching among alternative courses of action (both appropriate and non-appropriate), and selecting relevant strategies if task knowledge is incomplete (see Figure 9). Hirst uses two examples to illustrate the importance of task knowledge in the promotion of task performance (1987, p. 779):

> To illustrate, consider your reaction to the following goal-related instructions. "Perform two CATscans on Tuesday morning" or "Assemble 200 carburetors each week." For some, the first instruction is not interpretable because we have no knowledge of what the label "CATscan" represents. And although many of us can interpret the second instruction at a general level, it is likely that some will be unable to develop (search for and select) plans to guide action because of incomplete task knowledge about the component activities.

Most situations will not be as extreme as these. More often, goal instructions are communicated to individuals who have some task knowledge. Yet the level of task knowledge frequently is incomplete, resulting in the selection of invalid or incomplete task strategies. Even if goal setting induces an increase in the level and/or duration of effort, there may not be a corresponding increase in performance because the effort is misdirected or inefficient. At the extreme, incomplete task knowledge can preclude goal setting from having any effect on task performance.

Goal setting, especially goal specificity, makes behavior selective by focusing attention on certain task activities. Selective behavior can be functional if there is a reduction in the resources spent on performing irrelevant, nonproductive activities. On the other hand, dysfunctional selective behavior occurs when goal setting causes the exclusion of relevant activities. Anyone rushing to program a new VCR or assemble a complicated product probably has experienced the inefficiencies resulting from failing to heed the details of the instructions. Similarly, performance on any task can suffer from taking shortcuts or failing to select relevant strategies.

This narrow definition of task also can occur in organizations comprised of interdependent subunits. Baumler (1972) and Hopwood (1972) found evidence that specific subunit goals tend to focus managerial attention on subunit activities instead of on activities necessary to the effective management of subunit interdependence. Goal specificity and incomplete task knowledge can lead to the incorrect belief that subunit performance will be maximized by focusing on the former to the exclusion of the latter. Depending on the importance of the interdependent activities, subunit performance can suffer as a result.

Thus, task uncertainty can lead to incomplete task knowledge. The positive effects of goal setting in the absence of complete task knowledge may not be fully realized because of interference with the cognitive activities that translate goal setting into task performance. It follows then that task uncertainty will affect the relationship between goal setting and task performance, formally hypothesized by Hirst as follows (1987, p. 781):

> H1: There is an interaction between goal setting and task uncertainty affecting task performance.

The prior discussion implies that when task uncertainty is low, goal setting (i.e., setting specific, difficult goals) will lead to an increase in performance. On the other hand, when task uncertainty is high, goal setting will result in either a smaller increase, or no increase, or a reduction in performance.

Task uncertainty also has been suspected to operate at higher levels of an organization. In an organizational environment the level of task uncertainty primarily is determined by the repetitiveness of a function and the extent to which external factors affect the outcome of management decisions. According to Kren and Liao (1988, p. 283), "Task uncertainty is a function of the extent that an action by a manager will result in an expected outcome." Accounting measures increasingly lose their ability to accurately reflect the actions that will lead to the accomplishment of organizational objectives as task uncertainty increases. Consequently, reliance on accounting measures can lead to dysfunctional behavior when task uncertainty is high (Kren and Liao 1988).

In an earlier paper, Hirst (1981) suggested that these propositions may explain the contradictory results reported by Hopwood (1972) and Otley (1978). Howood hypothesized that subordinates evaluated under a system with high reliance on accounting performance measures would be more likely to experience job-related tension, have poor relations with superiors and peers, and be more likely to engage in dysfunctional behavior. His results generally were in agreement with his hypothesis. Otley replicated Howood's study and expanded it to include performance measures. His hypothesis was that high reliance on accounting performance measures in performance evaluation would lead to poor performance. Budget error was used as an objective performance measure. In contrast to Otley's expectations and Hopwood's results, Otly was not able to confirm and increase in job-related tension. Furthermore, high reliance on accounting performance measures actually improved performance rather than inhibit it.

The departments Hopwood studied were highly interdependent, implying substantial exposure to outside influence and, therefore, a high level of task uncertainty. In contrast, Otley described the organizational units in his study as operating independently of one another in a stable environment. This would imply a low level of task uncertainty. Therefore, Kren and Liao (1988) state that it can be argued that high reliance on accounting performance measures would be detrimental to the performance of the subjects in Hopwood's study but not in Otley's.

In summary, one contingent variable that could affect performance is the task uncertainty perceived by a subordinate. The effect appears to operate at various organizational levels. The intent of this study is to explore the effect of task uncertainty on performance within a goal setting framework.

Research Questions

Hirst asserts that "both argument and evidence suggest that task uncertainty will moderate the relation between goal setting and task performance" (1987, p. 781). Despite some prior research efforts, this moderating influence has not received much attention. In Hirst's words, "At this stage, however, evidence about goal-setting effects is limited, particularly where task uncertainty is high" (1987, p. 781).

This study used laboratory experiment to examine the effect of task uncertainty on performance in a goal setting environment. The objective was to address several research questions. As will be described later, the data were analyzed with a partial least squares (PLS) approach which does not require statements of formal hypotheses. Therefore, the research questions below were formulated to provide direction rather than to serve as the basis for traditional hypothesis testing:

1. Is the task performance of subjects performing a low uncertainty task greater than the performance of subjects performing a high uncertainty task?

2. Does the interaction between task uncertainty and goal setting affect task performance?

3. Is the goal commitment of subjects performing a low uncertainty task greater than the goal commitment of subjects performing a high uncertainty task?

4. Is the intensity of effort expended by subjects performing a low uncertainty task greater than the intensity of effort expended by subjects performing a high uncertainty task?

5. Is the duration of effort expended by subjects performing a low uncertainty task greater than the duration of effort expended by subjects performing a high uncertainty task?

6. Are the task strategies selected by subjects performing a low uncertainty task more appropriate than the task strategies selected by subjects performing a high uncertainty task?

7. Does the interaction between strategies and strategy appropriateness affect performance?

8. Is the task knowledge acquired by subjects performing a low uncertainty task greater than the task knowledge acquired by subjects performing a high uncertainty task?

9. What is the effect of ability on performance within a context of task uncertainty?

A brief discussion of the potential contribution of this study is next. Then the research methodology used to investigate these issues will be described.

Contributions

It is in the best interest of an organization to provide an environment in which individual employees are likely to make decisions that will contribute to the achievement of organizational objectives. An effective organizational control system encourages subordinates to accomplish personal goals that will support the achievement of the broader goals of the organization that employs them. Consequently, the investigation of how goals should be established, and by whom, as well as how individuals and groups respond to goal setting and goals, has been a topic of academic and practical importance. The result has been the development of a theory of goal setting and task performance. It is hoped that this study contributes to the continued development of goal setting theory by testing Hirst's proposition that goal directed performance is affected by task uncertainty.

The purpose of this study was to examine the effect of task uncertainty on task performance in the presence of goal setting. Although the robust effects of goal setting on performance have been well documented, inconsistencies remain which indicate the possibility of relationships among variables which have yet to be investigated. This study attempted to test the theoretical proposition that task uncertainty affects the relationship between setting a goal for a task and the ultimate performance of that task.

Chapter III

RESEARCH METHODOLOGY

A controlled laboratory experiment was conducted to examine the proposition that task uncertainty has an effect on task performance, and to investigate the potential mechanisms by which that could occur. This section begins with a description of the overall research design, followed by a description of the subjects and concluding with a detailed description of the experimental procedures.

Research Design

This experiment utilized a fully crossed, between-subjects factorial design. As shown in Figure 10, data were collected from 99 subjects who performed the experimental task under one of two conditions of task uncertainty (high or low) and one of two conditions of difficulty (easy or difficult) for specific goals.

The selection of a laboratory experiment to examine the effects of task uncertainty on performance was motivated by two factors. First, the laboratory often is a good starting place for the testing of theory. Experimental methodology affords the opportunity to more closely control the variables of interest while minimizing the effect of extraneous variables (conducting the entire experiment via the computer as described later provided

Figure 10

Research Design

Task Uncertainty	Goal Difficulty: Easy	Goal Difficulty: Difficult
Low	25 subjects	24 subjects
High	25 subjects	25 subjects

the opportunity for particularly close control). Theory that cannot be supported in the controlled environment of the laboratory is less likely to hold in the field. Second, little of the limited research conducted to date related to task uncertainty has been performed in the controlled setting of the laboratory and none has specifically addressed the theoretical proposition offered by Hirst.

Experimental Task Overview

The experimental task involved the manipulation of goal difficulty (i.e., goal setting) and the two primary elements of task uncertainty, repetitiveness and openness, using a timed computerized word search game adapted from a commercially sold version.[5] Subjects formed words from letters displayed on a computer monitor. Performance was measured in points awarded according to the size of the words formed.

A word search task was used for several reasons. First, from among the various tasks considered (see Appendix A for a list), it provide the cleanest manipulation and measurement of all of the relevant variables. Second, it could be learned quickly and did not require subjects to possess any unusual knowledge, talents, skills or experience. Third, similar tasks have been used in other goal-setting studies. Finally, it permitted a typical subject to complete the experimental task in approximately one hour as shown in Table 1, which provides summary statistics for experimental task completion times.

[5] The experimental task was based on the computer game *Word Hunt*, which is similar to the more familiar *Boggle* (available in both table and computer versions). Permission was obtained from the *Word Hunt* author to modify and use the game for educational research purposes.

Table 1

Summary of Experimental Task Completion Times
(hh:mm)

Mean	1:06
Median	1:05
Mode	1:01
Standard deviation	0:07
Minimum	0:48
Maximum	1:24

A design objective of limiting the task to approximately one hour and the entire session to approximately one and one-half hours was deemed important for three reasons. First it was believed that about ninety minutes, the typical length of many classes, would be the maximum length of time slots available from student subjects. Second, undesirable excessive fatigue could be minimized. Finally, lengthier commitments might have reduced participation by diminishing the attractiveness of the cash that could be earned ($10-$15 on average) by potential subjects, many of whom were employed in full or part time positions.

Random assignment of subjects to treatments controlled for the effects of English language proficiency and typing ability. The relatively short word lengths (roughly three to five letters) also should have helped to minimize the effects of any differences in language proficiency. The results of tests described in detail later confirmed that language ability was indeed randomly distributed across treatments and that it significantly affected task performance. No tests were conducted for typing ability to avoid adding substantially to the overall time required of the subjects with little expected benefit.

As noted earlier, Hirst (1987) defined goal setting as setting specific, difficult goals. Also, the state of not goal setting does not mean the complete absence of goals. This is because even if no goals or do-best goals are prescribed, individuals often will set their own internal specific goals. Consequently, goal setting was manipulated by varying the difficulty of the specific goal for each treatment group. Goal difficulty was manipulated by assigning either an easy or a difficult performance goal based on the practice period performance for each individual subject. Therefore, each subject had a unique performance goal. No specific knowledge of goal setting issues was required.

The manipulation of task repetitiveness included the number and arrangement of the letters and the time allowed to form words. The manipulation of task openness included two elements: (1) the skill level of a "competitor" against which each subject competed for points and (2) the possibility of interruptions during performance. The entire process was controlled by a computer program, including manipulation of the variables as well as measurement and recording of results. A more detailed description of the experimental task is presented later.

The use of word construction tasks in goal setting research is not new. Locke and Latham (1991 p. 40) identify fourteen laboratory studies that used word games as experimental tasks. Many used anagrams in which the subjects were asked to form words from the letters contained in a single line. In the words of Hollenbeck and Brief (1987, p. 400), "This task (anagram) has been used frequently in goal setting research." For example, in the study by Vance and Colellla (1990 p. 70), "subjects were provided with a set of seven letters and were asked to list as many words as they could in a three minute period." Nine sets of seven-letter anagrams were generated. A somewhat interesting feature of their study was that to insure comparable difficulty among the letter sets, they were equated for the ease with which letters comprising them could be used to make words in the English language according to letter values in the game of SCRABBLE. Similarly, subjects in studies by Tang, Liu and Varmillion (1987) and by Tang and Sarsfield-Baldwin (1992) solved a series of twenty-five letter anagram sets. One of the advantages of a word construction task is that, as noted by Tang and Sarsfield-Baldwin (1992, p. 416), "although college students are familiar with the anagram-solving task, they do not solve anagrams regularly." Thus, while essentially all college student subjects should possess sufficient ability to perform a word construction task, few or none would be expected to have a particular advantage over others in the subject pool.

A punched card letter decoding task is another type of alphabetical task used frequently in the accounting literature, most recently by Hirst in conjunction with Fatseas (Fatseas and Hirst 1992). Their task required subjects to determine letters on computer cards, for which the printing was suppressed, by analyzing the patterns of holes punched in the cards representing the letters. Among the several studies that have used a decoding task were Chow (1983) and Chow, Cooper & Waller (1986). Modifications of the task have been exported to the psychology literature as well (e.g., Farh, Griffeth & Balkin 1991; Hollenbeck & Brief 1987).

The word search task used for this experiment was a variation of *Word Hunt*, a commercially available computer game. *Word Hunt* is similar to the more familiar *Boggle*, a popular game available in both table top and computer versions. As opposed to anagrams, which present subjects with a single line of letters at a time from which to form words, the *Boggle* style of word search task presents subjects with a frame (square matrix or other shape) of letters from which to form words. Several references to matrix-style word search experimental tasks appear in the literature. In the first of successive articles, Amati (1991a) utilized the "*Boggle* Test" to calculate a verbal-cognitive index to determine the correctness of mental retardation diagnoses among school-age children. In the second study, Amati (1991b) examined the influence of age and grade level on performance on the "*Boggle* Test", described as a series of ten 4 x 4 letter grids from which subjects were to find as many words as possible from contiguous letters. In both studies, the results were evaluated according to the number and length of words found; the number of letters used; and the use of horizontal, vertical, and diagonal letter connections. Austin (1989) and Harackiewicz, Sansone and Manderlink (1985) also describe the task used in their studies as a 4 x 4 matrix word search game (specifically identified as *Boggle* in the Austin study). As noted previously, Phillips and Freedman (1988) used an somewhat similar embedded words search task in their goal-setting study.

Given the complexity of the relationships among the variables and the characteristics of the data, the partial least squares approach (PLS) to structural equation modeling (SEM) was used to analyze the results. Accordingly, a description of the path analysis model is presented next.

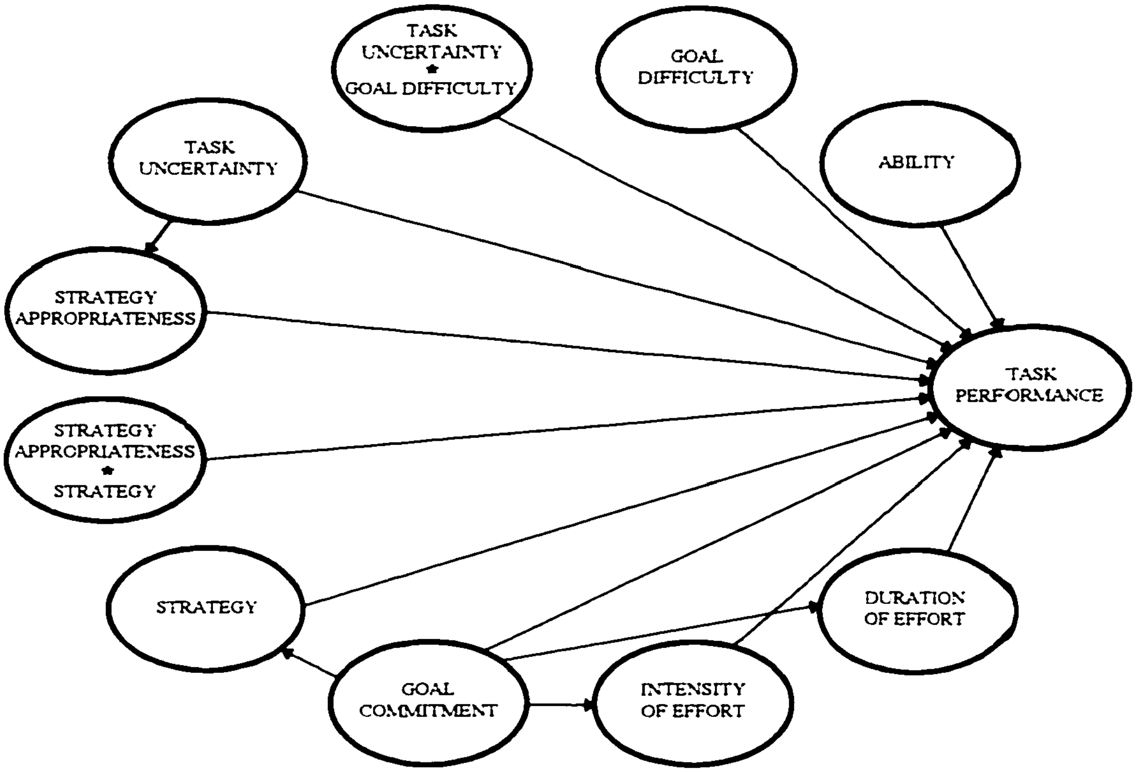
The Research Model

Figure 11 is a graphical representation of the research model designed to investigate how task uncertainty affects the task performance of individuals working in a goal setting environment. The diagrammatic description of Hirst's theory presented earlier in Figure 9 guided the design of the experiment. The final research model, however, was a synthesis of elements from goal setting theory, expectancy theory, and of course Hirst's task uncertainty proposition. There also are traces of achievement motivation theory included in the design, but to a much lesser extent.

Dependent Variable. Task performance was the dependent variable. It was measured as the number of points obtained by forming words from arrangements of letters displayed on the computer screen. Cash earnings were awarded to each subject based on $0.10 for each point accumulated, plus a $5.00 bonus for achieving an assigned goal.

Figure 11

Research Model Diagram



Moderator Variables. The primary focus of this investigation was the potential moderating effect of task uncertainty proposed by Hirst (1987) on the strength of the relationship between goal setting and task performance. Task uncertainty was manipulated by varying the content and arrangements of letters (task repetitiveness) and by introducing external and internal influences (task openness) in the form of unexpected interruptions and variable levels of task competition.

Goal difficulty was manipulated by assigning one of two goal levels, easy or difficult, to the subjects in each of the task uncertainty treatment groups. The practice period performance of each subject was used to determined the goal for that subject, rather than by following the more traditional approach of assigning a single normative goal to an entire treatment group based on pilot study results. The individual goal for each subject in the difficult-goal treatment group was calculated by increasing the average practice period performance of that individual by 20%. Subjects in the easy-goal treatment group received a goal that was 20% less than each of their individual average practice period performances. This approach was adopted to more accurately represent one of the most common goal setting conditions found in industry. While there are most certainly situations in which goals are set for entire groups (e.g., sales for an entire organization), it also is quite often that individuals are held responsible for the achievement of their own personal goals (e.g., a sales person covering a particular customer or territory). Professional sports are a setting in which individual goals abound. Player employment contracts often include a variety of performance incentives for that particular player (e.g., batting averages and earned run averages in baseball; rushing yardage, touchdowns and completion percentages in football, etc.) which are not directly connected to overall team performance. Similar arrangements can be found in other settings.[6]

Also included in the model are paths for two measured variables, ability and goal commitment, for which the moderating effects on task performance have been well documented. Ability was determined according to scores on standardized graduate admission exams. Goal commitment was measured by questionnaire items adapted from the goal setting literature administered both before and after the completion of the experimental task.

Two other moderators recognized in the literature, feedback and task complexity, were controlled in the experiment. Feedback was provided immediately and continuously (in the form of points accumulated and time remaining) throughout the experimental task. Upon completion of the task, subjects also were provided with detailed summaries of points achieved and cash earned.

Mediator Variables. As discussed in the earlier review of the goal setting literature, several mediator variables operate as mechanisms through which goal setting affects task performance. Duration of effort (also known as persistence) was defined in this experiment as time on task and measured using the internal computer clock. Intensity of effort was measured with questionnaire items adapted from the goal setting literature. Goal setting studies also have identified task strategy as a mediator variable. Task strategies are broadly defined: "task strategies are conscious or deliberate action plans motivated by goals." (Locke & Latham 1990, p. 87). Observation of task strategy in goal-

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[6] In fact, the pursuit of an individual goal can be in direct conflict with an organizational goal (such as a baseball player striving for more runs batted in or a higher batting average in a situation when a sacrifice would be better for the team).

setting research has proved to be somewhat elusive. According to Earley, Connolly & Egren (1989, p. 25), "Task strategy has proved difficult to measure adequately in goal-setting research to date". They also state that the typical goal setting study examining task strategies relies on such measures as the number of steps in a person's strategy (Earley et al., 1987), a descriptive analysis of the strategy (Campbell, 1984; Earley & Perry 1987), or an index of quality based on the relation of the strategy to key task characteristics (Earley et al., 1986). Other studies (e.g., Earley, 1985; Huber 1985) have relied on self-report measures of strategy, a technique that Earley, Connolly and Egren claim is of questionable validity (1989, p. 25).

Hirst (1987) suggests that task uncertainty will affect the selection of appropriate task strategies. In particular, he hypothesizes that high task uncertainty will lead individuals to select less appropriate task strategies than will individuals faced with tasks of low uncertainty.[7] Strategy selection was operationalized in this study by allowing each subject to chose from between two strategies. One strategy was to form shorter words for fewer points each, while the alternative strategy was to form longer words for greater point values. In addition, the appropriateness of the strategy selected by each subject was evaluated by comparing the chosen strategy with the expected strategy based on the practice period performance.

Interactions. Two interactions were included in the path diagram. As noted earlier, Hirst (1987) suggests an interaction between goal setting and task uncertainty affecting task performance. Generally speaking, goal setting includes a broad range of

[7] Although the goal setting literature distinguishes between strategy and direction of effort, this study views direction of effort as a component of strategy selection.

goal types, beginning with no goals and progressing to do-best, self-set, participatively-set, and assigned goals. When no specific goal is set (i.e., no goals or do-best), individuals often set their own internal personal goal that they do not communicate to others. Thus, a comparison of performance in the presence of goal setting with performance in the absence of goal setting is not truly possible. Furthermore, the accurate measurement of such goals would have been open to question.

Announced self-set and participatively-set goals can be accurately measured, but the manipulation of goal difficulty would have been problematic. Participatively-set goals also can be readily measured, but the complexity of the manipulation of goal difficulty would have presented significant programming and control challenges. Consequently, this study utilized assignment as the method of goal determination and goal difficulty as the manipulated condition.

The model also includes an interaction between strategy and strategy appropriateness. Recall that each subject selected from between two strategies for obtaining points based on word length. Thus, the strategy itself could result in the accumulation of greater or fewer points for the same number of words formed. However, one of the two strategies could be more appropriate for a particular subject depending on the individual's ability and desire to find shorter or longer words.

Subjects

A total of 103 graduate student subjects from the University of Houston participated in the experiment, of which 100 produced usable data. One subject did not complete the experiment because of a computer failure, one subject completed the experimental task but failed to answer any of the questionnaire items, one subject elected to terminate the experiment prior to completion for personal reasons, and the academic records for one subject did not include admission test scores (used to evaluate ability).

All subjects were business administration, computer science, or math masters level students enrolled in a variety of masters level courses in business administration. The experiment was conducted starting in April of 1998 and continuing throughout the calendar year. This relatively lengthy data collection occurred because participation was entirely voluntary. The only incentive was the possibility of earning a sum of cash determined by the level of performance achieved on the experimental task. Subjects did not receive cash merely for volunteering for the experiment, nor did they receive any noncash compensation, such as course credit, that would encourage participation.

Acquisition

Subjects were invited to participate in several ways. The primary method was a personal appeal by the experimenter to the various classes (with permission from the course instructors) to ask for volunteers. Potential subjects were provided only with enough information to make an informed decision. In particular, they were told that the experiment would be performed entirely on a personal computer provided by the experimenter, with no special skills, talents, or knowledge required. They also were told that an opportunity existed to earn a significant sum of cash and that, while the amount would depend on their individual performance on the experimental task, the average was expected to be in the range of $10 to $15, although some might earn significantly more while others might earn significantly less. Finally, it was explained that the amount of time required would be between 75 and 90 minutes on average.

In addition to personal invitations to classes by the experimenter, a similar announcement also was included in the College of Business Administration internet newsletter. Several subjects were obtained in this manner. Finally, a few subjects became aware of the opportunity through other subjects. As will be described later, no subject indicated that the nature or the results of the experiment were discussed with another subject.

Interested potential subjects were provided with an Experiment Appointment Form to schedule a time for participation and an Information Release Form that summarized the requirements for the experiment, provided directions to the laboratory, and granted the experimenter written permission to access university records to obtain scores on the Graduate Management Admission Test (College of Business graduate students) and the Graduate Records Examination (other graduate students). Subjects were told only that these scores would be used for experimental control purposes. The Experiment Appointment form, shown in Appendix B, included e-mail address and telephone number information used to contact subjects if rescheduling became necessary (change in availability of the laboratory, the same time requested by more subjects than computers available, etc.). The appointments for all subjects were confirmed via e-mail (all subjects had e-mail addresses) and a reminder was sent via e-mail two days before the scheduled appointment. The Information Release Form, shown in Appendix C, was collected when the subjects arrived at the laboratory. The specific experimental procedures are described in more detail later.

Demographics

The sample included 58 females, 41 males, and one subject who did not disclose gender information. The average subject was 27.5 years of age with 5.2 years of work experience. Average graduate admission exam verbal and math percentile scores were 57.2 and 75.3 respectively. Table 2 summarizes demographic information.

Verbal percentile scores were the primary measure of ability. No formal attempt was made to determine the principal language of each subject in an attempt to avoid the potentially incorrect presumption that the ability of subjects with English as a second language would be inferior to those with English as their primary language. In fact, anecdotal evidence based on observation by the experimenter indicated otherwise. The subject who achieved the highest task performance exhibited an excellent command of the English language although it did not appear to be the primary language of that subject. On the other hand, again anecdotally, among the poorest performers were several subjects for whom English appeared to be the primary language. Furthermore, it was not deemed practical to measure proficiency in the many diverse languages of a widely international student population. Nor would self reported measures be of value since is conceivable that some would view their own proficiencies as equal.

Other standardized tests for verbal ability were not administered to subjects immediately prior to or part of the experimental sessions. Such measurements were not deemed to be sufficiently superior to the admissions exam scores to warrant the additional time required of the subjects.

Table 2

Subject Demographic Information

Average Age	27.5
Gender	
Female	58
Male	41
Undisclosed	1
Total	100
Average percentile score on graduate admission test	
Verbal	57.2
Math	75.3
Average work experience (years)	5.2

Experimental Procedures

As noted previously, the experimental task was conducted entirely by personal computer. This approach was selected because the nature of the theoretical propositions tested demanded a level of complexity, flexibility, and sophistication which could not be accomplished manually. Many of the manipulations and measurements were designed to correspond to a variety of possible outcomes and events, and they often had to occur instantaneously and simultaneously. Of equal importance was a required level of control that only the computer could provide.

The introductory explanations, the instructions, the training and examples required to familiarize the subject with the word finding task, the scoring and compensation procedure, the practice period, the production period, the feedback, and the questionnaires all were controlled by the computer program and displayed on the monitor. All manipulations and controls were performed by the computer and all data were captured and recorded by the computer. The subject used only the keyboard and the monitor to perform the experiment. No other items, such as writing materials and calculators, were required or allowed. Except for the check-in and check-out procedures, the entire experimental task was conducted without contact with the experimenter.

Physical Laboratory Arrangement

The experiment was conducted in the University of Houston College of Business Administration behavioral laboratory in Melcher Hall. The laboratory is composed of five separate activity rooms surrounding a central control room. Thus, as many as five subjects could perform the experiment at any one time. Communication between rooms was not possible. The rooms were separated by soundproof walls and could be physically accessed only through a door connecting to an outside hall. Doors remained shut during the entirety of each experimental session. Although the activity rooms contained wall-mounted video cameras and one-way windows designed for observation from the central control room, it was thoroughly explained that these devices were not used in any way during this experiment. There was no evidence of non-acceptance of this explanation.

Check-in and Check-out Procedures

The central control room was used for check-in and check-out procedures. To facilitate efficiency, subjects were instructed to complete the Information Release Form in advance prior to check-in. Any subject who had not done so was allowed to complete the form in the control room. All Information Release Forms have been retained in a permanent file.

Each subject also completed the Informed Consent Form required by the University of Houston Committee for the Protection of Human Subjects. A sample form is shown in Appendix D. All completed forms have been retained in a permanent file.

Social security numbers were recorded and checked against a list of those who had completed the experiment to prevent attempts to participate more than once. Although no surreptitious attempts were detected, several subjects did express an interest in repeating the experiment. Reasons given ranged from a desire to earn additional cash compensation, a desire to exceed their personal performance, and enjoyment in performing the task.

Each subject received a preprinted instruction sheet, shown in Figure 12, instructing the subject that the entire experiment would be performed on the computer, that writing materials were not permitted in the computer rooms, that the total time required would be approximately one hour, and not to discuss the experiment with another subject who had not yet participated. The experimenter reviewed the instructions with each subject and answered any questions.

The check-in procedures concluded with the experimenter providing each subject with a prepared computer disk that allowed access to the experiment program and was used to record experiment data. Subjects then were escorted to a vacant computer room and reminded to insert the disk into the disk drive (the computer was already on), click the "START" button on the screen to begin the experiment, and progress screen by screen to the completion of the experiment.

Upon completion, subjects returned the disk to the central control room. They received the amount of cash earned, were reminded again not to discuss the experiment with other subjects, were debriefed about the purpose of the experiment, and thanked for their performance.

Random Selection of Subjects and Assignment of Treatments

The experimental procedures included randomized selection of subjects and assignment of treatments to subjects. As described previously, subjects were recruited from a broad population of graduate students and participated on a purely volunteer basis.

Figure 12

Printed Subject Instructions

INSTRUCTIONS

Everything you do will be at the computer:

1. Insert the disk into the disk drive.
2. Click the START button on the screen.
3. Follow the instructions on each screen to completion.

PLEASE DO NOT USE ANY HANDWRITING MATERIALS.

The time required is approximately one hour.

Please do not discuss the experiment with anyone else who might be a subject.

Thank you for participating in this experiment.

Subjects arrived at the laboratory at a time of their own choosing completely randomly. Arrival times were selected entirely without influence by the experimenter.

The computer disk provided to each subject was the means by which treatments were assigned randomly. Each disk contained a code that determined which of the combinations of task uncertainty (high, low) and goal difficulty (easy, difficult) the subject would encounter during the production period of the experiment when points were earned for cash compensation. Disks were arranged randomly, stored in a secure container, and provided in the order in which they were stored to subjects as they arrived at the laboratory.

The code contained on each disk also determined the sequence in which the arrangements of letters, called frames, would appear during the production period. Subjects attempted to form words from letters in series of four production frames. The order of appearance of the four frames was random for each subject within each treatment group (e.g., 1-2-3-4, 4-2-1-3, 2-4-1-3, etc.; frames are described in detail later).

The Experimental Task

In addition to the aforementioned subject time commitment, other important considerations were incorporated into the design of the experimental task. A significant objective was to develop a user interface that was simple, consistent, easy to use, and relatively seamless from screen to screen. A carefully planned, high quality professional appearance was developed with the objective of maximizing the likelihood that subjects would take the experiment seriously and perform accordingly. Colors, font sizes and styles, and placement and designs of information displays were selected to maximize the efficiency and effectiveness of subject interaction with the system (e.g., background colors and fonts were selected to minimize eye strain; important information, such as the countdown timer, was prominently yet unobtrusively displayed, etc.).[8] Finally, every effort was made to create manipulations and controls that were as realistic and strong as possible, and to measure the results completely and accurately in a format that was readily transferable to standard data analysis packages.

The program was written in Visual Basic in order to meet these rigorous design specifications. Aside from its relatively simple and straightforward programming style, Visual Basic provided the essential capability to create the complex and dynamic graphical user interface (including animation) required by this experiment. It also provided the capability to simultaneously access, evaluate, and record data, as well as the flexibility of selecting from among several recording methods. Of no less importance, Visual Basic has been designed to create stand-alone application programs that can run within the Windows 95 or higher operating environment with or without a Visual Basic package resident on the computer.

The completely self-contained experimental ask was programmed to be seamless and fluid from screen to screen. The start, introduction, general instructions, practice period instructions, practice period, practice period summary, and pre-production questionnaire sections were identical for all subjects in all treatments. The task uncertainty and goal difficulty manipulations occurred in the production period instructions and

[8] The color scheme generally included teal blue backgrounds, yellow titles, light blue or white text, gray control buttons and message boxes with black lettering, and black graphics.

production period portions, leading to corresponding differences in the post-production summary and post-production questionnaire.

The description of the experimental task has been organized into the following sections:

- Start
- General instructions.
- Practice period.
- Pre-production questionnaire.
- Production period.
- Post-production questionnaire.
- Conclusion

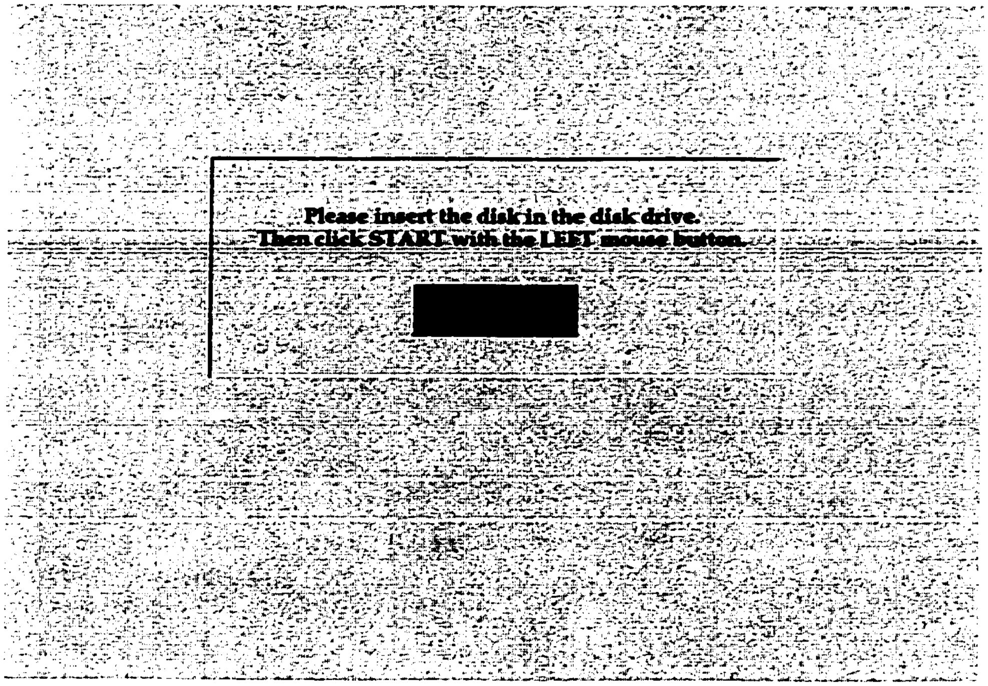
Each section contains descriptions of one or more screens that were presented to the subjects with programmed animation in order to provide an attractive, efficient interface. The appearance of most screens began with a blank background, followed by the sequential display of titles, borders, text and graphics, generally in that order over a period of a few seconds. This was done to attract and maintain subject attention, as well as to enhance viewing comfort, by providing a smooth screen-to-screen progression. The screens are described next.

Start. The first two screens are shown in Figure 13. Upon entering the computer room, subjects found the computer on with the start screen displayed. As shown in Figure 13-a, the start screen repeated the instructions to insert the disk in the disk drive and click the "START" button to begin the experiment. The program included a control to alert the subject in the event that the wrong disk, or no disk, had been placed in the disk drive. In either of those events a message box appeared on the screen instructing the subject to place the correct disk in the disk drive. Also, if the subject attempted to perform the

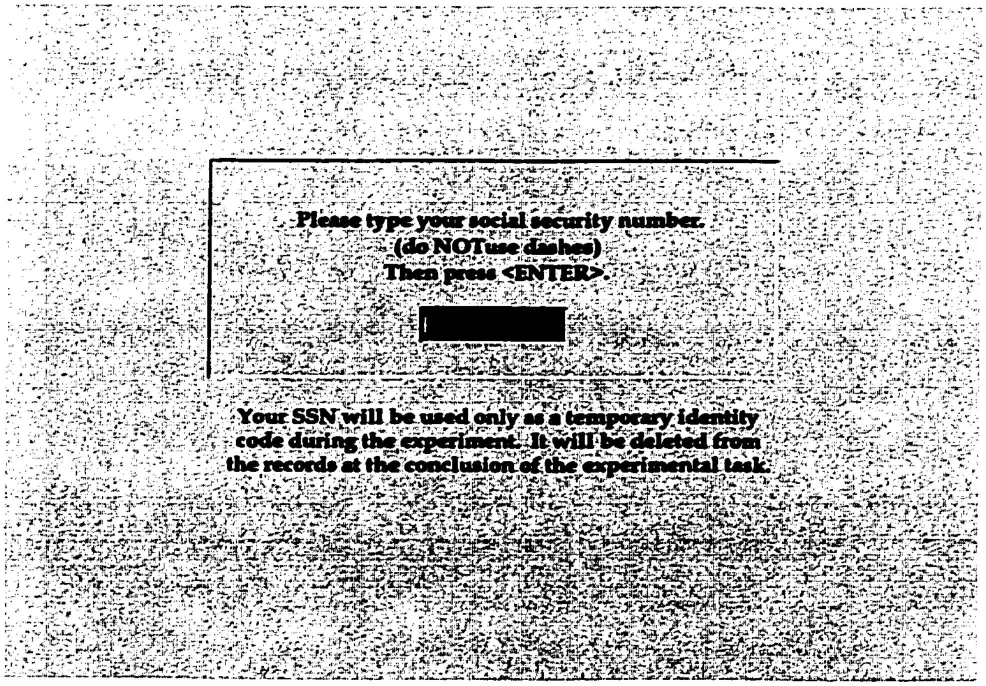
Figure 13

Start and SSN Screens

a. Start



b. SSN Entry



experiment a second time (i.e., attempt to achieve a better score and overwrite the data from the first session), the program would halt and display a message box instructing the subject to return the disk to the control room. When the START button was clicked, the program recorded the date and time of the start of the experiment in the data file.

The program automatically restarted and displayed the start screen after a two minute delay following completion of the experiment by the previous subject. This eliminated the need for the experimenter to perform that operation manually for each new subject. With as many as five subjects participating simultaneously, restarting the program might have been untimely or even overlooked, resulting in an undesirable appearance of confusion for arriving subjects. In addition, manually restarting the program on each computer would have required the experimenter to leave the control room for several minutes for each occurrence (access was through outside doors not connected to the control room nor the hall leading to the control room). Arriving subjects would have encountered a vacant check-in area during those times. Possibly more important would have been the significant increase in the amount of intrusion by the experimenter and the detraction from the appearance of program quality.

The screen shown in Figure 13-b was used to record the social security number of the subject. It repeated the statement contained in the Information Release Form (see Appendix C) assuring that social security numbers would be used only to access graduate admission test (GMAT and GRE) results and would be deleted from the records following the conclusion of the experiment.[9] When the <ENTER> key was pressed to record the data, the program performed a reasonability check and displayed a message box asking the subject to confirm the correctness of the social security number before proceeding to the next screen.[10] If the response was negative, the cursor was returned to the entry box for corrective action. If the response was affirmative, the program recorded the social security number in the data file and displayed the next screen.

General Instructions. Figure 14 shows the first of the several screens designed to familiarize the subject with the experimental task. Figure 14-a shows the screen which introduced the subject to the task. The purpose of this screen was to provide an overview to the purpose of the experiment, to inform the subject that the experiment is described on subsequent screens followed by an opportunity to practice, to inform the subject about the use of the mouse as the primary computer control used to navigate from screen to screen, and to remind the subject of the opportunity to earn a significant amount of cash and that the results of the experiment would remain anonymous.[11]

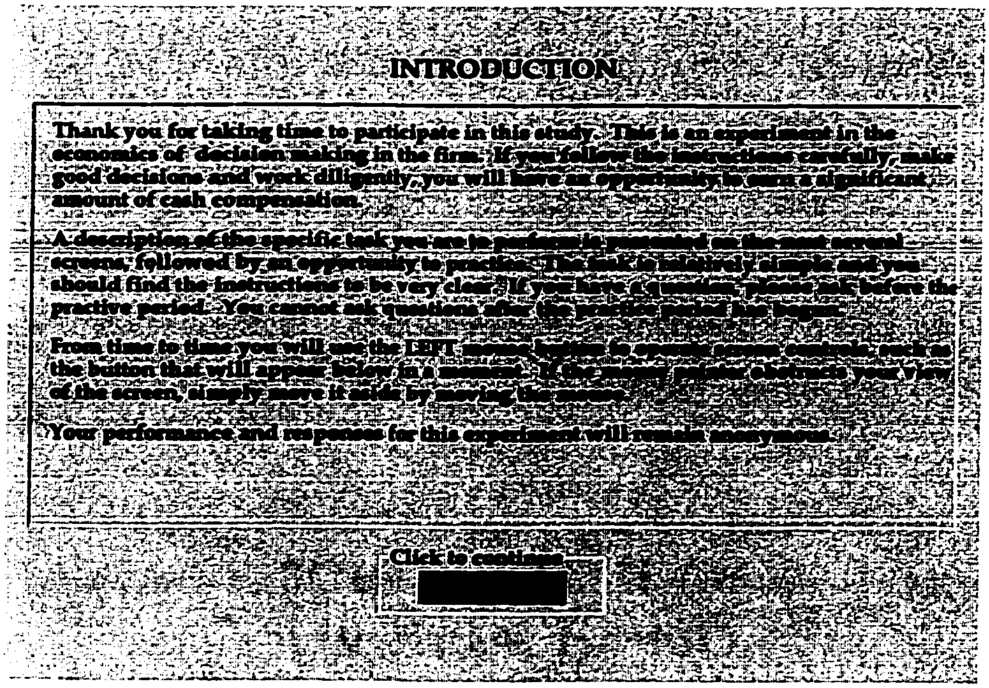
The method of display for this and all subsequent screens was intended to enhance the likelihood that the subject would pay careful attention to the information. The first paragraph appeared alone in white letters. After an appropriate pause of a few seconds to allow the subject to read the paragraph, the text color changed to light blue and the next

[9] To avoid self reporting, the experimenter accessed student records and manually entered the data in the data file after the completion of the experiment.
[10] The program checked first for the correct number of digits. If the number of digits did not equal nine, a message box was displayed asking the subject to reenter the social security number. If the number of digits equaled nine, a message box appeared on the screen asking the subject to confirm that the social security number was correct before proceeding to the next screen. The subject clicked either a YES button to proceed or a NO button to reenter.
[11] Notices of the opportunity to earn cash and of anonymity also were provided in the Information Release Form described earlier

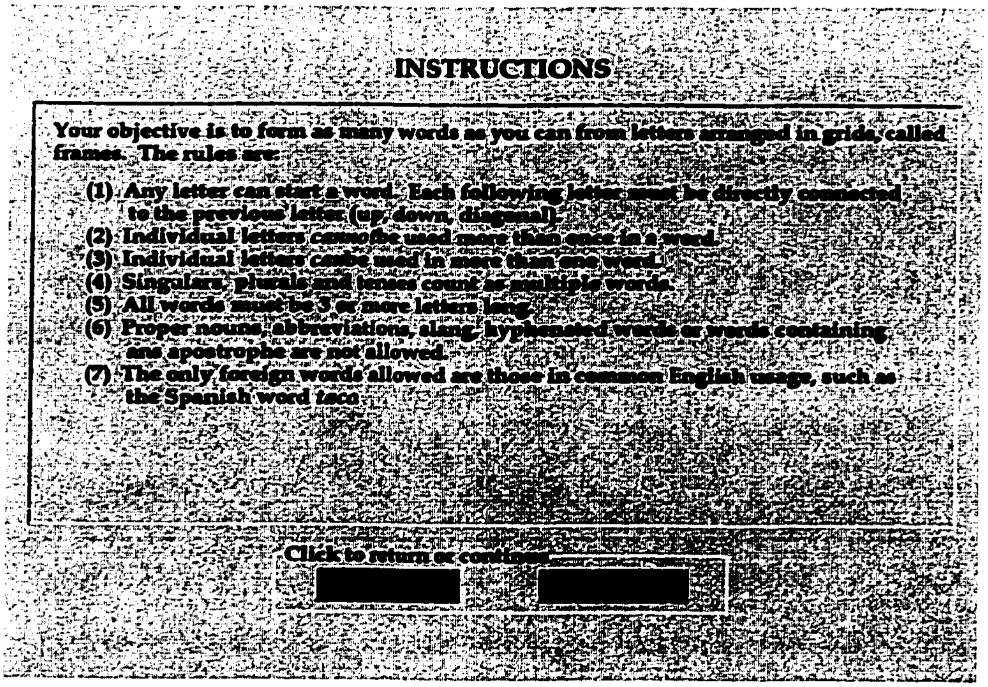
Figure 14

Introduction and General Task Instruction

a. Introduction



b. General Task Instructions



paragraph appeared in white letters. Upon completion of the display of all of the paragraphs, the text color of all paragraphs returned to white and the NEXT button appeared at the bottom of the screen. Clicking the NEXT button allowed the subject to proceed to the next screen (returning to the previous screen was not allowed). Although the display of the individual paragraphs was controlled by a programmed timer, the time allowed to view the complete screen was not limited.

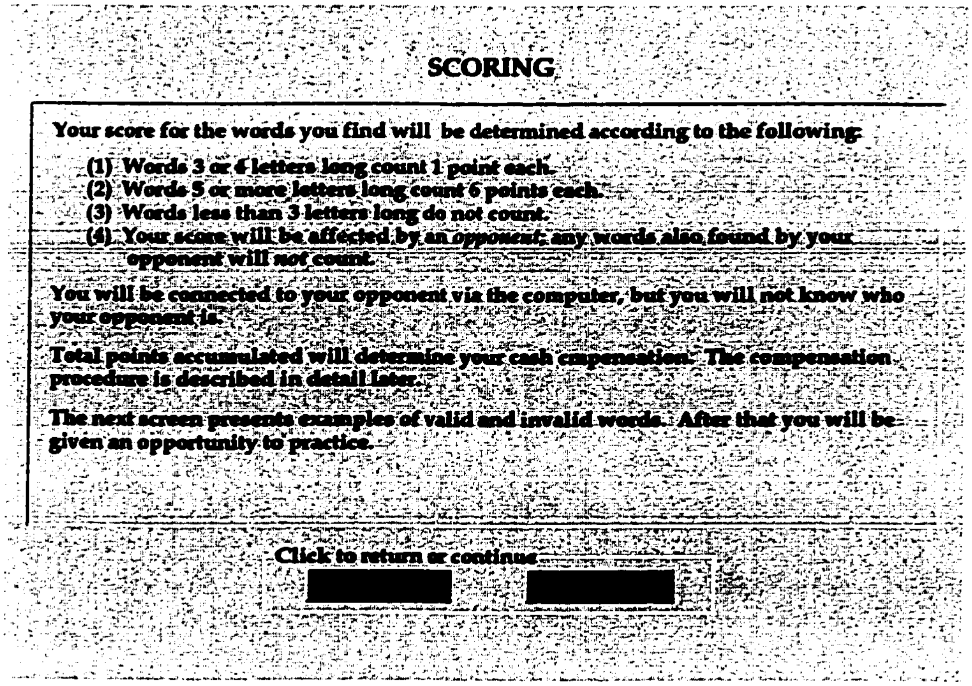
A series of specific task instructions began with those shown in Figure 14-b. Included were rules governing the formation of words and minimum length requirements. As can be seen, the rules allowed for a number of word forming strategies (e.g., forming derivative plurals and tenses to leverage the value of a single core word). The controls at the bottom of this screen allowed to the subject the option of returning to the previous screen or proceeding to the next screen. This design feature was included to allow the subjects to review the information contained on the previous screen(s).

The task instructions continued as shown in Figure 15. Figure 15-a introduced the subject to two key elements of the experiment. The first element was the definition and the differential value of short and long words. Short words were defined as those consisting of three letters or four letters, while long words were those of five or more letters in length. One and two letter words were not accepted. There was no maximum word length imposed according to the rules (although as a practical matter, a maximum was governed by the possible words that could be formed from each particular frame of letters, as discussed in some detail later).

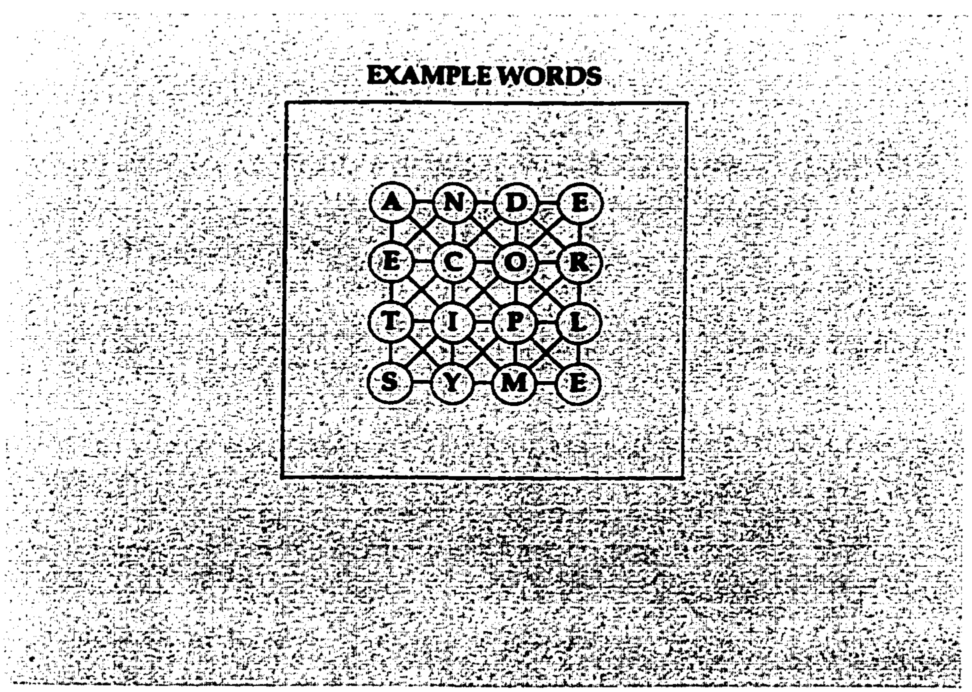
Figure 15

Scoring Instructions and Example Words Letter Frame

a. Scoring Instructions



b. Example Words Letter Frame



The assignment of point values based on word length was the method by which strategy choice was incorporated in the experiment. Recall that the Hirst (1987) theoretical proposition upon which this study is based included strategy choice as a mechanism by which task uncertainty could affect task performance. Hirst theorized that individuals working under conditions of high task uncertainty would be more likely to make inappropriate strategy selections than would individuals working under conditions of low task uncertainty.

Subjects in this experiment were required to chose between two point scoring strategies. They could elect to attempt to form short words (three or four letters) for a value of one point for each word or they could elect to attempt to form long words (five or more letters) for a value of six points per word. Subjects were not allowed to pursue both strategies simultaneously, nor were they allowed change their strategy after the choice had been made. In other words, each subject had to stick with the chosen strategy throughout the production period. Strategy choices were made based on experience with the task gained during the practice period.

Point values were determined according to the results of a pilot study (conducted in late 1997) involving eleven subjects of similar background and capability to the subjects who participated in the experiment. Pilot study subjects found words in an average ratio of five short words to one long word. The slightly increased 6:1 point scoring scheme was adopted so that the short-word strategy would be slightly less appropriate according to pilot test results and the long word would be slightly more appropriate. Furthermore, the 6:1 ratio was chosen to avoid artificially inducing subject behavior.

The second key feature introduced by the screen shown in Figure 15-a is an opponent to the subject, a feature which affect the subject's point score. The opponent represented the first of two elements of openness believed to affect task uncertainty by Hirst (1987). In particular, the opponent was the method by which the internal influence component of openness was a representation of the competitiveness often found within organizations. It is not uncommon for members of organizations to receive full credit (in the form of raises, promotions, bonuses, and awards) for accomplishments or ideas generated alone. When two or more contribute to the achievement or have the same idea, one or more often goes unrecognized.

From the screen shown in Figure 15-a the subject knew only that there was an opponent and that any words found by the subject that also were found by the opponent did not count. Actual experience with the opponent was provided during the subsequent practice period. The computer was programmed to provide the role of the opponent. Acceptable words formed by the subject were compared with a list of words "found" by the opponent and counted toward the score only if the word did not appear in the opponent word list. For each word frame the opponent word list was created (by the experimenter) by randomly preselecting a set of words of the appropriate length from the complete solution set. Thus, for each frame two lists of words were required: words of three or four letters to be used if the subject elected to pursue a short-word strategy and words of five or more letters if the subject chose a long-word strategy. In addition, subjects in the low task uncertainty treatment were informed on a subsequent screen (to be described later) that the opponent would be of a relatively constant skill level, while those in the high task uncertainty treatment group faced an opponent with varying skill level from frame to frame. This was accomplished by either varying (high uncertainty) or not varying (low uncertainty) the length of the randomly preselected list of opponent words from frame to frame for the four-frame production period for each treatment. The total number of opponent words, both short and long words, for all four low uncertainty frames was the same as the total for all four high uncertainty frames.

Although not essential for the success of the opponent manipulation, a certain feeling of reality apparently resulted from the physical arrangement of the laboratory facility and the representation of the opponent on the screen. The laboratory rooms, as described earlier, were separated from one another and the computers appeared to be networked even though they were not. This combination convinced at least some subjects that they actually competed against one another as opponents.[12]

Figure15-b shows the screen used to demonstrate the formation of words from a typical frame of letters. Example words were displayed by changing the background color of the letters one letter at a time each half second under the control of a programmed timer. The entire word was displayed for several seconds and then cleared for the display of the next word by returning the letter backgrounds to their original color. As an example, the display of the word "tip" is depicted in Figure 16. The final screen displayed a message indicating the acceptability of the example word.

Twenty example words were displayed. The example set of words was divided equally between short words and long words to prevent inducing any bias toward either of the point scoring strategies from which the subject would later choose. All subjects in all

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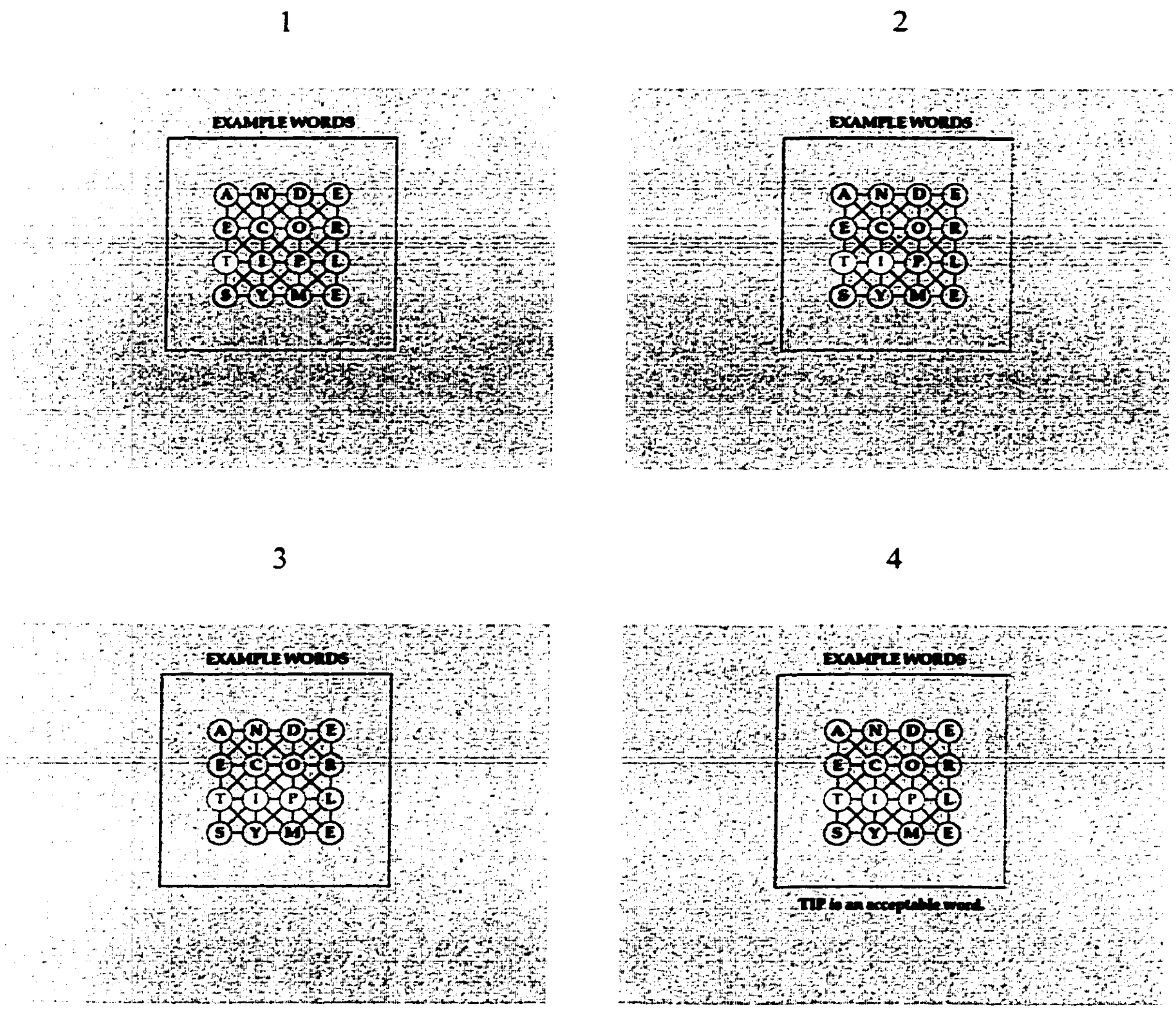
[12] One group of subjects, who had participated in the experiment simultaneously, even requested an opportunity to "complete" against one another a second time.

Figure 16

Animated Example Word Display



treatments were shown the same words in the same order. The example word set included seventeen acceptable words and three unacceptable words. The acceptable words were selected to demonstrate the many ways in which words could be formed efficiently, including using tenses and plurals of one word to form several additional words, reversing the order of letters in a first word to form a second, attaching additional letters to a word to form one or more entirely different ones, and substituting one or a few letters in a word to create other words. The example word set also was designed to encourage the subject to look for words in a variety of patterns, starting with the standard left to right, but also including patterns that are right to left, top to bottom, bottom to top, crossing, spirals, etc.

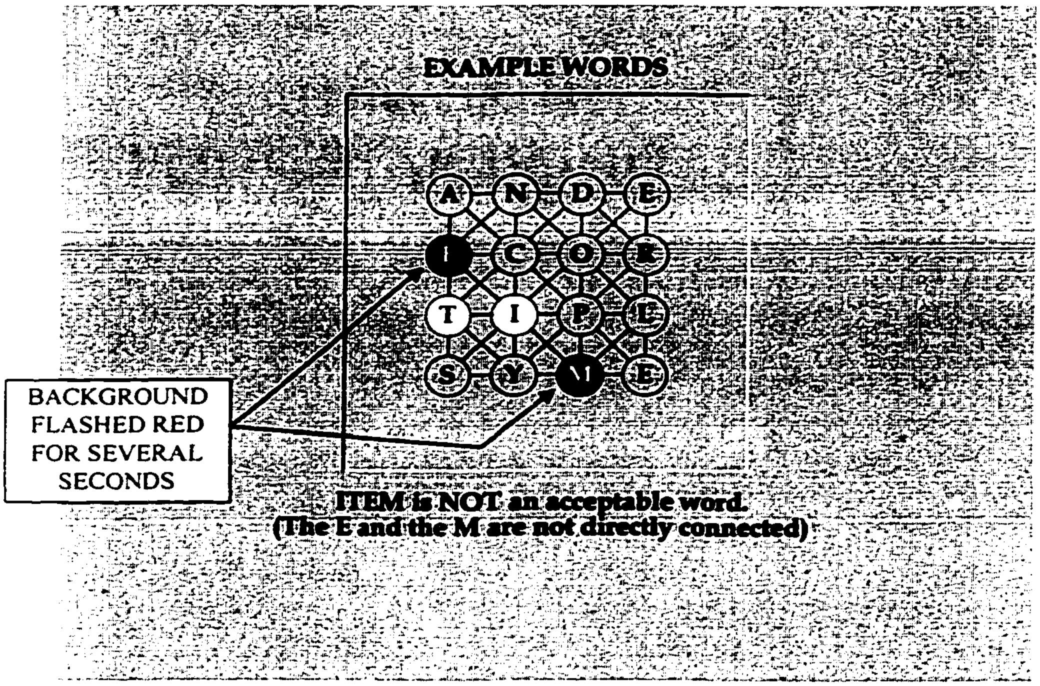
The unacceptable words were selected to demonstrate the three primary reasons (other than merely misspelling) for rejection: too few letters, disconnected letters, and letters used twice in the same word. The backgrounds of the letters of each unacceptable word were flashed in red for a few seconds to call attention to them, and the reason for the rejection was displayed beneath the letter frame along with a message that the word was unacceptable. An example is shown in Figure 17-a.

The demonstration screen was designed to acquaint the subjects with the task as quickly and efficiently as possible and to prevent any impression that short words would predominate and that the entire solution set would be small. The last demonstration screen, shown in Figure 17-b, was designed to closely resemble what the subject would encounter in the practice and production periods. A total of 132 words was displayed. The viewing time was restricted to two minutes to prevent unlimited practice (as will be described later, the practice frames included the same restriction).

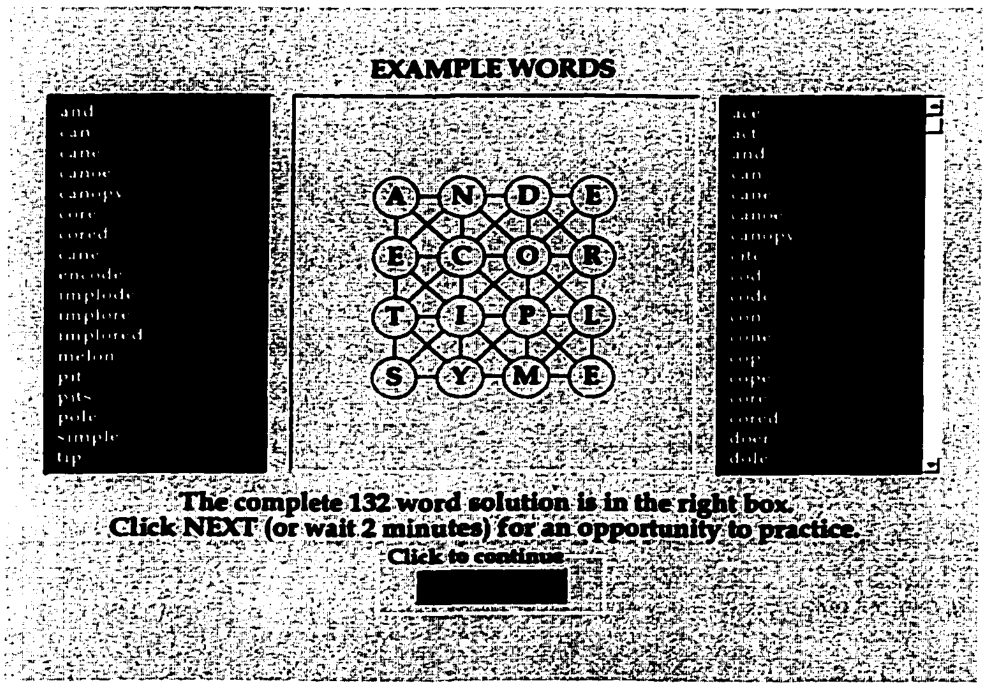
Figure 17

Unacceptable Word Display and Example Words Final Screen

a. Unacceptable Word Display



b. Example Words Final Screen



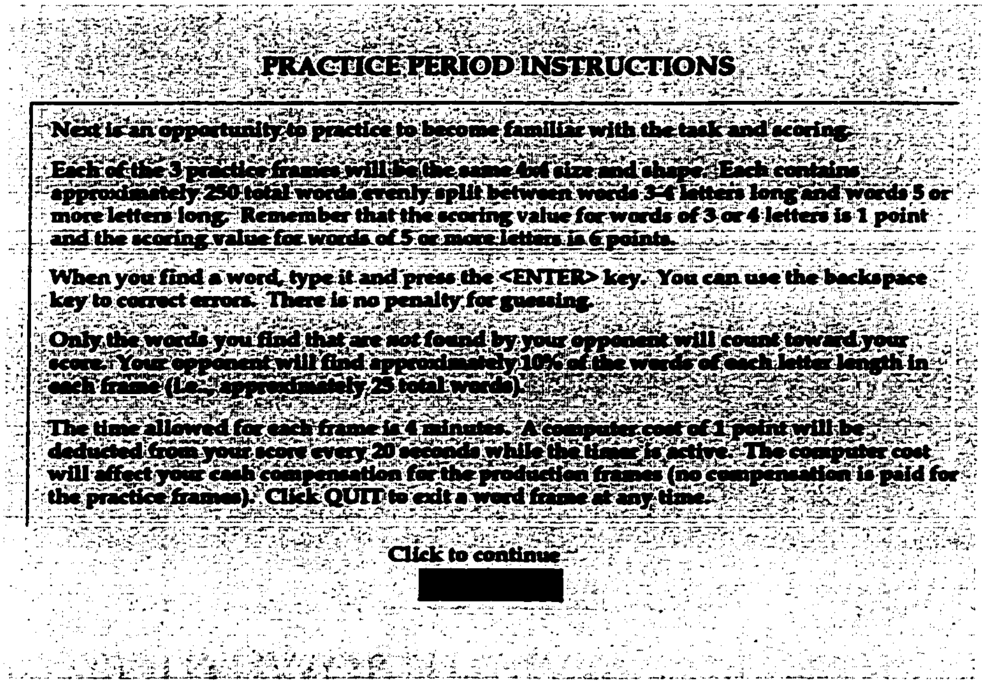
Practice Period. The practice period phase of the experiment began with the practice period instruction screen and the rules review screen shown in Figure 18. The information on both screens was displayed one paragraph at a time as described earlier. The practice period instructions (Figure 18-a) explained that there would be three practice frames and that each would be the same 4 x 4 shape (also the same as the demonstration frame just viewed). Subjects were informed that each frame would contain 250 words evenly split between short words and long words, they were instructed how to enter words, they were reminded of the 1 point and 6 point word values, and they were informed that guessing would not be penalized. In addition to a reminder that only words not found by their opponent would count, subjects also were informed that the opponent they would encounter during the practice period would find approximately ten percent of the words of each length contained in each frame.

Finally, subjects were alerted to the four minute time limit for each of the three practice frames and to a "computer cost" that would be imposed by deducting one point every twenty seconds. The computer cost was imposed only during the four minutes allowed for finding words. Although no compensation was awarded for practice period performance, the computer cost was imposed during the practice period to allow subjects to become familiar with it prior to the production period for which they did receive compensation. Following the premise that productive resources usually are not free, the computer cost was included to provide an incentive for discontinuing effort during the production period. Recall that one of Hirst's (1987) propositions was that task uncertainty affects duration of effort. As will be seen later, each frame featured a QUIT

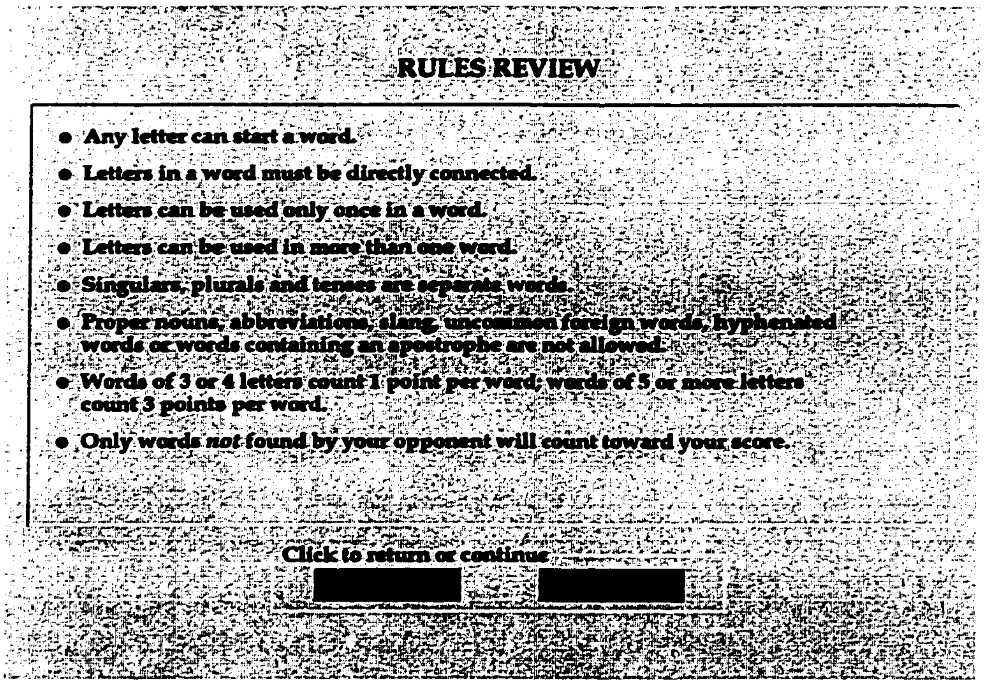
Figure 18

Practice Period Instructions and Rules Review

a. Practice Period Instructions



b. Rules Review



button that allowed the subject to avoid further computer cost by discontinuing effort. This mechanism recognized that although the physical effort of entering (typing) words might stop, the mental effort of searching for words to enter could easily continue. Thus, two measures of cessation of effort were recorded in this experiment. First, the time of the last attempt to enter a word (regardless of acceptability) by pressing the ENTER key was recorded. Second, if the subject elected to quit the frame by clicking the QUIT button, that time was recorded as well. In both cases, the internal computer clock was used to record the point in time of the action.

The purpose of the rules review (Figure 18-b) was to remind the subject of the basic rules immediately before beginning the practice period. The objective was to use succinct repetition to start to move the subjects up the learning curve as quickly and as efficiently as possible.

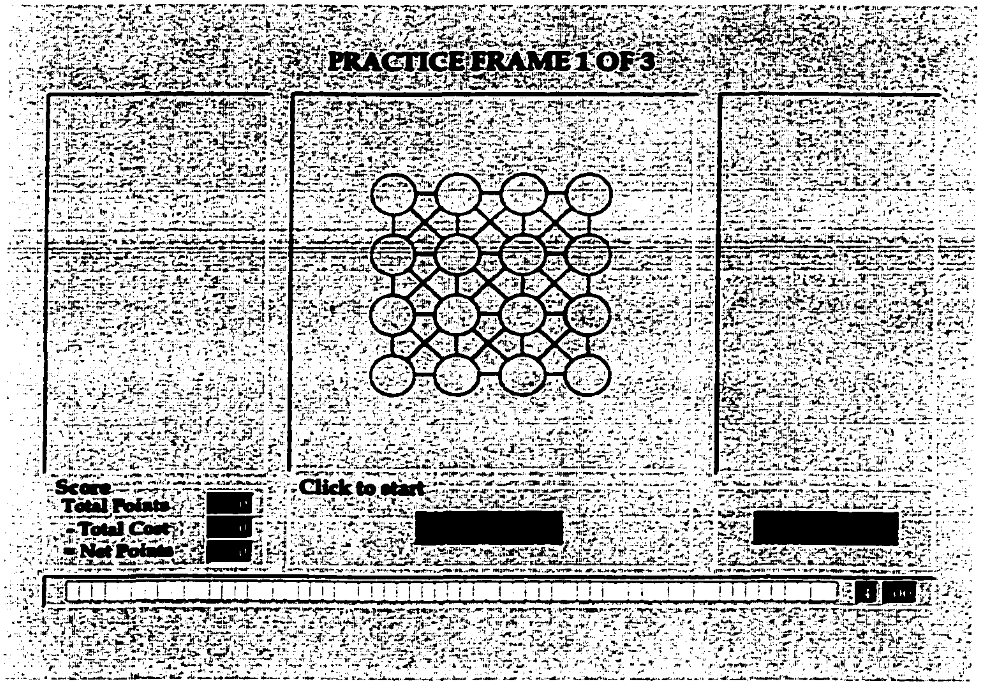
The first practice period frame, shown in Figure 19, immediately followed the rules review screen. In order to provide a transition, the letter frame was blank and the digital countdown timer (which displayed the four minute time limit) and indicator bar were inactive as shown in Figure 19-a. The QUIT button, appearing in the lower right of the screen, also was initially inactive as indicated by the dimmed button label. This button did not become active until the subject clicked the START button to reveal the letters and activate the timer. Each frame was titled with a "Practice Frame X of 3" convention so that the subject would know which frame was in progress at all times.

Figure 19-b shows the first practice frame several seconds after activation by clicking the START button, which (1) transformed it into a box used to enter words (with

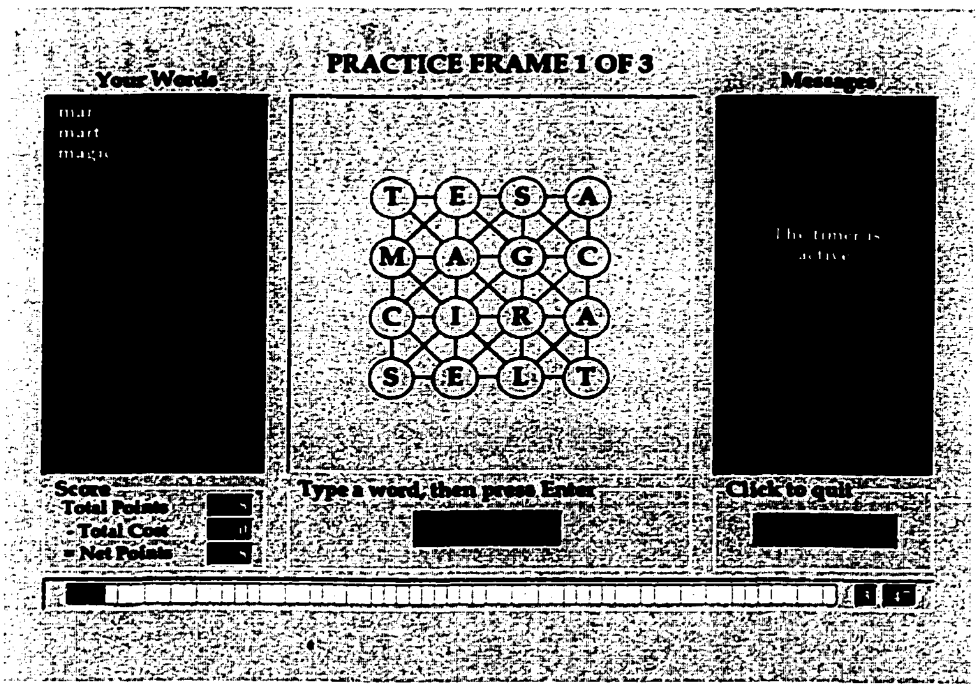
Figure 19

Practice Period Screens - Initial

a. Inactivated Practice Frame 1



b. Activated Practice Frame 1



a flashing cursor) by typing them and pressing the ENTER key on the keyboard, (2) displayed the letters, (3) activated the countdown timer, (4) activated the QUIT button (indicated by a darkening of the letters on the face of the button), and (5) activated the message boxes on either side of the letter frame. The digital countdown timer indicated the time remaining, which also was represented graphically by the change of colors from left to right on the indicator bar. Although the indicator bar was redundant, it was included to provide the subjects with a quick method of determining the approximate amount of time left. Its size and colors placed it in the peripheral view of the subjects at all times. During the final 20 seconds of each frame (both practice frames and production frames), the remaining indicator bar segments and the digital time display were changed to red to alert the subject to the impending elapse of the allotted time.

The message boxes provided feedback information. The left box displayed words in the order in which they were attempted. As will be shown later, information also was included to indicate duplicate, invalid, and opponent words. If the number of words attempted exceeded the capacity of the box, the next word appeared at the bottom and the list rolled up moving the top word out of view. The right box displayed status messages. Figure 19-b shows that the timer became active when the START button was clicked to begin the frame. Several other messages will be shown in later figures.

Cumulative score feedback was displayed in the lower left corner of the screen. Figure 19-b shows three words found, two short words and one long word, for a total of eight points. Because the deduction for the computer cost occurred after each twenty seconds of elapsed time, none was deducted at this point. A significant programming challenge was to simultaneously (1) determine the validity of the attempted word, (2) determine if the word was one found by the opponent, (3) determine if the word was a duplicate of one already found by the subject, (4) add the word to the display of attempted words, (5) increment and display the total number of points, and (6) record the attempt and the results in the data file, all of which had to occur instantaneously to allow the subject to begin entering another word immediately. This procedure was followed for all three practice frames as well as for all four production frames.

The program recorded the attempt in the data file each time the <ENTER> key was pressed. Data items included (1) the word, (2) whether the word was valid or invalid, (3) if valid, whether the word was a duplicate of one already found, (4) if the word had been found by the opponent, (5) the elapsed time when the attempt was made and (6) the points awarded. Words could be ruled invalid for several reasons: they might not be words at all, they might be words excluded by the rules (e.g., foreign words, proper nouns, etc.), and formation might not be possible within the constraints of the letter frame arrangement.

The word validity check was performed by comparing the attempted word with the complete solution of all valid words for each frame. The solution set for practice frames included all words of three or more letters, i.e., both short words and long words, that could be formed from the letters in the frame. As will be described later, validity checks for production frames required the additional step of comparing the attempted word with the solution set that corresponded with the particular strategy selected by each subject.

Solution sets for both practice frames and production frames were generated by computer as described in Appendix E.[13]

Lists of opponent words were predetermined for all frames by randomly selecting a certain percentage of words from the complete solution set for each frame. Commensurate with the instructions shown in Figure 18-a, the opponent word list for each practice frame consisted of ten percent of the complete solution set. This was done in order to maintain a constant opponent skill level throughout the practice period frames. Equality was maintained between short and long words. The lists of opponent words for production frames in the low uncertainty treatment also were a constant ten percent of the total, while lists of opponent words for production frames in the high uncertainty treatment varied in size to account for the variation in opponent skill. However, the entire set of opponent words for the high task uncertainty treatment likewise totaled ten percent of the aggregate solution for all four frames combined. Thus, an equal probability of encountering opponent words across all four production frames was maintained between the low and high task uncertainty treatments. Any remaining effect was due to variability in opponent skill (the internal influence component of openness in Hirst's hypothesis).

The discovery of duplicate words was accomplished by comparing each new attempted word with a list of previously discovered valid words. The list was dynamically maintained by adding to the list each new valid word found by the subject. Figure 20-a shows the manner in which the subject was informed that attempted words were valid,

[13] Only one subject reported finding a word that was rejected when it was believed to be valid. An investigation revealed that the subject attempted to enter "deers' as an invalid plural of "deer."

invalid, duplicate, or opponent words. When the subject pressed the ENTER key after typing a word in the word entry text box (immediately below the letter frame), the attempted word was instantaneously added to the word list displayed to the left of the letter frame. Valid words were added to the list with no message and the score was increased by the appropriate amount. Other words also were added to the list, but with a message indicating that they were invalid, duplicate, or found by the opponent (with no change in the score). To make sure that the subjects were fully cognizant of the existence and effect of the opponent during the practice period, the program forced the fourth, sixth, and ninth valid words attempted to be opponent words if they were not already included in the randomly pre-selected opponent word set. This prevented the possibility that a subject might not encounter enough (or even any) opponent words during the practice period. This was included in the programming for the first practice frame only.

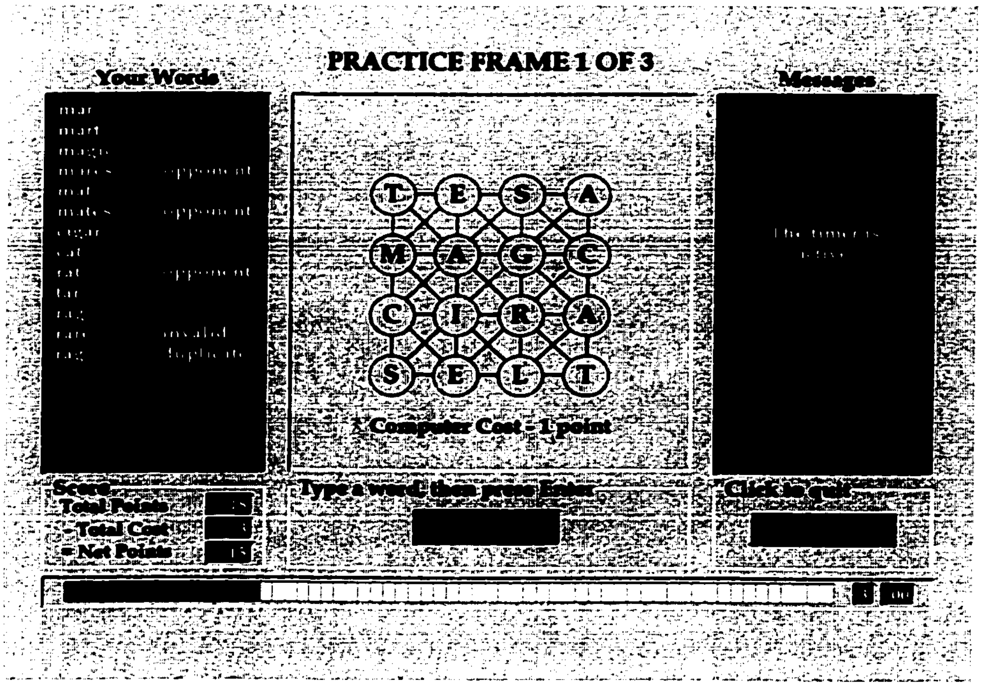
Figure 20-a also shows the manner in which the subject was informed of the imposition of incremental computer cost. A message that appeared each twenty seconds immediately below the letter frame indicated that an additional cost of one point had been deducted from the aggregate point total. In this particular example one of the four minutes has just elapsed, resulting in a total computer cost deduction of three points. The "Computer Cost - 1 point" message was removed after several seconds and displayed again after another twenty seconds of elapsed time.

Figure 20-b shows the appearance of the screen if subjects elected early termination of a frame (practice and production). When the QUIT button was clicked the timer was paused, a message was displayed in the message box, the letters were hidden

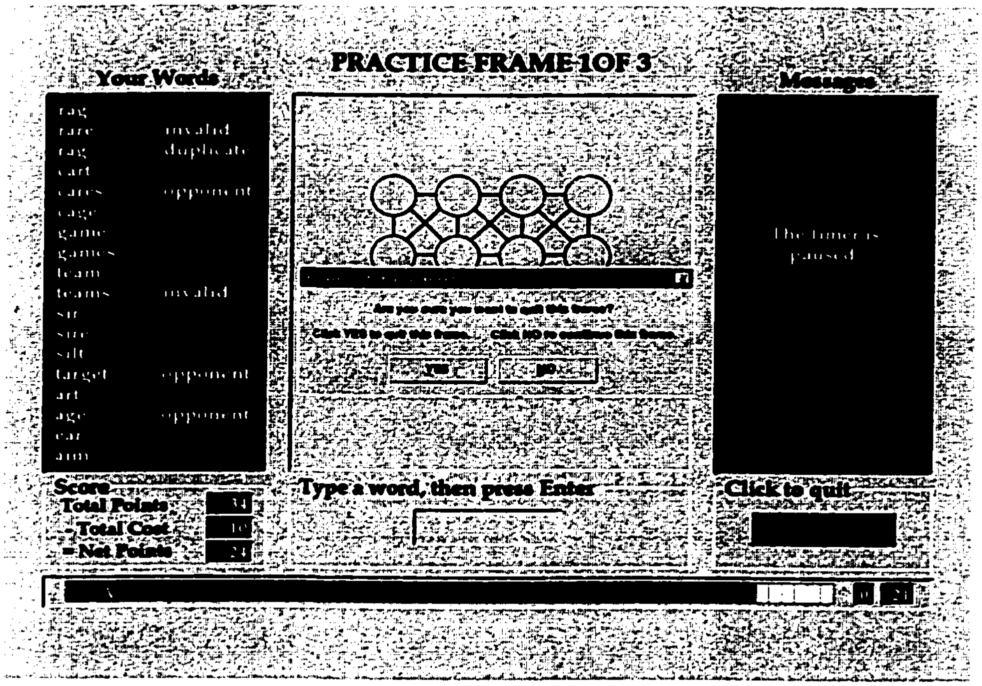
Figure 20

Practice Period Screens - Continued

a. Message Boxes and Computer Cost Message



b. Early Termination of Practice Frame 1



from view, the word entry text box was disabled, and a message box appeared asking for confirmation of the early termination decision. Hiding the letters and disabling the word entry box prevented subjects from continuing to form words while the timer was paused.

Confirmation was required to prevent accidental early termination. Clicking the NO button in response to the confirmation request returned the frame to its condition immediately prior to clicking the QUIT button: the message box was removed, the letters were redisplayed, the word entry text box was enabled, and the timer was reactivated.[14] Clicking the YES button initiated the same normal termination routine that would have occurred had work continued until the end of the allowed time. Ten subjects chose to terminate frames early. Eight subjects terminated the first practice frame early, three subjects terminated practice frame two early, and five subjects terminated practice frame three early. Only two subjects terminated all three practice frames early, and two subjects terminated two of the three practice frames early.

Figure 21 shows the normal termination sequence. Figure 21-a and 21-b show how the screen appeared immediately before and after the allowed time elapsed. As can be seen, the word entry box was disabled and blanked, and the label was changed to indicate that time had expired. The box to the left of the letter frame, in which the chronologically ordered list of words found by the subject had been displayed, was blanked, as was the message box to the right of the letter frame. The QUIT button was removed and the label was changed, and the digital time display was dimmed. Finally, the last computer cost message was displayed.

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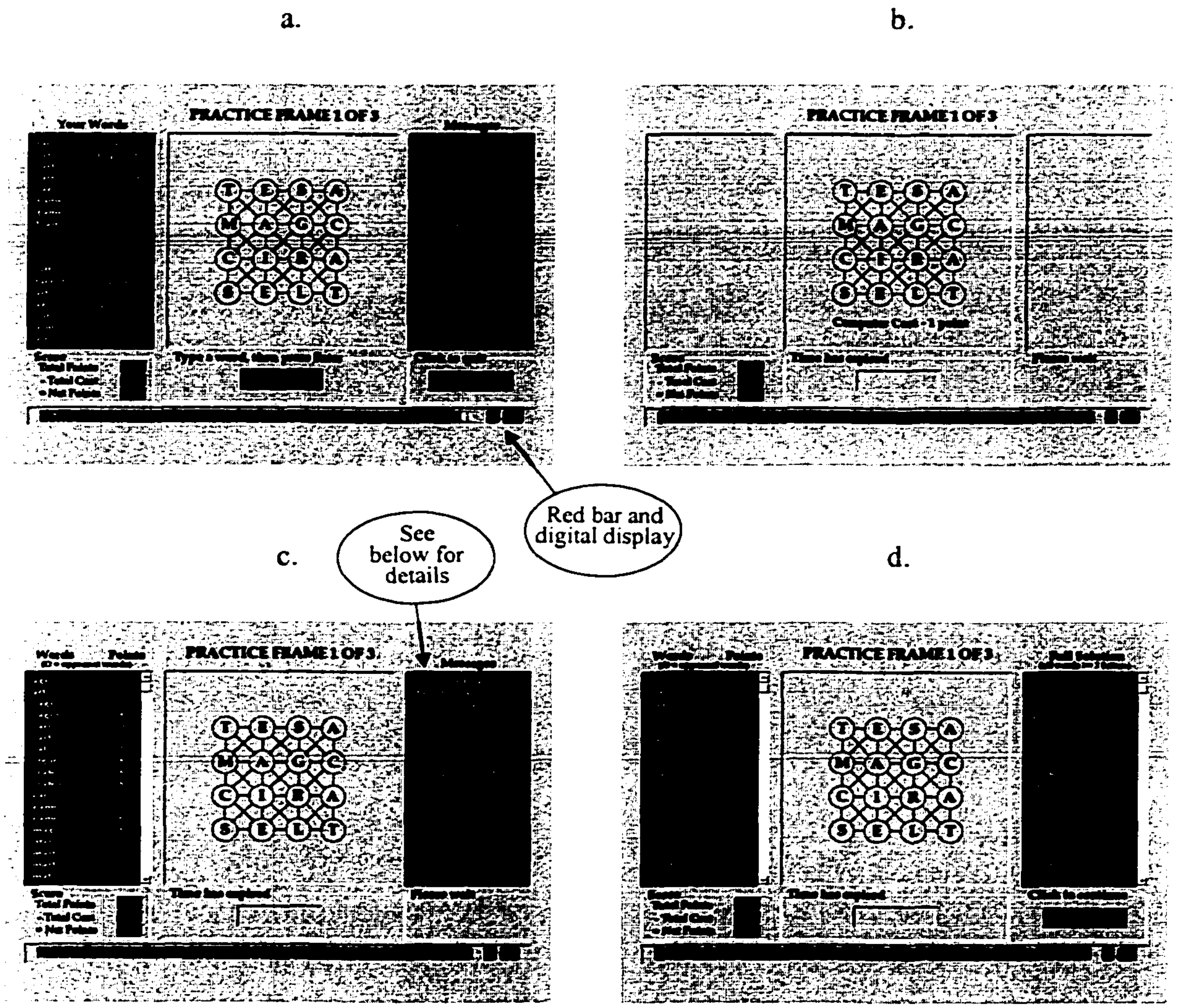
[14] There was no evidence that any subjects used the early termination confirmation procedure simply as an opportunity to rest during a frame.

Figure 21

Frame Termination Sequence



Panel c message box details:

Your words are in the left box. A score of 0 points and an 'O' indicate a word found by your opponent.

The full solution will appear in this box in a moment.

You can view this screen for 2 minutes.

Click the NEXT>> button when you are ready to go to the next screen.

After a momentary pause, the screen elements were changed to appear as shown in Figure 21-c. The left box displayed the entire list of valid words found in alphabetical order, along with the appropriate point value and an indication of which words also were found by the opponent. A vertical scroll bar was used to view the entire list when the length exceeded the size of the box. Invalid and duplicate words were not included. Although not depicted in Figure 21-c, the paragraphs in the right message box were displayed one by one with momentary delays between them as a way of encouraging the subjects to read the information.

Figure 21-d shows that the right message box was cleared and changed to display the entire solution set. Again, a scroll bar permitted scrolling through the complete list. Viewing time was limited to two minutes to provide consistent learning opportunities and to move the subjects on to the next frame.

It is important to note that all frames, both practice and production (and both low task uncertainty and high task uncertainty), were of the same design and followed the same basic pattern that has been described. With the exception of different letters, and different sizes and arrangements in the case of the high uncertainty frames described later, the screens for the remaining two practice frames and all of the production frames were identical in appearance and function to those in the preceding figures. The differences that did exist of course were the result of the manipulation of the variables of interest.

At this point it also is appropriate to mention that not only were the screens identical expect for variables manipulations, but also that care was taken to insure that the physical features of all of the laboratory rooms and equipment were as identical as possible. The rooms themselves were at least similar in size and appearance, and the furniture and lighting were the same in each. More importantly, the computers were completely identical (the CPUs, the keyboards, the monitors -- size and resolution --, and the monitor settings) in order to prevent introducing unintended variability into the results.

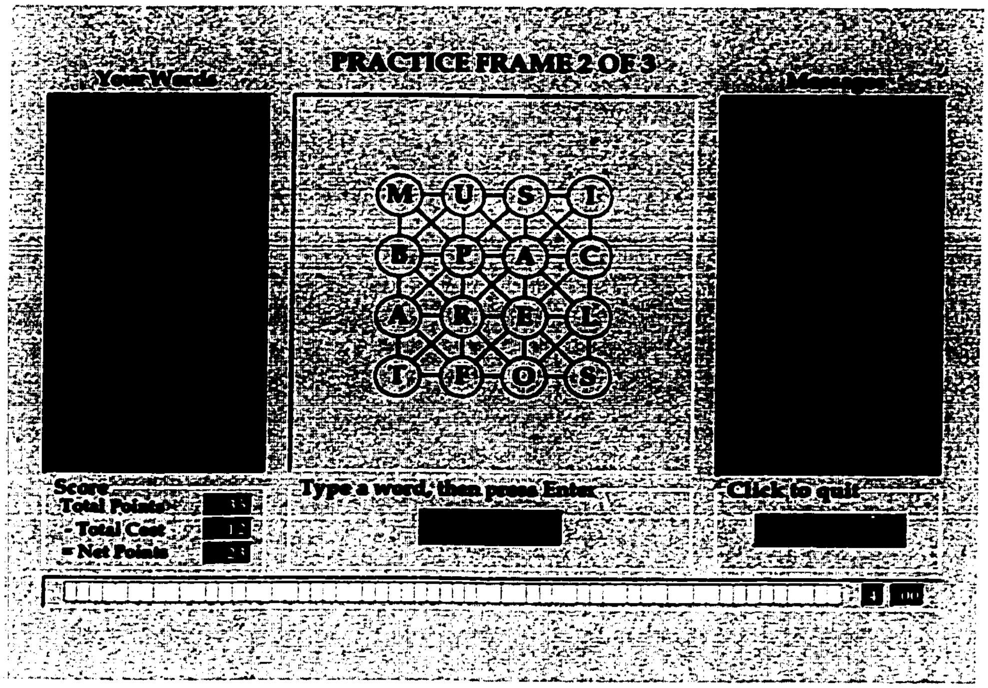
The second and third practice frames are shown in Figure 22. Except for different letters (and therefore different solutions) they were identical in all respects to the first. All three practice frames began with a blank letter frame that was activated by clicking the START button. The time allowed for each frame was four minutes. All three letter frames were the same 4x4 size and shape, and each solution set contained exactly 250 total words, exactly evenly split between 125 short words and 125 long (as noted previously, these facts were made known to the subjects). The display of time remaining, words found (valid, invalid, duplicate, opponent), score, and messages were identical, as were the imposition and notification of the computer cost point deduction. Frames were prominently titled (e.g., Practice Frame 1 of 2) to provide the subjects with a convenient reference point.

Three frames were included in the practice period for two primary reasons. First, as described in more detail later, the production period goal was based on the results of the two highest practice period frames. The results of the lowest frame were omitted from the goal determination to allow the subjects to become acquainted with the task in the first practice frame and to provide for the possibility that some subjects might elect to terminate a practice frame early (especially the last) to move on to the production period quickly. The subjects did not know that the goal was based on practice period results. Also, the practice period included three frames so that, when combined with the

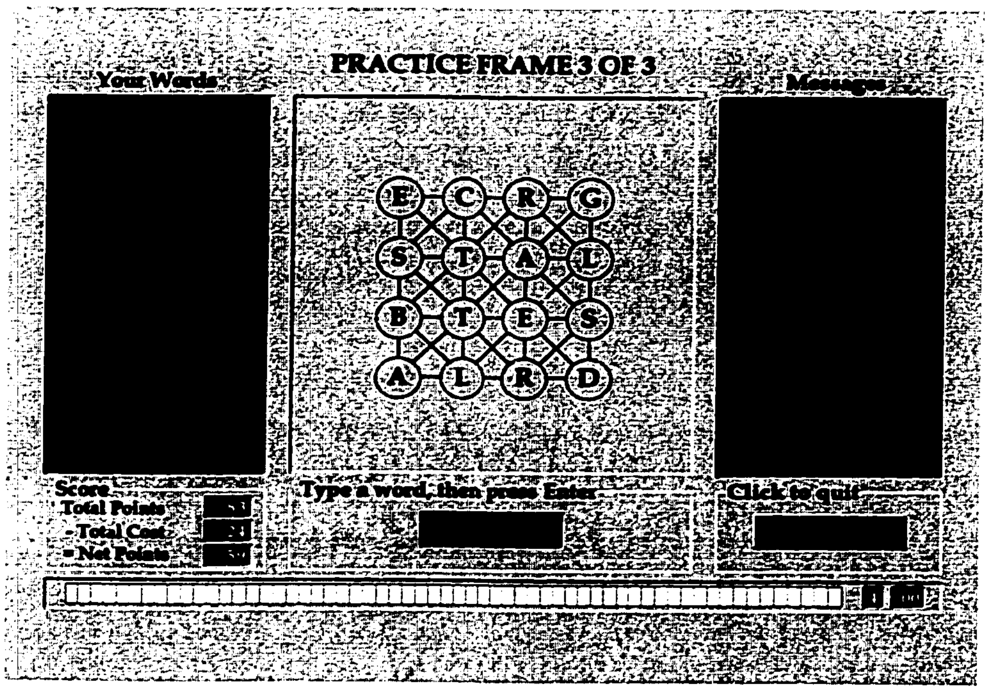
Figure 22

Practice Period Screens - Continued

a. Practice Frame 2



b. Practice Frame 3



demonstration frame described earlier, the total experience would be roughly equivalent to the four frame production period.

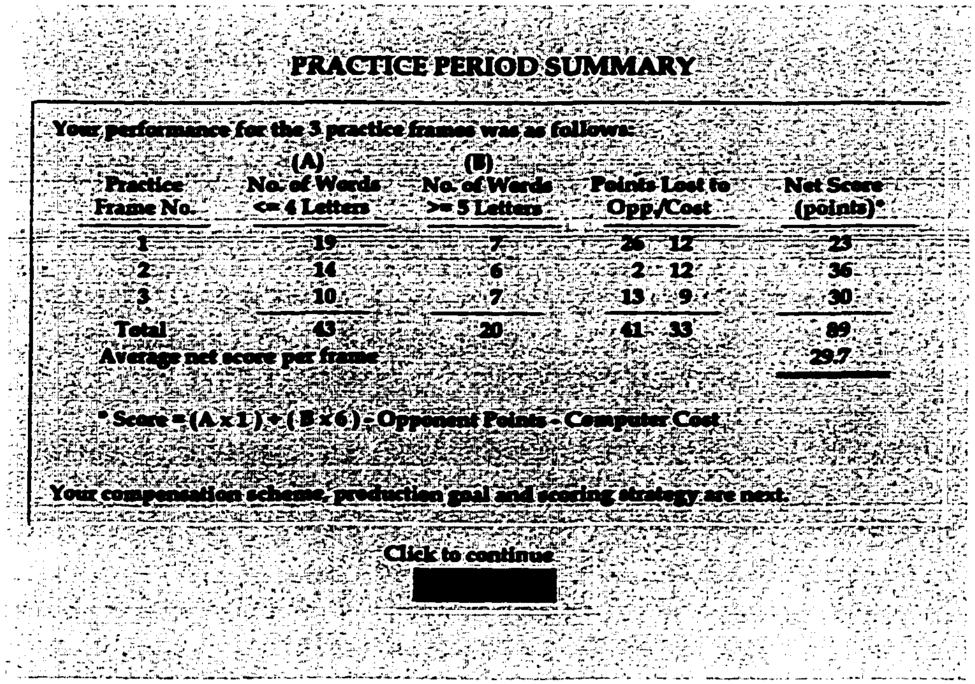
Figure 23 shows examples of the two screens that ended the practice period and provided a transition to the production phase of the experiment. Figure 23-a shows the screen that displayed a summary of the practice period results. Included were the number of short words found in each frame, the number of long words found in each frame, the points deducted for opponent words and for the computer cost, the net score for each frame, the total score for all three frames, and the average score per frame. A significant amount of detail was provided to enable the subjects to make informed strategy choices (on a subsequent screen) and to reinforce the importance of the opponent and computer cost manipulations. The scoring equation was provided of course to explain the net score calculation, but also to further emphasize the strategy, opponent, and computer cost features of the experiment. Finally, subjects were allowed only to advance to the next screen. To prevent additional practice, a return to the practice frames was not permitted.

Figure 23-b shows the production period preview screen. This screen was designed to provide final closure to the practice period and to provide an orientation to the first several screens of the production period. As shown in Figure 23-b, subjects were told that the production frames and compensation scheme would be described, that they would receive a goal for production period performance, that they would select a scoring strategy, and that they would respond to some questions. Notice that this screen permitted a return to the practice period summary presented on the previous screen.

Figure 23

Practice Period Summary & Production Preview

a. Practice Period Summary Example



PRACTICE PERIOD SUMMARY

Your performance for the 3 practice frames was as follows:

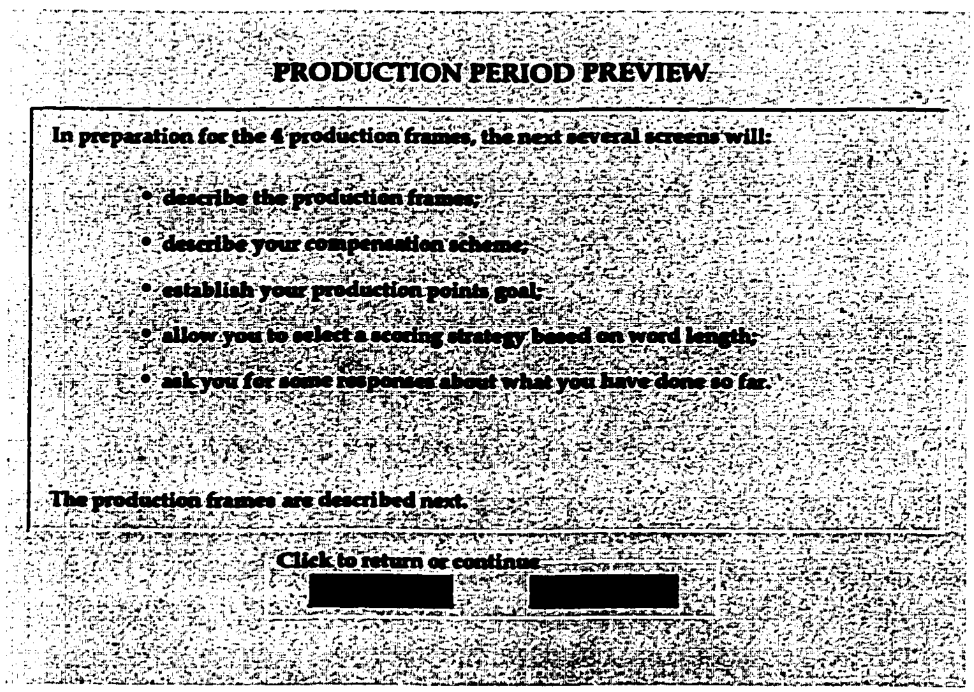
Practice Frame No.	(A) No. of Words <= 4 Letters	(B) No. of Words >= 5 Letters	Points Lost to Opp./Cost		Net Score (points)*
1	19	7	26	12	23
2	14	6	2	12	36
3	10	7	13	9	30
Total	43	20	41	33	89
Average net score per frame					29.7

* Score = (A x 1) + (B x 6) - Opponent Points - Computer Cost

Your compensation scheme, production goal and scoring strategy are next.

Click to continue

b. Production Preview



PRODUCTION PERIOD PREVIEW

In preparation for the 4 production frames, the next several screens will:

- describe the production frames;
- describe your compensation scheme;
- establish your production points goal;
- allow you to select a scoring strategy based on word length;
- ask you for some responses about what you have done so far.

The production frames are described next.

Click to return or continue

The manipulation of task uncertainty came next. Figure 24 shows the screens that described the production frames for each of the two task uncertainty treatment groups. Subjects in each treatment were presented with one of the two frames. Those in the low task uncertainty treatment group received the screen in the form shown in Figure 24-a, while subjects in the high task uncertainty treatment group received the screen shown in Figure 24-b. As with other instructional screens, the information contained on these screens was added incrementally (border, title, paragraph 1, frame replica(s), paragraph 2, paragraph 3, etc.).

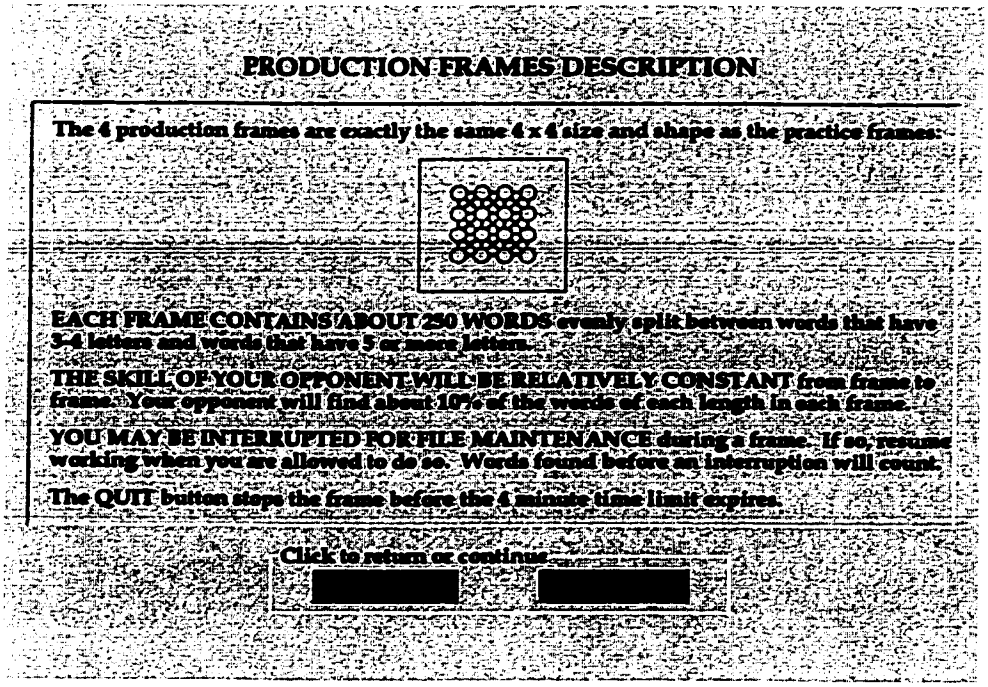
Overall, the screens informed the subjects of the degree of repetitiveness of the four production frames. The first paragraph at the top of the screen shown in Figure 24-a informed the subjects in the low uncertainty treatment group that all four of the production frames were of the same 4x4 size and shape as the practice frames. As a visual reinforcement, a miniature replica of the 4 x 4 letter arrangements "exploded" onto the screen during a few seconds. Starting from a single dot, the replica increased in size in a continuous fashion until reaching full size. The intent was to attract the attention of the subjects with the objective of strengthening their awareness of and familiarity with the repetitiveness of the upcoming production frames.

In contrast, subjects in the high task uncertainty treatment group were informed that their production frames would have four different sizes and shapes, none of which was the same as those encountered during the practice period. The four frame replicas "exploded" onto the screen in the same manner described above. The order of appearance was "cross" (third from the left), "star" (far left), "diamond" (far right), and "donut"

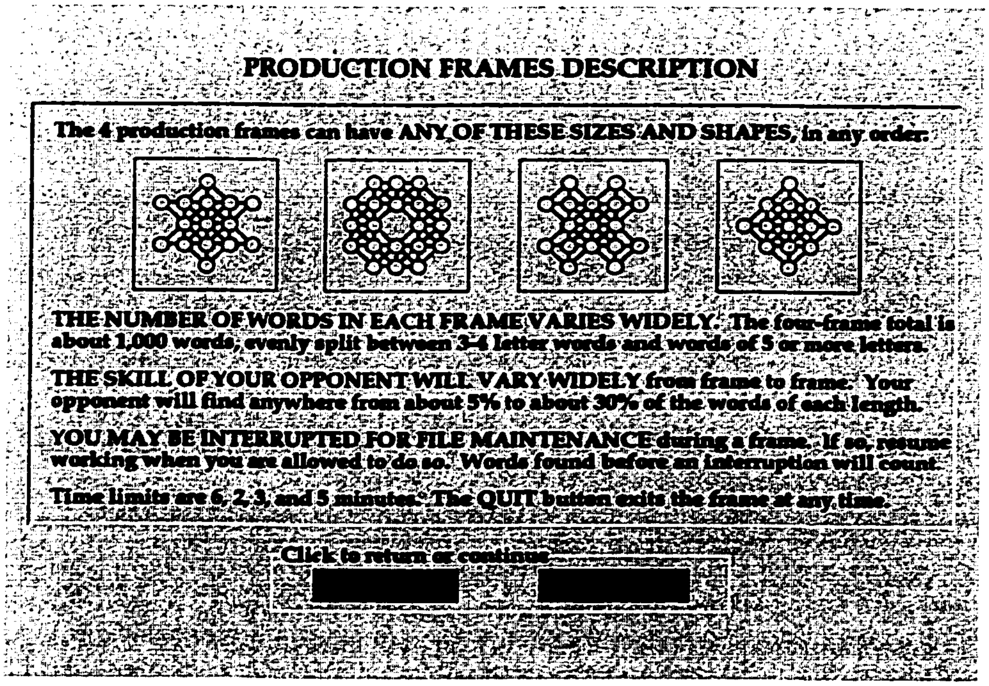
Figure 24

Production Frame Description

a. Low Task Uncertainty Treatment



b. High Task Uncertainty Treatment



(second from the left) to prevent any assumptions about the order to be encountered during the actual production period.

The paragraph immediately below the frame replica(s) provided additional information about the letter frames. Subjects in the low task uncertainty treatment group (Figure 24-a) were told that each of the production frames contained 250 words, for a total of 1,000 words, evenly divided between short and long words. Subjects in the high task uncertainty treatment group (Figure 24-b) were told that although all four frames contained a total of 1,000 words evenly split between long and short words, the number of words in each frame varied widely. These differences were designed to increase the repetitiveness and non-repetitiveness of the low and high task uncertainty treatments, respectively, while maintaining an equal level of difficulty for each treatment.

Next, additional details about the opponent were provided. The low task uncertainty subjects were told that their opponent would exhibit a relatively constant skill level by finding approximately 10 percent of the words of each length in each frame. Although it was not revealed to the subjects in order to preserve the appearance of reality, the opponent word list contained exactly 10 percent of the words contained in each frame. To maintain an equal probability of finding opponent words between the two task uncertainty treatments, and therefore equalize the level of difficulty, the high uncertainty treatment opponent word list also was exactly 10 percent of the total words contained in all four frames. However, as shown in Figure 24-b, the percentage of words expected to be found by the opponent varied from frame to frame in the range of 5 percent to 30 percent of the total words of each length in each frame. Not only did this operationalize the internal influence component of task openness, one of the elements of task uncertainty, but it also added further to the difference in task repetitiveness between the two treatments.

The next paragraphs displayed on each screen were identical. Subjects in both treatment groups were informed of the possibility of an interruption for file maintenance during each of the production frames. However, an interruption actually occurred only during the high task uncertainty treatment frames. This manipulation operationalized the external influence component task openness, the second element of task uncertainty. It also increased the difference in task repetitiveness between the two treatments. The high task uncertainty treatment group was forewarned to intensify the expectation of uncertainty, but also to prevent any belief of a program malfunction that might have resulted from a completely unexpected interruption. Although an interruption did not occur during any of the low task uncertainty frames, the low uncertainty treatment subjects were told that an interruption was possible in order to maintain control consistency between the two treatment groups.

Finally, the last paragraph displayed on these screens provided information about the time allowed for the production frames and the function of the QUIT button. As shown in Figure 24-a, the low task uncertainty treatment group was told to expect the time allowed for each frame to be four minutes. Conversely, the high task uncertainty treatment group was told, as shown in Figure 24-b, to expect times allowed for the frame to be two, three, five, and six minutes. Again, the objective was to strengthen the dichotomy between repetitiveness and non-repetitiveness. The particular time limits were selected to equalize the difficulty by equalizing the total time allowed at 16 minutes for all four frames. The subjects could return to the previous screen or advance to the next screen by clicking the appropriate button.

In addition to the animation of the replicas described above, colors and flashing were used to strengthen the manipulations by adding emphasis to the information contained on these screens. The frame replica outlines were displayed in white to provide a clear and noticeable contrast to the teal screen background. As shown, key words were printed in uppercase, but they also were displayed in a bright green color and flashed four times as each paragraph appeared in sequence.

Figure 25 shows the next two screens, which were identical for both treatment groups. Figure 25-a shows the screen which described the compensation scheme in detail and established the production period point goal. Following a reminder that the cash compensation for performance would be $0.10 per point plus a $5.00 bonus for reaching the production goal, the goal was prominently displayed in red to make as noticeable as possible.

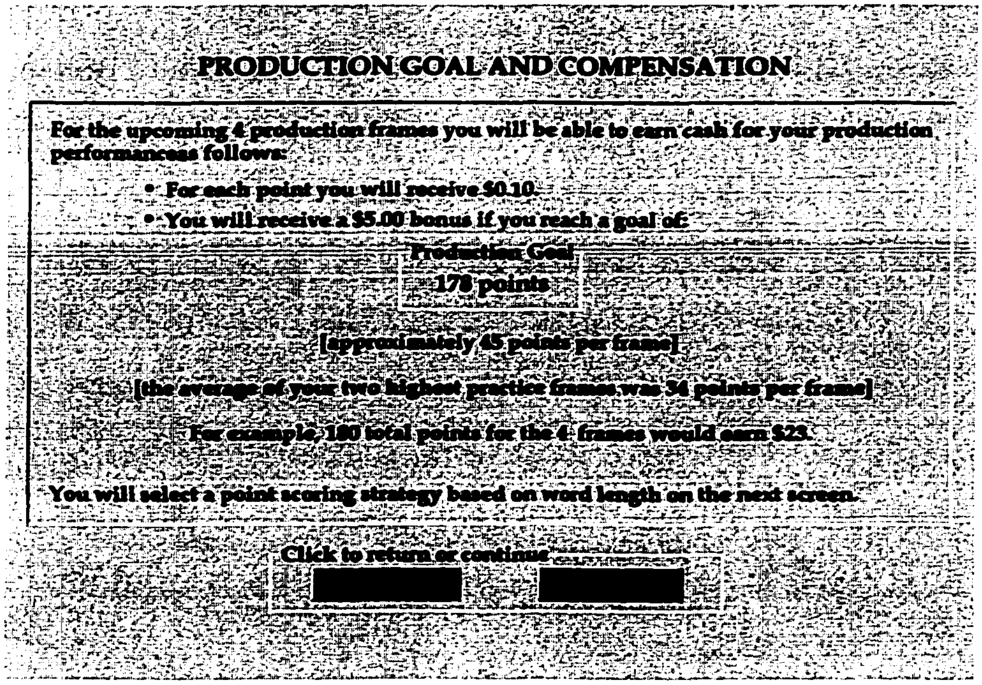
The average points per frame required to achieve the goal and the average of the two highest practice frame scores was displayed immediately below the production goal to provide information about relative goal difficulty. Finally, a hypothetical cash compensation calculation was included to exemplify the compensation scheme and to emphasize the importance of reaching the production goal.

The manipulation of goal difficulty was an important result of the calculation of the production goal. Unlike most other goal setting studies which have used a single normative goal for all subjects in each treatment, this study calculated a unique goal for

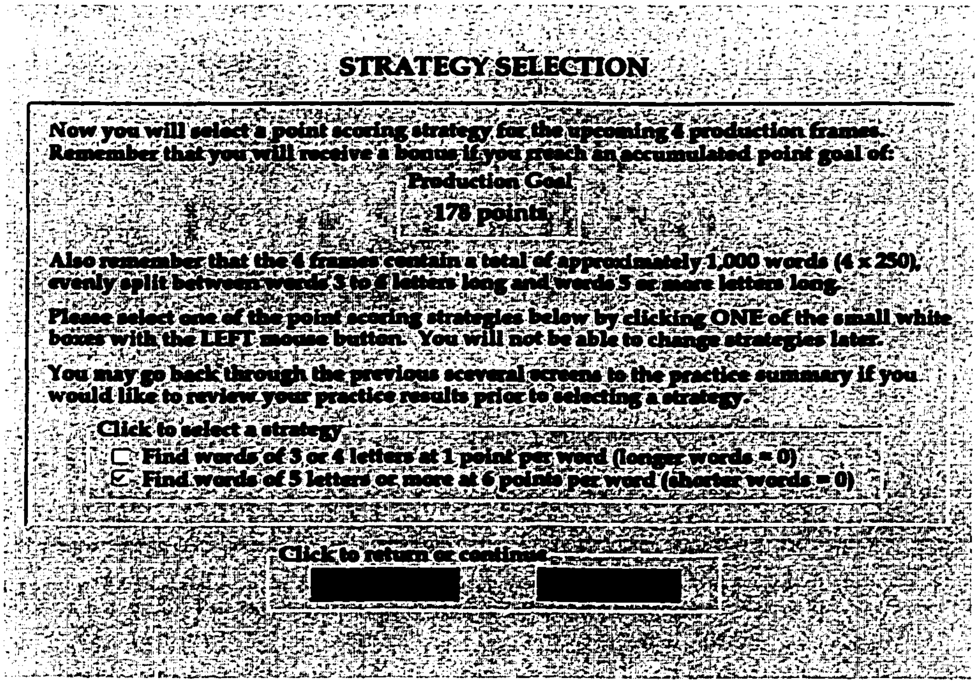
Figure 25

Production Goal and Compensation

a. Production Goal and Compensation



b. Strategy Selection



each subject. These unique goals were calculated based on the point totals for the two highest practice period frames. As noted previously, the practice frame for which each subject achieved the lowest results was omitted for two reasons. First, this allowed for the learning that almost certainly occurred during the initial practice frame. Second, it also allowed for the possibility that subjects might reduce (or even cease) their effort, particularly on the last frame, if they felt confident in their understanding of the task after the first two practice frames.

As described earlier, for consistency of appearance between the practice frames and the production frames, both featured a QUIT button that permitted early termination of any frame. Consequently, the production goal calculation was not simply based on the points achieved for the two highest practice frames. Instead, the calculation was based on the two practice period frames for which the points achieved per half-second were the highest.[15] Those results were then multiplied by the total number of half-seconds allowed for the four production frames (1920 half-sec) and decreased by 20 percent or increased by 20 percent to arrive at the easy and challenging production goals, respectively. Thus, the calculations of the easy goal and the difficult goal were identical except for the difficulty adjustment:

$$\text{goal} = \frac{\Sigma \text{ two highest practice frame scores}}{\Sigma \text{ two highest practice frame elapsed half-sec}} \times 1920 \text{ half-sec} \times \text{ADJ}$$

where: ADJ = 0.80 for the easy goal and 1.20 for the difficult goal.

[15] The computer timer recorded half-second increments.

Using a points per half-second basis rather than a points per frame basis allowed for the possibility that subjects might elect to terminate activity on one or more of the practice frames prior to the completion of the full time permitted. Time increments were measured in half-seconds because they were the smallest practical timer control parameter.

Figure 25-b shows the screen used by each subject to select a point scoring strategy for the four production frames. As a reminder, the production goal was displayed again. Reminders of the extensive number of possible words and of the chance to receive a goal achievement bonus also were provided. The number of words was emphasized on this and the previous production frames description screen (Figure 24) to avoid a reduction of effort from incorrectly concluding that most of the available words had been found. The subjects were instructed to select either a short-word strategy or a long-word strategy by clicking one of the two check boxes. The strategy description beside each check box contained reminders of the word length requirements and the points awarded for each word found with each strategy.

As with the other instructional screens, the paragraphs were displayed one at a time to attract attention. The strategy selection area (the bordered area containing the two check boxes) was flashed on and off several times to emphasize the strategy selection and as a way to prevent monotony with the relatively numerous instructional screens that appeared to this point in the experiment. The <<BACK buttons on this and the several previous screens permitted a review of prior information back to the practice period results as an aid in making the strategy choice. When the NEXT>> button was clicked to advance to the next screen, a message box appeared (not shown[16]) asking for a confirmation of the strategy selection before proceeding. This was included to prevent an inadvertent strategy selection error. Subjects wishing to change strategies were permitted do so at this point, but also were informed that future changes were not allowed. No subjects reported having to pursue an unintended strategy. If neither strategy was selected or both strategies were selected, a similar message box requested a correction.

The next screen, shown in Figure 26, displayed a summary of the selected strategy and compensation scheme. The purpose was to reinforce the awareness of the key elements and manipulations encountered in the production period phase of the experiment. The low task uncertainty treatment screen shown in Figure 26-a and the high task uncertainty treatment screen shown in Figure 26-b were identical except for the lines specifically tailored for the particular treatment group and the strategy selected by the individual subject. These differences were contained in the first, fourth, and sixth items, which reiterated the strategy choice and repetitiveness/non-repetitiveness (frame size and shape, times allowed for each frame, opponent skill). Figure 26-a is an example of the screen that was shown to a subject of the low task uncertainty treatment group who elected to pursue a long-word strategy. Figure 26-b is an example of the screen that was shown to a subject of the high task uncertainty treatment group who elected to pursue a short-word strategy.

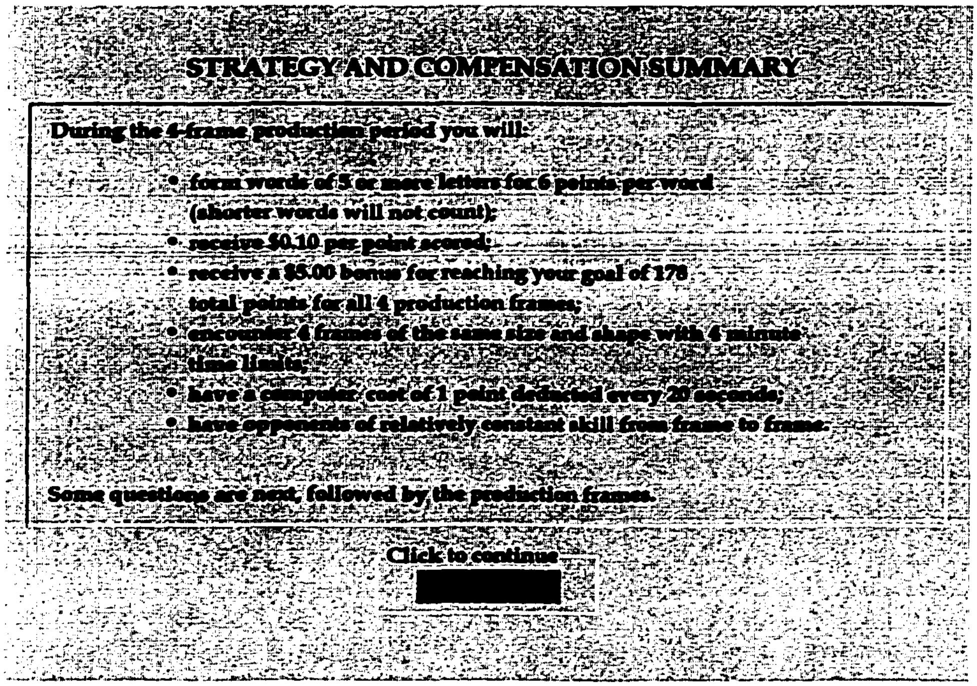
The other items were identical for both treatments. Subjects in both groups were reminded that the compensation scheme included a payment of $0.10 for each point plus a

[16] See the display of a similar message box in Figure 20-b for an example.

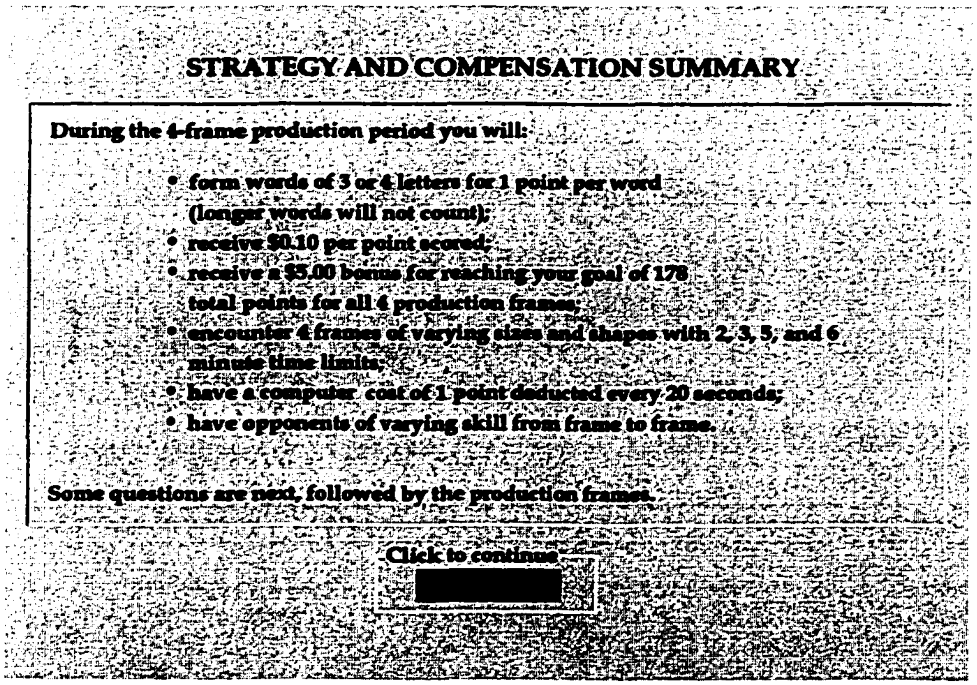
Figure 26

Strategy and Compensation Summary

a. Low Task Uncertainty Treatment



b. High Task Uncertainty Treatment



$5.00 bonus for reaching the goal and that a computer resource cost of one point would be deducted every twenty seconds. Also, subjects in both groups were reminded individually of their point goals for the production period. Subjects were not permitted to return to prior screens to change strategy or view previous information.

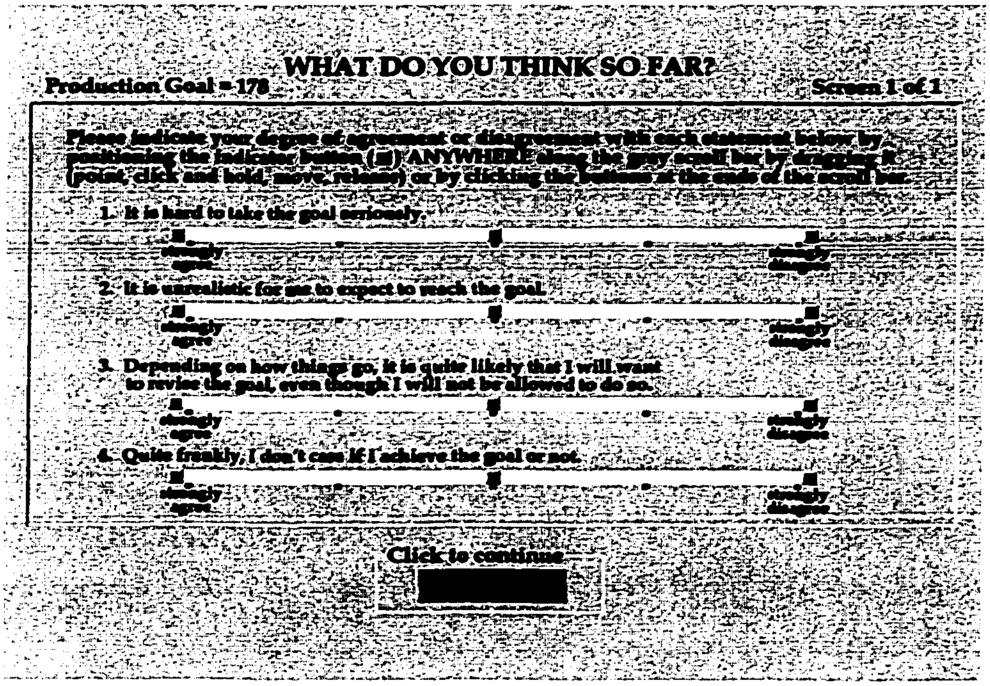
Pre-production questionnaire. Figure 27 shows the pre-production period questionnaire used to gather goal commitment data. This incremental display of this screen started with the border, proceeded with the title and page number, added the instruction paragraph, and after a pause of several seconds, finished with the simultaneous display of all four questions. At that time, the individual production goal was flashed on and off several times in the upper left corner as a convenient reference for responding to the questionnaire items.

The questions were adapted directly from the four-item unidimensional measure of goal commitment developed by Hollenbeck, O'Leary, Klein, and Wright (1989). Their purpose was "to develop an efficient, construct-valid measure of goal commitment (p. 955)." Drawing from a set of nine unidimensional items, they developed a four-item scale that exhibited a 0.71 internal consistency estimate of reliability (Hollenbeck, et al. 1989, p. 955). They performed a construct validity analysis consisting of "empirical checks that assessed (a) dimensionality and internal consistency, (b) convergence with alternative measures of the same construct, (c) relatedness to measures of separate constructs within the nomological net of the focal construct, and (d) discriminability from constructs not within the nomological net" (p. 955). The items (Figure 27-a) were (1) "It is hard to take the goal seriously," (2) It is unrealistic for me to expect to reach the goal," (3) Depending

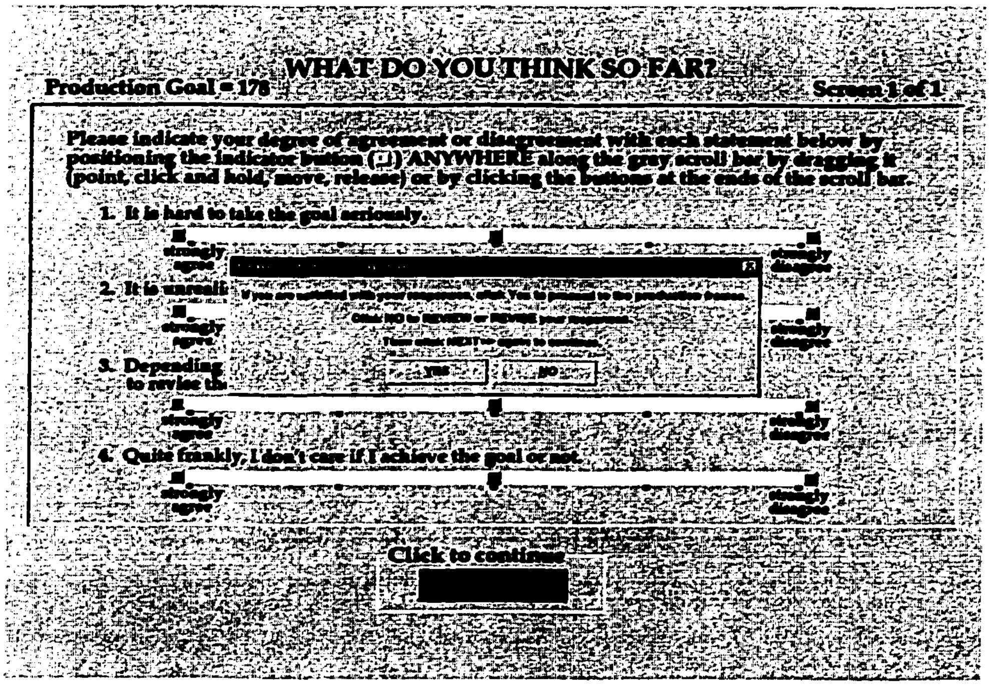
Figure 27

Pre-Production Questionnaire

a. Questionnaire Screen



b. Response Confirmation Message Box



on how things go, it is quite likely that I will want to revise the goal, even though I will not be allowed to do so," and (4) " Quite frankly, I don't care if I achieve the goal or not." All items were anchored by "strongly agree" on the left and "strongly disagree" on the right.

Hollenbeck, et al. (1989) found the scale to be significantly related to two alternative measures of the same construct: self-set goal-assigned goal discrepancy and force to attain the goal. It also was related to a third alternative measure of the construct, actual goal change, when tested with the sign test for correlated samples. With respect to other constructs, their results indicated that the scale was consistently related to performance. Importantly, the relationships with expected antecedents such as monetary incentives, involvement, need for achievement, locus of control, and goal publicness were statistically significant and in the predicted direction. Furthermore, there were no significant relationships between the scale and theoretically irrelevant variables such as age, gender, subject major, generalized intelligence, and generalized anxiety.

This study measured the goal commitment of both treatment groups both before and, as will be shown in later screens, after completion of the task. Subjects in both the task uncertainty treatment groups received the same questionnaire shown in Figure 27-a. Hollenbeck, et al. (1989) reported that the timing of the measurement of goal commitment with their scale did not have a strong effect on the results obtained in their studies, but that "in the few instances in which differences were obtained, however, the results were stronger for measures taken during or after task completion, relative to those taken before subjects started the task" (p. 955). Nevertheless, pre-production responses were used as measures of goal commitment for theory evaluation purposes because of the potential biasing effect of actual production results on a post-production measure.

The design of the questionnaire utilized a horizontal scroll bar to record the responses as continuous variables instead of the traditional five or seven point discrete scale.[17] As described in the instruction paragraph above the questions, subjects positioned the indicator button anywhere along the length of the scroll bar by dragging it or by clicking the buttons at either end. Five demarcation marks (the small black squares along the lower edge of the scroll bar) were provided as relative reference points. As can be seen in Figure 27-a, the indicator buttons were initially displayed in the neutral center position along the scroll bar to avoid biasing the subjects' responses.

When the NEXT>> button was clicked to proceed to next screen, a message box appeared asking for confirmation of the responses to the four questionnaire items as shown in Figure 27-b. Clicking the "Yes" button allowed continuation to the production frames and recorded the responses. Clicking the "No" button cleared the message box and permitted a review and/or revision of any or all of the responses. Then clicking the NEXT>> button initiated the same confirmation sequence again until the "Yes" button was selected. The purpose was to prevent subjects from inadvertently proceeding to the production period phase of the experiment without responding to the questionnaire items.

<u>Production period</u>. Immediately following the goal commitment questionnaire, subjects in each task uncertainty treatment group proceeded to the production period. During the production period, the elements of task uncertainty were manipulated. The

[17] The measurement range of each scroll bar included a minimum of 1 and a maximum of 200 in increments of 1; thus, while the design did not achieve perfect continuity, the approximation permitted analysis of the variables as if they were continuous rather than discrete.

manipulations included (a) the size and shape of the letter frames, (b) the time allowed for each frame, (c) the skill level of the opponent, and (d) the absence or presence of an interruption during each frame. All other elements were held constant, including the appearance of the screens (except, of course, for the letters in the letter frames), the total number of all possible words contained in all four frames, the total number of possible short words in all four frames, the total number of possible long words in all four frames, the total number of vowels in all four frames, and the total number of consonants in all four frames, the total number of short words found by the opponent in all four frames, and the total number of long words found by the opponent in all four frames.

These parameters are summarized in Table 3. As shown by the boxed areas of this table, both the low and high uncertainty production frames contained exactly the same total number of short and long words in the aggregate solution set: 516 short words and 484 long words, for a total of 1,000 words. Thus the opportunity to find words, and therefore accumulate points, was exactly the same for the low and high task uncertainty treatment groups. Secondarily, the total number of letters, both consonants and vowels, also was very close to the same for the two treatments. Finally, the total number of words found by the opponent (pre-programmed as explained earlier) for all four production frames was exactly the same for each treatment group (100). However, the low task uncertainty treatment group opponent word percentages were a constant 10 percent for each frame (25 words out of 250 for each strategy choice). The high task uncertainty treatment group percentages varied from 4.5 percent to 16.3 percent, but the overall average also was 10 percent for all four frames (100 words out of 1,000). Opponent

Table 3

Word Frame Parameters

Frames	Letters			Frame Words			Opponent Words		
	Vowels	Cons	Total	Short	Long	Total	Short	Long	Total
Demonstration	7	9	16	95	37	132	n/a	n/a	n/a
Practice Frames									
Frame 1	6	10	16	139	108	247	13	12	25
Frame 2	6	10	16	138	112	250	14	11	25
Frame 3	4	12	16	98	156	254	10	15	25
Totals	16	32	48	375	376	751	37	38	75
Average	5	11	16	125	125	250	12	13	25
Low Uncertainty Production Frames									
Frame 1	7	9	16	129	121	250	25	25	50
Frame 2	7	9	16	129	121	250	25	25	50
Frame 3	7	9	16	129	121	250	25	25	50
Frame 4	7	9	16	129	121	250	25	25	50
Totals	28	36	64	516	484	1000	100	100	200
Average	7	9	16	129	121	250	25	25	50
High Uncertainty Production Frames									
Frame 1 (donut)	8	12	20	139	105	244	12	11	23
Frame 2 (cross)	6	11	17	106	141	247	14	23	37
Frame 3 (diamond)	5	8	13	129	123	252	32	31	63
Frame 4 (star)	5	10	15	142	115	257	42	35	77
Totals	24	41	65	516	484	1000	100	100	200
Average	6	10	16	129	121	250	25	25	50

words for each of the three practice frames were 10 percent (75 out of 750) of the solution set as well. It should be noted that this percentage was calculated using both short and long opponent words because no strategy choice was made during the practice period. The percentage calculations for the low and high task uncertainty treatment frames included only short or long words because a strategy choice was made during the production period.

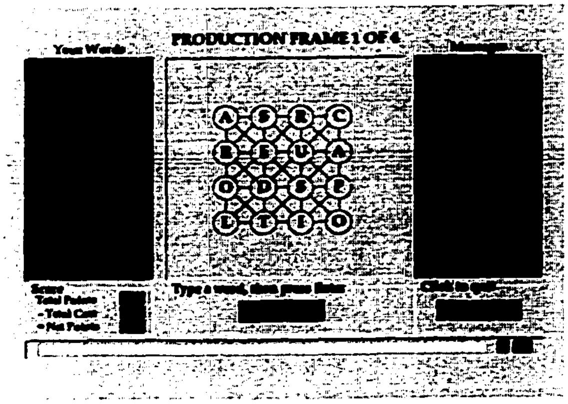
Subjects in the low task uncertainty treatment group were presented with four frames of the same 4 x 4 size and shape encountered during the practice period, but with different arrangements of letters from frame to frame. The order of appearance was random for each subject. It was determined by the sequence code on the access disk presented to each subject at check-in as described earlier.

The set of four low task uncertainty treatment group production frames is shown in Figure 28. The four frames not only were of the same size and shape, but actually were identical. The letters were simply rotated from frame to frame to give the appearance of four different arrangements. The solutions were identical because the relative positions of the letters remained the same. The purpose was to minimize boredom that could arise from simply memorizing words from the same solution set, which would not be possible for the high task uncertainty treatment group. Although this design feature was not revealed, anecdotal evidence obtained during check-out debriefing indicated that it was discovered by a few subjects, usually after the second frame. It was not possible to determine if there was any effect on the results, which could have been either positive or negative. An obvious positive effect might have been that words were remembered and

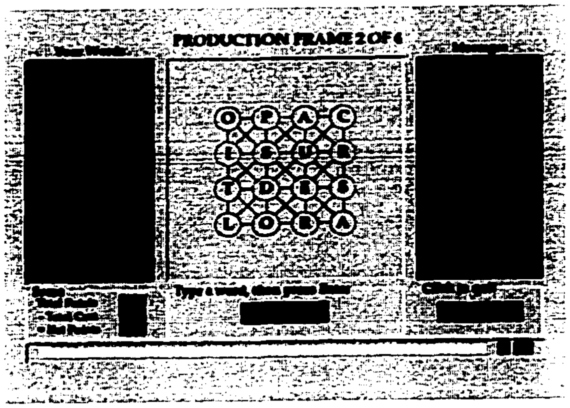
Figure 28

Low Task Uncertainty Production Frames

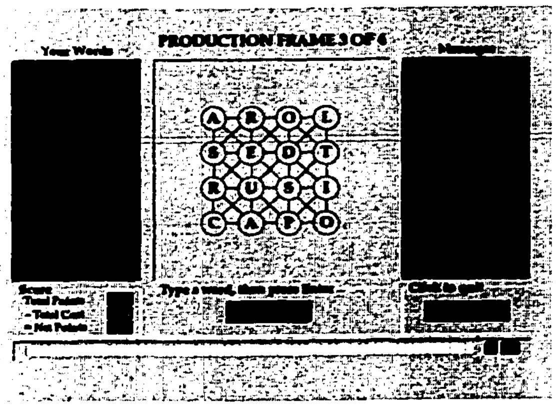
a.



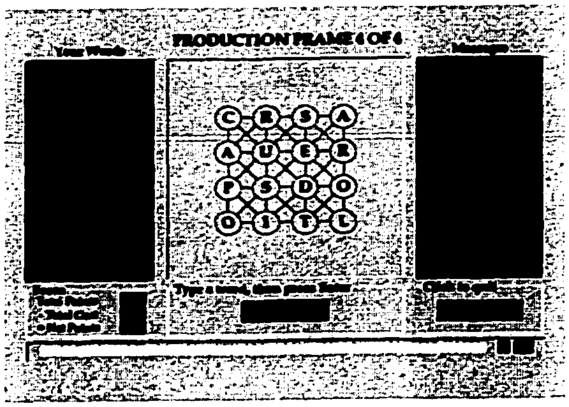
b.



c.



d.



entered quickly from frame to frame. On the other hand, remembering the same set of words from frame to frame might have resulted in such a narrow focus that additional words were overlooked.

Figure 28 also shows that the time allowed for each frame was the same four minutes. As noted previously, the skill of the opponent was consistent from frame to frame.

Words were attempted in the same manner described earlier for the practice frames. The program recorded the attempt in the data file each time the <ENTER> key was pressed. Data items included (1) the word, (2) whether the word was valid or invalid,(3) if valid, whether the word was a duplicate of one already found, (4) if the word had been found by the opponent, (5) the elapsed time when the attempt was made, (6) the points awarded, and one additional item (7) if there was a strategy mismatch.

Words could be ruled invalid for several reasons (not a word at all, excluded by the rules, formation not possible within the constraints of the letter frame arrangement) in the same manner as the practice frames. The word validity check was performed by comparing the attempted word with the complete solution of all valid words for each frame. Validity checks for the production frames (both low and high task uncertainty) required the additional step of comparing the attempted word with the solution set that corresponded with the particular strategy selected by each subject. In other words, the program accessed the set of all possible words of three or four letters for subjects who selected the short-word strategy and the set of all possible words of five letters or more for subjects who selected the long-word strategy.

The high task uncertainty treatment group subjects were interrupted during each of the four production frames to operationalize the outside influence component task openness. Both the low task uncertainty treatment group subjects and the high task uncertainty treatment group subjects were informed of the possibility of an interruption for file maintenance during the production period frames (see Figure 24), but only the high task uncertainty subjects actually were interrupted. Both groups were forewarned in order to maintain consistency of instruction between the two treatments.

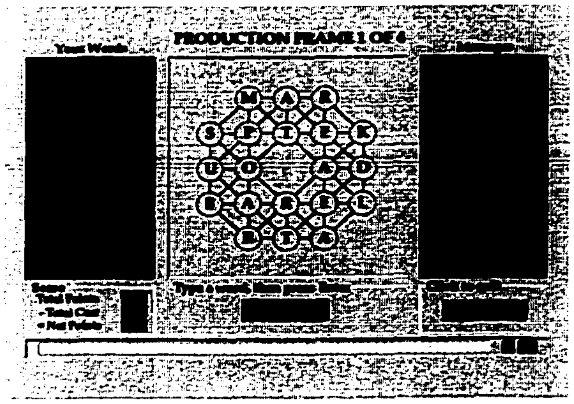
The four high task uncertainty treatment frames are shown in Figure 29. A comparison of these screens with the low task uncertainty frames shown in Figure 28 reveals that the shapes of the letter frames and the time limits are the only visual differences between the low and high task uncertainty frames. The presentation sequence of the four high uncertainty frames was assigned to subjects randomly according to the sequence code on the access disk given to the subjects at check-in. This was the same procedure used to determine the random presentation sequence for the low task uncertainty frames. The letter arrangements were designed to maximize the non-repetitiveness of the high task uncertainty frames compared with the low task uncertainty frames, but with the same total number of vowels and consonants and the same number of possible words in the overall solution sets (see Table 3).

Time limits were assigned to the high uncertainty frames based on the number of words in the solution set (more time for more words). The individual time limits were

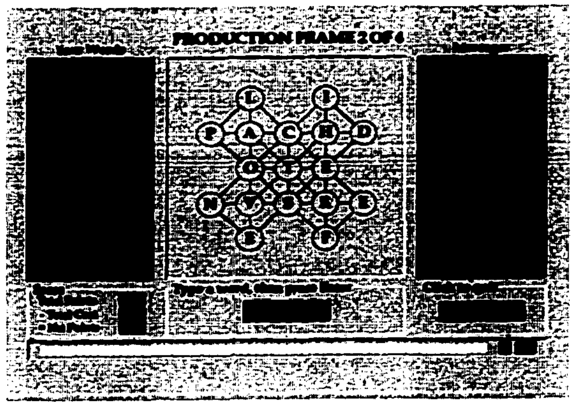
Figure 29

High Task Uncertainty Production Frames

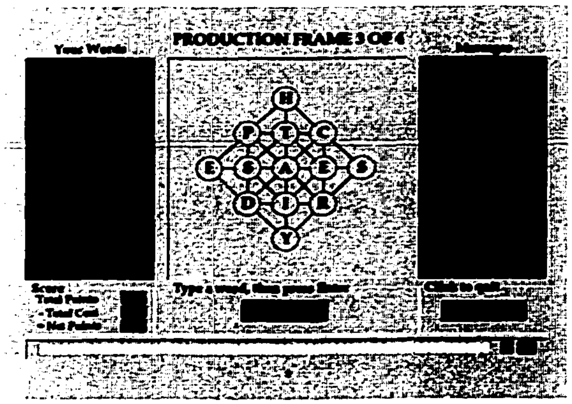
a.



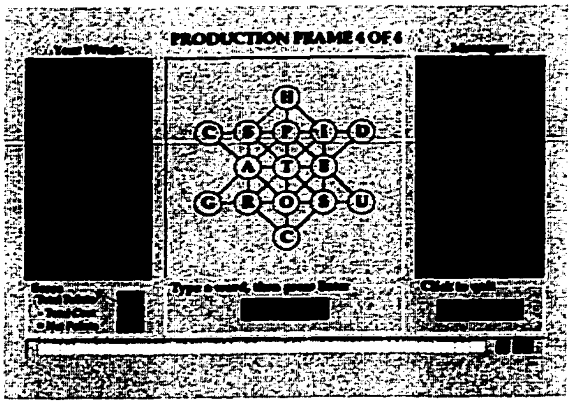
b.



c.



d.



selected to achieve the same sixteen minute total time on ask for both treatments:

Low task uncertainty: $4 + 4 + 4 + 4 = 16$

High task uncertainty: $2 + 3 + 5 + 6 = 16$.

A significant design challenge was to select five different time limits (2, 3, 4, 5, and 6 minutes) that could be combined to total sixteen minutes and that also could be displayed in a countdown timer indicator bar of constant length (i.e., number of segments).

Word attempts were recorded in the same manner already described for the low task uncertainty frames. As noted previously, the data recorded included the word, its validity, if it was a duplicate or opponent word, the point of elapsed time of the attempt, the points awarded, and if there was a strategy mismatch.

In addition to the achieving low and high repetitiveness by varying the letter arrangements and time limits, the internal and external components of task openness also were manipulated. Internal openness was manipulated by varying the skill level of the opponent. The opponent skill level was predetermined by randomly selecting lists of words from the solution sets to represent those "found" by the opponent during each production frame.[18] The opponent word list for each of the low task uncertainty production frames was a constant percentage of the total solution set for each frame. On the other hand, the percentages for the high task uncertainty production frames varied significantly from frame to frame. However, for both task uncertainty conditions the total number of opponent words for all four production frames was the same percentage of the

[18] Solution sets were imported into the Minitab statistical software package, which was used to randomly select the opponent word lists.

entire solution set for each treatment (see Table 3). Thus, the only difference between the two treatments was the variability from frame to frame.

The opponent represented a common dynamic frequently encountered in organizational settings. Individual employees often compete with one another for a variety of rewards, either knowingly or unknowingly. It is not unusual for the reward to be bestowed upon the first individual to achieve the desired results. A suggestions box system, in which only one individual is rewarded for an accepted idea, is a typical example. Pay increases and bonuses when resources are limited (as is usually the case) also are examples. Others include promotions to one or a limited number of higher level positions (i.e., senior to manager to partner in accounting firms), performance recognition (i.e., awards given to top sales personnel), and the distribution of perquisites (office size and location, parking, etc.) and special favors. The opponent concept in this experiment was designed to represent those situations in which only one individual could receive the reward. Consequently, subjects received points only for those words that were not also found by the opponent.[19]

The final manipulation was of the outside influence element of task openness. This manipulation was accomplished through the presence or absence of an interruption of the production frames. During the production period instruction phase, subjects in both task uncertainty treatment groups were told that an interruption for file maintenance might occur. Both groups were forewarned to maintain comparability. However, none of the low task uncertainty treatment frames was interrupted, while each high task uncertainty

[19] An alternative would have been to award points only for those words found by both the subject and the opponent, which would have represented a type of quality control function.

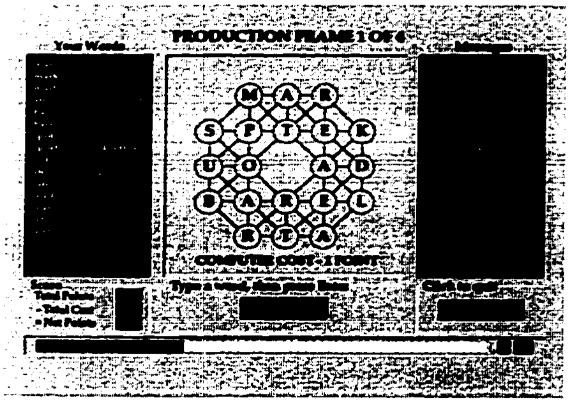
production frame was interrupted once. Although the interruptions served no real functional purpose other than as experimental manipulations (i.e., no file maintenance actually occurred), they were designed to be as convincing as possible.

The file maintenance interruption was operationalized as shown in Figure 30. Figure 30-a shows one of the high task uncertainty production frames as it might have appeared immediately prior to the interruption. Figure 30-b shows the initiation of the interruption with the following events: (a) the letters were removed from the screen, (b) the countdown timer and cost deduction were paused, (c) the mouse pointer was changed to an hourglass (standard programming procedure for indicating a pause), (d) the list of words found to that point and displayed in the left message box was dimmed, (e) the new word input box was disabled, (f) the QUIT button was disabled, (g) the time of the interruption was recorded in the data file, and after two seconds (h) a message was displayed in the right message box indicating that the timer had been paused. A few seconds later, a progress message box appeared on the screen to add to the perception of reality. An example of a partially completed fictitious data transfer is shown in Figure 30-c. Full completion is shown in Figure 30-d. The design was patterned after the typical progress message box style used in most Windows-based applications with which the subjects were expected to be quite familiar. A title bar across the top read "One moment please," a primary message in the middle read "Saving files .....XX%" to indicate the nature of the operation and the extent of completion, and a corresponding segmented progress bar across the bottom provided a graphical representation of progress toward completion. The percentages and indicator bar were incremented in a manner analogous

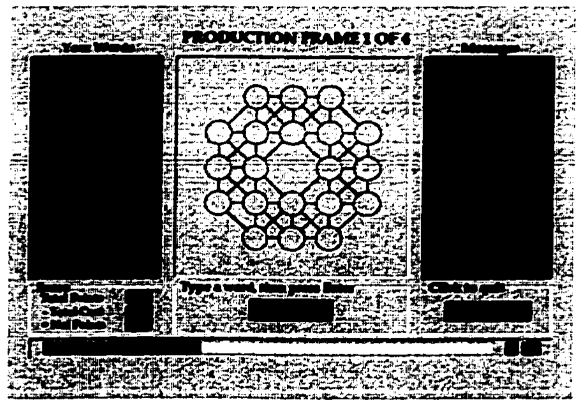
Figure 30

Outside Influence Manipulation - "File Maintenance" Interruption Part 1

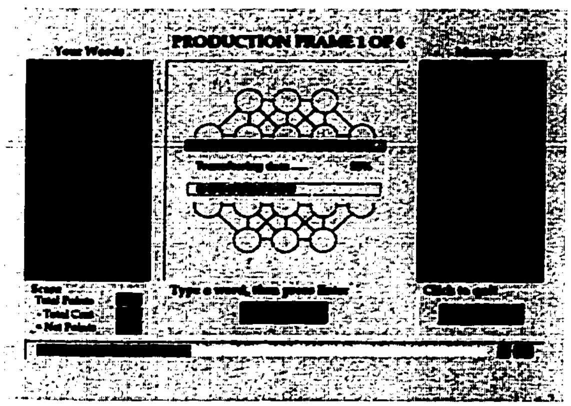
a. Typical Frame Immediately Prior to Interruption



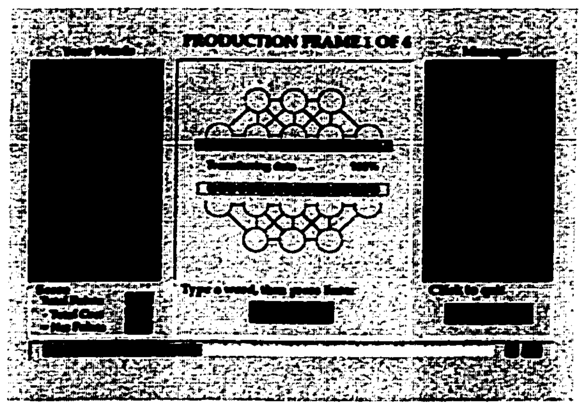
b. Initial Interruption



c. Less Than 100% "Data Transfer"



d. 100% "Data Transfer"



to an actual data transfer: The percentages changed in an irregular pattern, as did the progress bar, the two patterns were not synchronized, and both were incremented numerous times.

A second phase of the file maintenance interruption, shown in Figure 31, was included to strengthen the effect. At the completion of the fictitious data transfer, the message was cleared and changed to read "Saving files," the progress bar was cleared, and the percentage was reset to zero as shown in Figure 31-a. New and different percentages and progress bar increments indicated the progression of the fictitious file saving operation as depicted in Figure 31-b (partial completion) and Figure 31-c (full completion). Also shown in Figure 31-c is the five second reactivation warning that was displayed in the right message box upon completion of the fictitious data transfer operation.

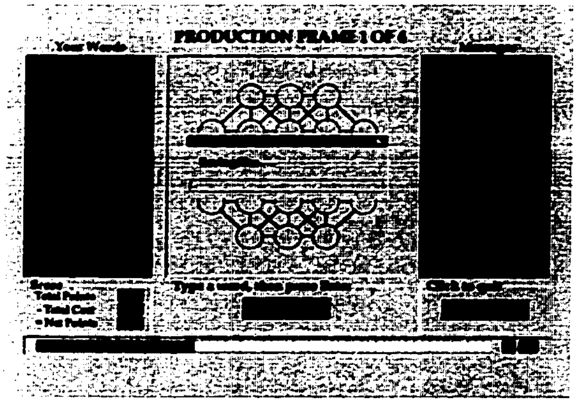
After five seconds, the production frame was reactivated as shown in Figure 31-d. The list of words found prior to the file maintenance interruption was no longer dimmed; the new word entry box, the timer, and the QUIT button were reactivated; and a resumption message was displayed in the right message box. Also displayed in the right message box was an indication that the letter set had changed, but that points earned prior to the interruption had been saved (which also was reflected by the score display).

The letter set was changed to strengthen the effect of the interruption and to represent those organizational situations in which circumstances and events are not the same after a real interruption of one kind or another. A total change of the letters, however, would have prohibited comparisons between treatments because there would be different solution sets before and after the interruption. Consequently, each of the four

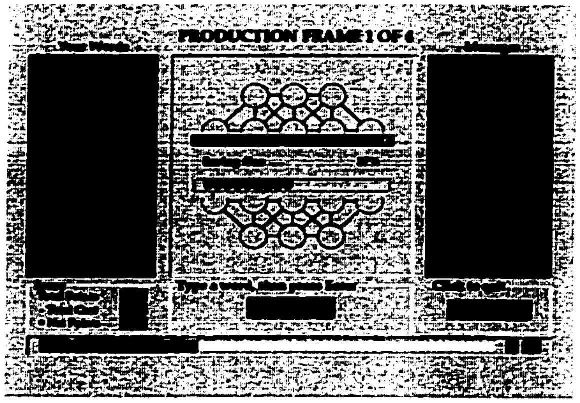
Figure 31

Outside Influence Manipulation - "File Maintenance" Interruption Part 2

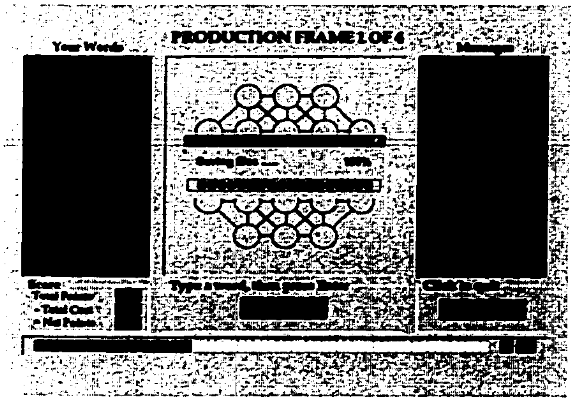
a. Message Box, Progress Bar, and Percentages Cleared and Reset



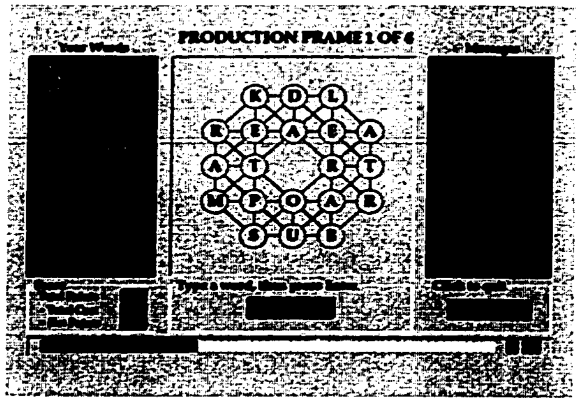
b. Less Than 100% Completion



c. 100% Completion



d. Resumption w/Letter Rotation



high task uncertainty treatment production frames was designed so that the letters could be rotated without changing the relationships of the letters to one another and, therefore, without changing the solution sets. Thus, the appearance of a new letter frame after the interruption was accomplished without losing comparability by simply rotating the letters in a number of alternative ways. The alternatives included rotations of 90 degrees, 180 degrees, 270 degrees, or 360 degrees around the center axis, clockwise or counter-clockwise. They also included flipping the letter arrangement from top to bottom, left to right, and corner to corner. Any combination of the rotations and flips also was possible. A comparison of Figure 30-a with Figure 31-d reveals that the letters in this particular high task uncertainty frame were rotated 90 degrees counterclockwise. No two of the four high task uncertainty production frames were rotated in the same way.

Importantly, because the solution sets did not change, the potential effect of changing the letters was theoretically neutral. While the effects of work interruptions can be negative because of the disruption of concentration and effort, they also can be positive if they provide the opportunity for a needed break or a new perspective on the task at hand. Therefore, within the context of this experiment, the effect of the rotation of the letters after the interruption of each of the high task uncertainty production frames could have been negative if the subject was having good success finding words at the moment of interruption. For example, a subject might have been in the process of entering several derivatives of the same base word (plurals, tenses, etc.) prior to the interruption, but unable to locate them, or even realize they were still there, afterwards. Conversely, the rotation of the letters could have had a positive effect if the subject was having difficulty finding words and the new arrangement provided a new and beneficial perspective. It is well recognized that the recollection of facts, the creation of ideas, and the discovery of solutions to problems often occur when the work process has been set aside and resumed after a break.

The interruptions were programmed to occur one time per frame at various points during the times allowed. The average interruption across all four frames occurred at the half-way point. The interruption sequence concluded with a redisplay of the original pre-interruption message in the message box to the right of the letter frame (not shown in Figure 31, see Figure 30-a) which indicated the active status of the timer, the amount of the production period point goal, and the selected point scoring strategy. Work on the production frame resumed and continued in the normal fashion for the remainder of the allotted time.

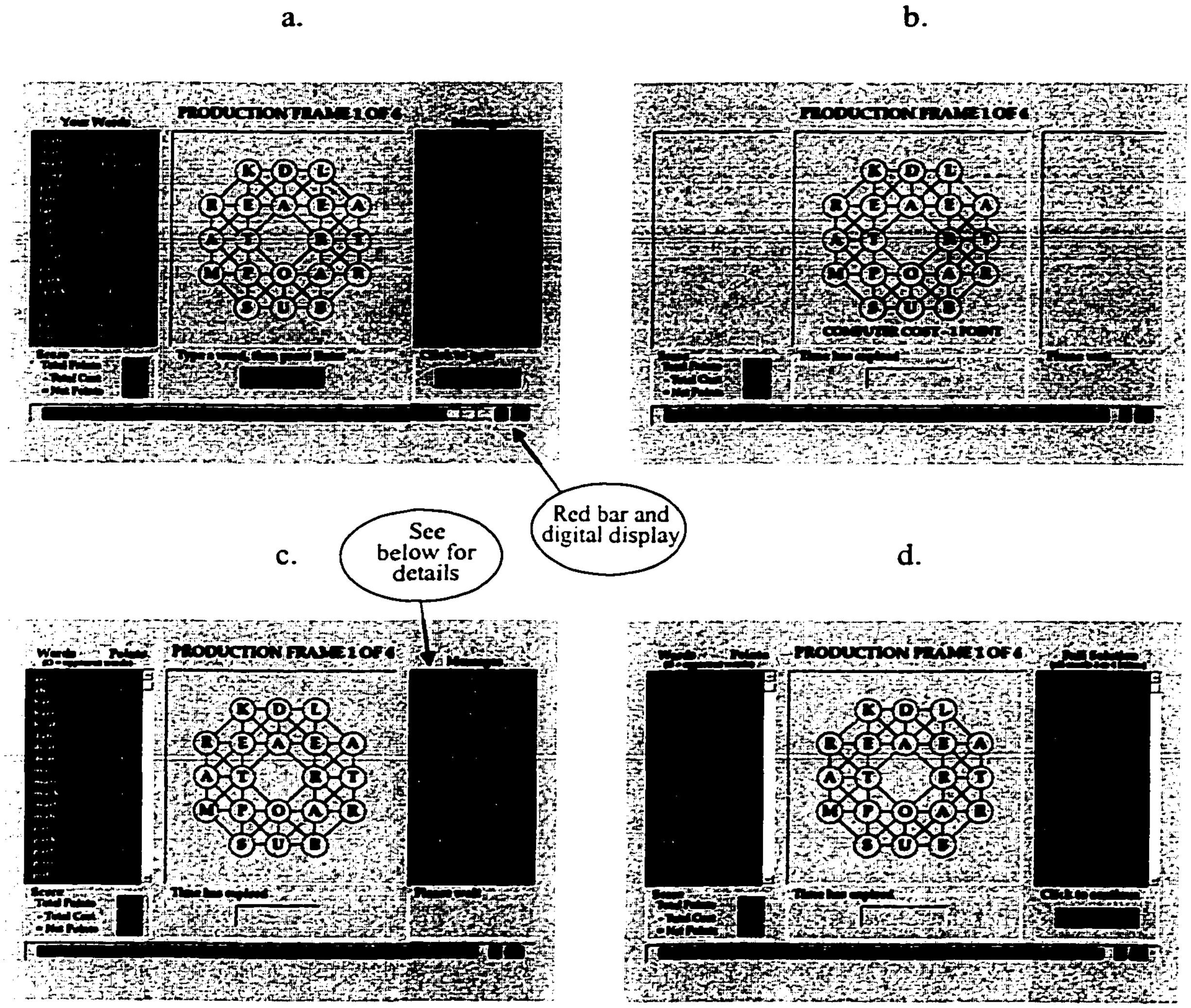
Frame termination for both the low and high uncertainty frames occurred in one of two ways. First, the allowed time could simply expire. Second, each frame could be terminated prior to the elapse of the allowed time by clicking the QUIT button. The incentive for doing so was to avoid the deduction for computer cost when finding additional words became difficult. In other words, the subject could terminate a frame after making a judgment that any incremental points were not likely to be greater than the remaining computer cost to be incurred. The purpose of this feature was to measure duration of effort. Recall that Hirst's (1987) theory suggested that task uncertainty would have an effect on persistence. For those subjects who chose not to terminate early, the point in time of the last word attempt provided an alternative measure. However, this would be the point of the last physical effort, but not necessarily the last mental effort. Because considerable mental effort could be expended searching for words long after the last entry, the alternative to terminate a frame provided an indication of the end of cognitive effort.

The termination sequence a the end of all production frames (either after the expiration of the allotted time or as a result of early termination by the subject) for both task uncertainty treatments was the same. It also was the same as the conclusion sequence for the practice period frames (see Figure 21). Figure 32 depicts the termination sequence for a typical production frame (in this case a high task uncertainty frame). Figure 32-a shows the frame just prior to the expiration of the allotted time. Figure 32-b shows the beginning of the termination sequence. The word list box to the left of the letter frame and the message box to the right were blanked, the new word entry box was disabled with the title changed to "Time has expired," the QUIT button was disabled with the title changed to "Please wait," and the digital timer display was dimmed. Two seconds later, the list of words found by the subject was displayed in the left box in alphabetical order with point values to the side, along with an indication of those words found by the opponent (points = 0). A vertical scroll bar allowed the review of any lists too long to fit within the dimensions of the display area.

Over the next several seconds, four informational paragraphs appeared in the right message box sequentially to indicate that the word list to the left contained the words found with the corresponding score, that the full solution that would appear shortly and could be viewed for two minutes, and that the NEXT>> button could be used to advance to the next screen. This phase is shown in Figure 32-c. After a few more seconds, these paragraphs were replaced by the full solution and the NEXT>> button was displayed and

Figure 32

Frame Termination Sequence



Panel c message box details:

> Your words are in the left box. A score of 0 points and an 'O' indicate a word found by your opponent.
>
> The full solution will appear in this box in a moment.
>
> You can view this screen for 2 minutes.
>
> Click the NEXT>> button when you are ready to go to the next screen.

activated. A vertical scroll bar was used to scroll through the solution set. This final phase is shown in Figure 32-d.

An alternative would have been to not display the full solution for review by the subjects. This was not done for two reasons. First, as discussed previously, goal setting has been shown to be most effective in the presence of feedback. The entire solution was a form of feedback. Second, it should have been apparent that the large number of words in each set provided ample opportunity to find as many as effort, ability, and time allowed. Consequently, subjects should not have been likely to cease their efforts as a result of believing that most, or even all, of the words had been found. Thus, effort, ability and time allowed were the determinants of how many words could be found, not the size of the solution set.

At the conclusion of the four-frame production sequence, a performance summary was displayed. The summaries shown to the low and high task uncertainty treatment group subjects were identical in format. The only difference in content was as a result of the strategy choice (to find short words or to find long words) made by each subject in both treatment groups. Figure 33 shows the production period summary screen for both strategy choices. Figure 33-a shows an example of the summary for a subject who chose the long-word strategy and Figure 33-b shows an example of the summary for a subject who chose the short-word strategy. Following the presentation style for all informational screens, the production period summary information was displayed incrementally starting with the border and proceeding through the title, column headings, data lines for each production frame, totals, production goal, score calculation formula, compensation, and next screen description line. The sequence concluded with the display of the NEXT>> button for advancement to the subsequent screen.

The production period summary reported feedback information for each of the four production frames, including the number of words found, the number of points lost to the opponent (the number of words found included words also found by the opponent), the number of points deducted for computer cost, and the net score. The net score calculation formula was displayed as a reference. Figure 33-a portrays the results for a hypothetical subject in either task uncertainty treatment group who (a) elected to pursue a long-word strategy and (b) received the $5.00 bonus for exceeding the production goal ([198 points * $0.10/point] + $5.00 = $24.80). Figure 33-b portrays the results for a hypothetical subject in either task uncertainty treatment group who (a) elected to pursue a short-word strategy, but (b) did not reach the production goal and therefore did not receive the $5.00 bonus (142 points * $0.10/point = $14.20).

Post-production questionnaire. The post-production final questionnaire followed the production summary. The screens are shown in Figures 34, 35, and 36. The questionnaire consisted of twenty-five items for the low task uncertainty treatment group and twenty-six items for the high task uncertainty treatment group. The additional item for the high task uncertainty treatment group was included on the last of five sequential screens to investigate the effect of the interruption that occurred during the high task uncertainty production frames only. Otherwise, the questionnaires for the two treatment groups were identical. Figures 34 and 35 show the first four screens, which were common

Figure 33

Production Period Summary

a. Long-word Strategy Screen Format

PRODUCTION PERIOD SUMMARY

Your performance for the 4 production frames was as follows:

Production Frame No.	(A) No. of Words <= 4 Letters	(B) No. of Words >= 5 Letters	Points Lost to Opp./Cost		Net Score (points)*
1	n/a	9	12	12	30
2	n/a	13	24	12	42
3	n/a	19	36	12	66
4	n/a	21	54	12	60
Total	n/a	62	126	48	198
Production Goal					178

* Score = (A x 1) + (B x 6) - Opponent Points - Computer Cost

Your total cash compensation is $24.80

Some final questions are next.

Click to continue

b. Short-word Strategy Screen Format

PRODUCTION PERIOD SUMMARY

Your performance for the 4 production frames was as follows:

Production Frame No.	(A) No. of Words <= 4 Letters	(B) No. of Words >= 5 Letters	Points Lost to Opp./Cost		Net Score (points)*
1	37	n/a	12	6	19
2	52	n/a	14	9	29
3	85	n/a	15	15	55
4	88	n/a	31	18	39
Total	262	n/a	72	48	142
Production Goal					178

* Score = (A x 1) + (B x 6) - Opponent Points - Computer Cost

Your total cash compensation is $14.20

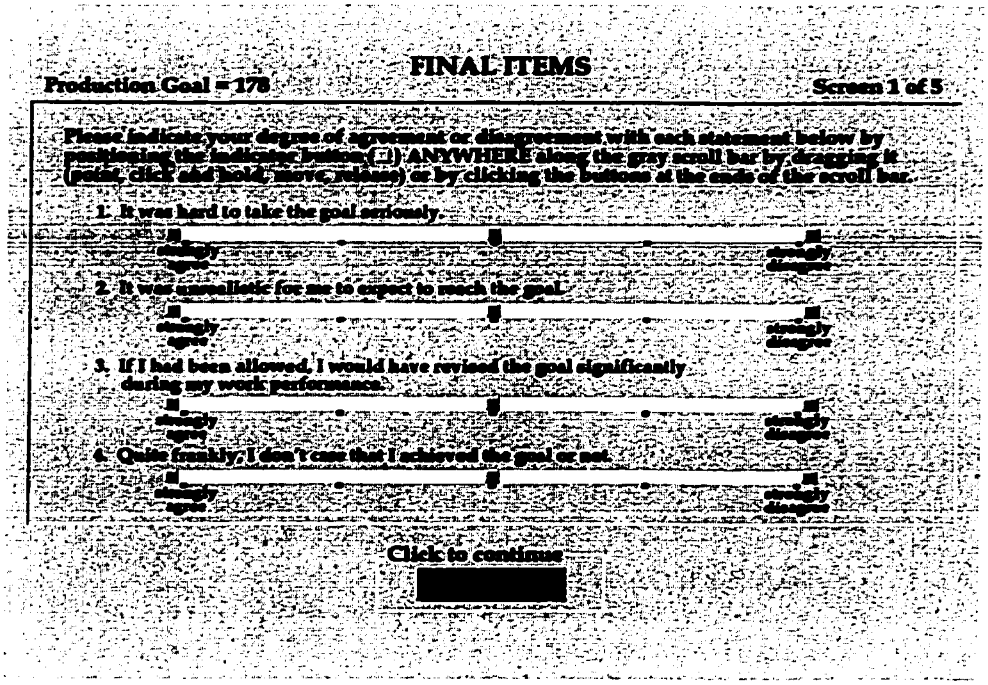
Some final questions are next.

Click to continue

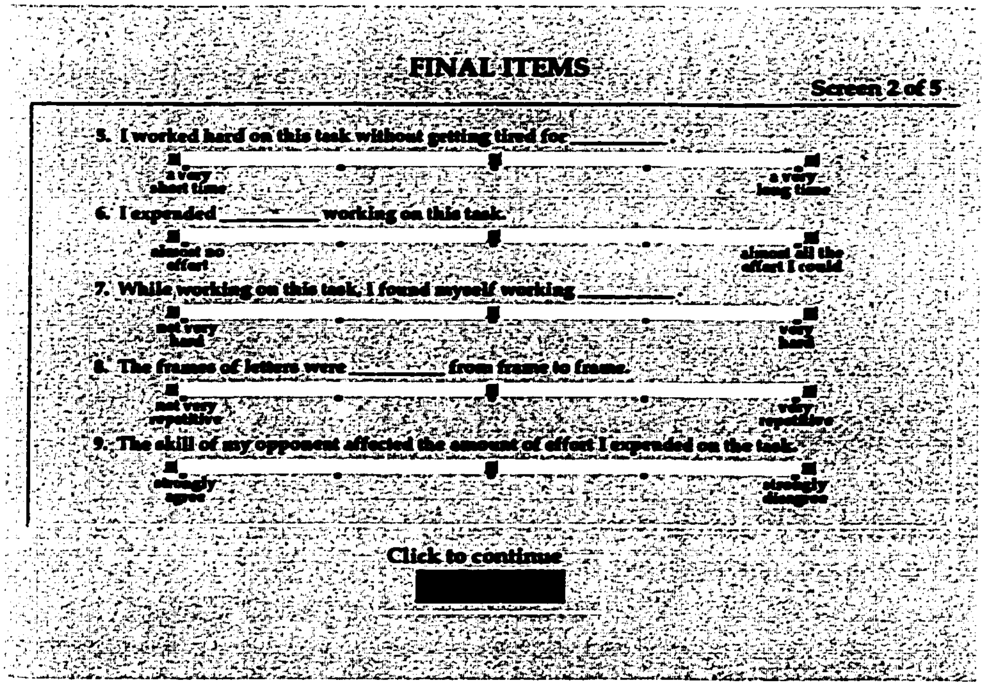
Figure 34

Post-production Questionnaire, Screens 1 & 2

a. Screen 1 of 5



b. Screen 2 of 5



to both versions. Figure 36 shows both versions of the final screen, which differ only by the inclusion of the additional question posed to the high task uncertainty subjects.

The first screen, shown in Figure 34-a, presented the subject with the same items included in the pre-production questionnaire (see Figure 27), but constructed in the past tense rather than in the present and future tense. This was done to provide for possible comparisons between pre-production and post-production levels of goal commitment. As noted previously, Hollenbeck, et al. (1989) reported that the timing of the measurement of goal commitment did not have a strong effect on the results obtained. Consequently, in this experiment the pre-production responses were used as measures of goal commitment for theory evaluation purposes to avoid the potential biasing effect of actual production experience on the post-production measure.

The questionnaire items were (1) "It was hard to take the goal seriously," (2) "It was unrealistic for me to expect to reach the goal," (3) "If I had been allowed, I would have revised the goal significantly during my work performance," and (4) "Quite frankly, I don't care that I achieved the goal or not," anchored by "strongly agree" and "strongly disagree." As a reminder, the production goal was displayed in the upper left corner just above the border. In the same manner as the pre-production questionnaire described earlier, a horizontal scroll bar was used to record the responses as continuous variables (subjects dragged the indicator button or clicked the end buttons, demarcation marks provided a relative reference, indicator buttons were initially displayed in the neutral center position).

The second screen of the questionnaire sequence is shown in Figure 34-b. The first three items were adapted from Earley and Wojnaroski (1987) to measure intensity of effort. They were (5) "I worked hard on this task without getting tired for _____ (a very short time/a very long time)," (6) "I expended _____ working on this task (almost no effort/almost all the effort I could)," and (7) "While working on this task, I found myself working _____ (not very hard/very hard)." In their study, Earley and Wojnaroski found a Cronbach's alpha measure of reliability of 0.71 for these three items. This experiment followed their procedure of forming a composite score for energy expended using the mean of the responses to these items.

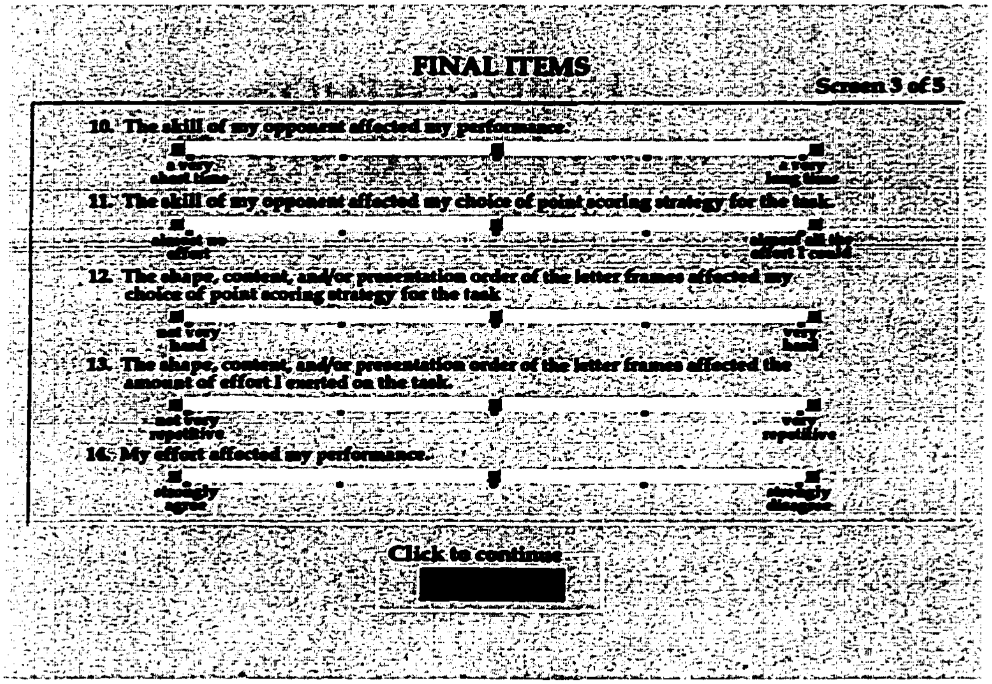
The next two items were developed by the researcher as an indication of the effect of the task repetitiveness and internal influence (opponent) manipulations. They were (8) "The frames of letters were _____ from frame to frame (not very repetitive/very repetitive)," and (9) "The skill of my opponent affected the amount of effort I expended on the task (strongly agree/strongly disagree)."

The third and fourth screens of the sequence are shown in Figure 35. Again, the objective was to perform checks of the experimental manipulations. The third screen is shown in Figure 35-a. The first two questions continued the evaluation of the effect of the opponent manipulation. They were (10) "The skill of my opponent affected my performance (strongly agree/strongly disagree)" and (11) "The skill of my opponent affected my choice of point scoring strategy for the task (strongly agree/strongly disagree)." The next two questions examined the effect of the repetitiveness or non-repetitiveness of the letter frames. They were (12) "The shape, content, and/or presentation order of the letter frames affected my choice of point scoring strategy for the task (strongly agree/strongly disagree)" and (13) "The shape, content, and/or presentation

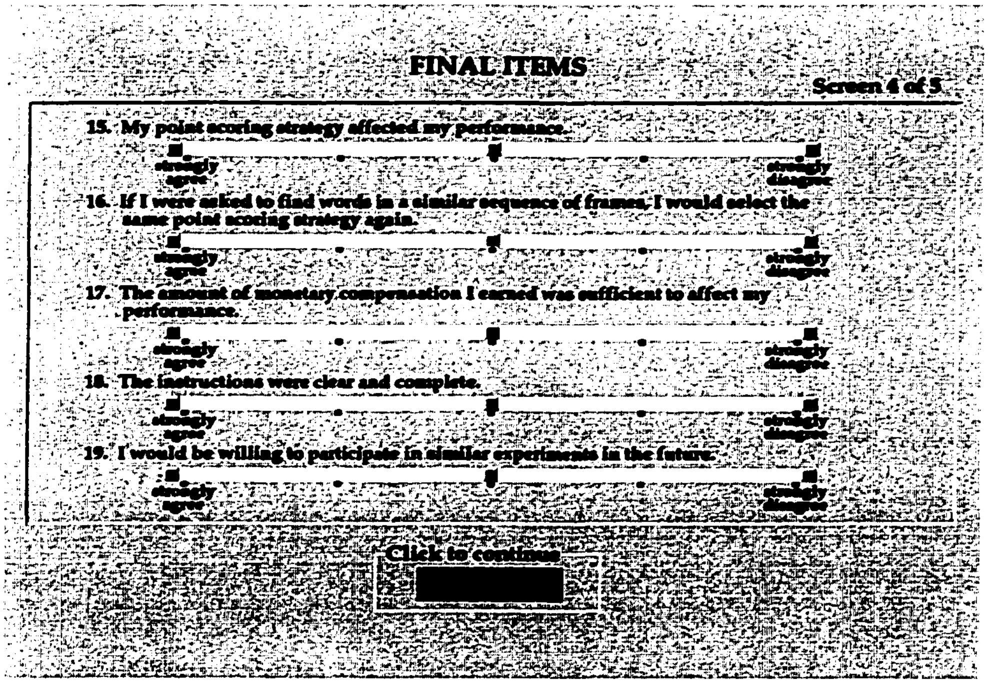
Figure 35

Post-production Questionnaire, Screens 3 & 4

a. Screen 3 of 5



b. Screen 4 of 5



order of the letter frames affected the amount of effort I exerted on the task (strongly agree/strongly disagree)." The last item on this screen and the first two items on screen 4, shown in Figure 35-b, were included as overall checks of the effort, strategy and performance relationships. They were (14) "My effort affected my performance (strongly agree/strongly disagree)," (15) "My point scoring strategy affected my performance (strongly agree/strongly disagree)," and (16) "If I were asked to find words in a similar sequence of frames, I would select the same point scoring strategy again (strongly agree/strongly disagree)."

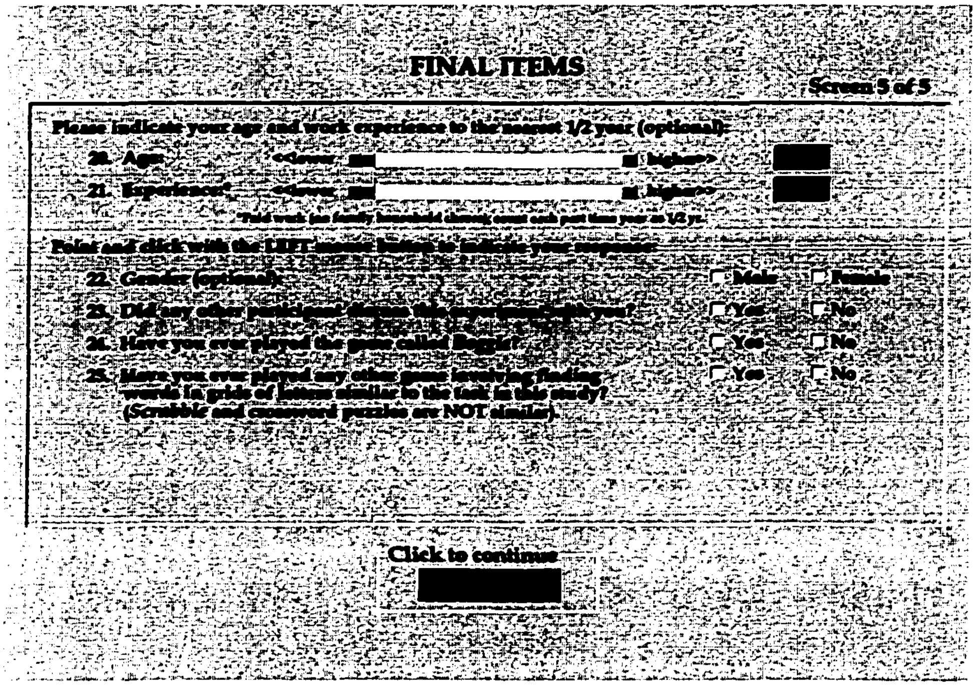
The next three items provided feedback about the adequacy of the monetary compensation, the quality of the instructions, and the satisfaction of the subjects with the experiment. They were (17) "The amount of monetary compensation I earned was sufficient to affect my performance (strongly agree/strongly disagree)", (18) "The instructions were clear and complete (strongly agree/strongly disagree)," and (19) "I would be willing to participate in similar experiments in the future (strongly agree/strongly disagree)."

Figure 36 shows the final screen of the post-production questionnaire sequence. Figure 36-a presents the screen for the low task uncertainty treatment and Figure 36-b displays the screen for the high task uncertainty treatment. The only difference was the inclusion of an inquiry about the effect of the interruptions during the high task uncertainty production frames (item 20 in Figure 36-b). The other items collected demographic and subject experience information and were identical for both treatments. Included were age,

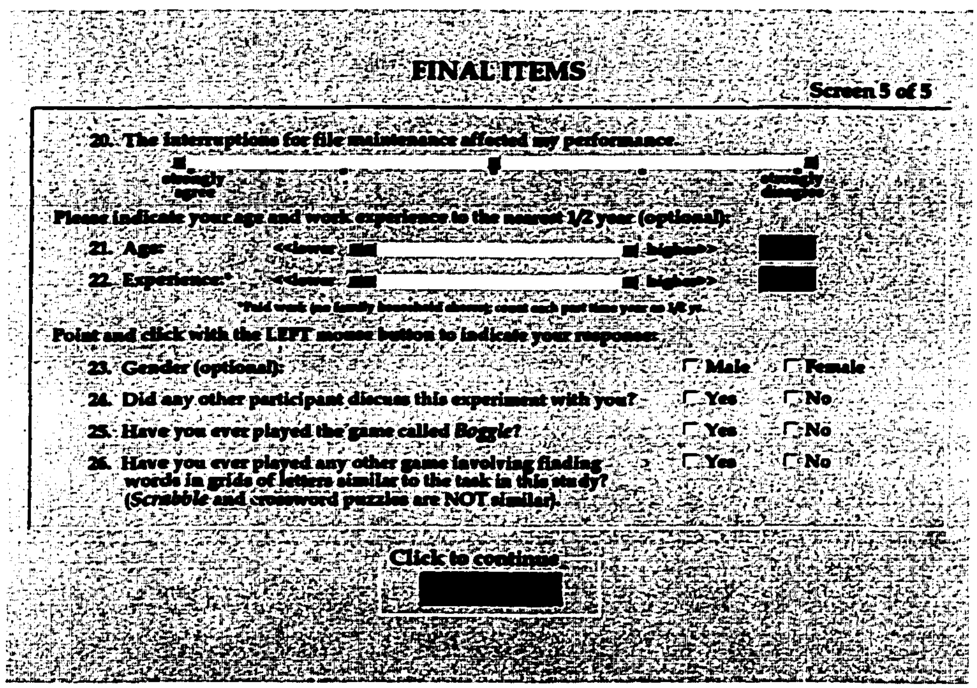
Figure 36

Post-production Questionnaire, Screen 5

a. Low Task Uncertainty Treatment



b. High Task Uncertainty Treatment



work experience, gender, discussions with other subjects, and experience with commercial word games similar to the task in this experiment.

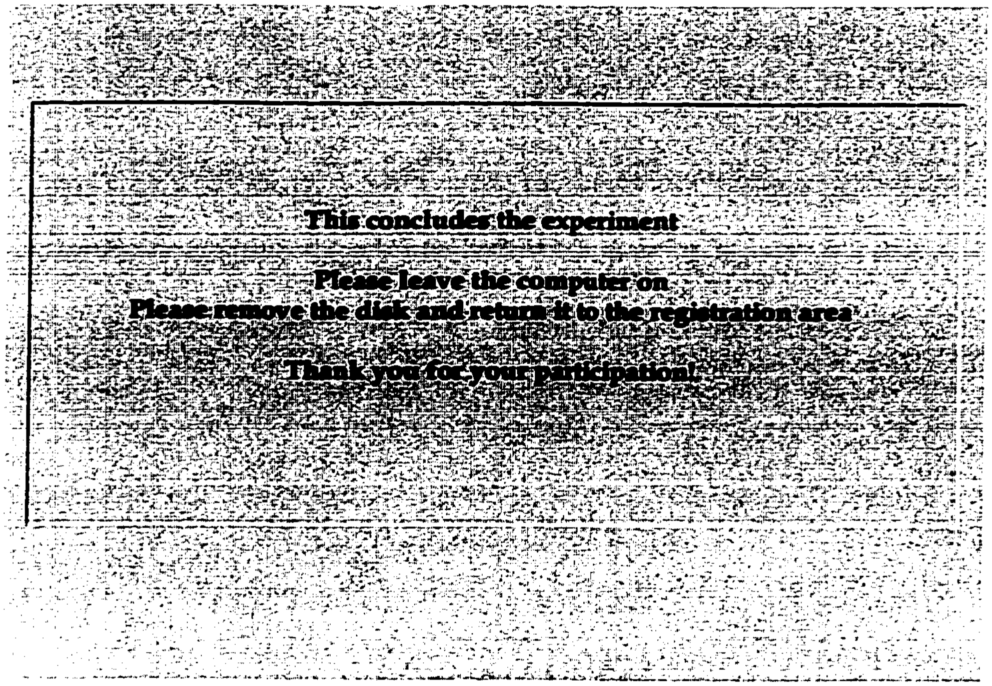
Subjects advanced to the each screen in the questionnaire sequence by clicking the NEXT>> button. Confirmation of choices was requested in the same manner as for the pre-production questionnaire (a message box appeared asking the subject to click the YES button if satisfied with the responses or NO if not; see Figure 27-b). Clicking YES advanced to the next screen and recorded the responses in the data file. Clicking NO returned to the questionnaire screen for modifications and corrections. The process was repeated until the subject clicked YES to proceed to the next screen.

Conclusion. The final screen, shown in Figure 37, provided a definite conclusion to the experiment and thanked the subjects for their participation. It also instructed the subject to leave the computer on, remove the disk from the disk drive, and return to the registration area. This screen was identical for both treatments. As described previously, after two minutes the program reset for the next subject by clearing all internal settings and data files and displaying the initial screen (see Figure 13-a).

Subjects returned to the registration area to receive their cash earnings and a debriefing. The amount of cash was determined by accessing the data disk, where the total amount earned had been recorded automatically during the experiment. The cash was paid immediately and directly to each subject from a cash box prior to leaving the registration area. Subjects were provided with a brief explanation of the purpose and importance of the experiment, and each was asked not to discuss the experiment with anyone currently enrolled in masters level courses in the College of Business Administration who had not yet participated.

Figure 37

Final Screen



The data disks were stored in a secure area until all subjects had completed the experiment. At that time, the GMAT/GRE admissions test scores were obtained by accessing university records and adding the data to each data file. The official university record for each subject was accessed by computer and the test scores were included by adding the necessary lines of space and keying in the test score information. Because of the manual entry element of this process, the admission test data were rechecked to ensure accuracy.

The experimental design for this study included a variety of manipulated, measured, and controlled variables. Figure 38 and Table 4 summarize those variables. A comparison of Table 4 with Figure 9 reveals that completeness of task knowledge is a component of the Hirst model of the effects of task uncertainty on task performance that is not included in Table 4 as a specifically manipulated, measured, or controlled variable. As will be described in the data analysis section later, acquisition of task knowledge was measured by comparing scores for the last two production frames with scores for the first two production frames for each treatment. However, this measure was only a rough measure of the acquisition of task knowledge and not the completeness of task knowledge. Completeness of task knowledge was difficult, if not impossible, to measure. Furthermore, the task used in this study was not overly complex and every effort was made to provide complete instructions to make task performance possible.

The acquisition of task knowledge was analyzed separately from the path analysis of the other variables for two reasons. First, acquisition of task knowledge does not necessarily result in completion of task knowledge. More importantly, the acquisition of

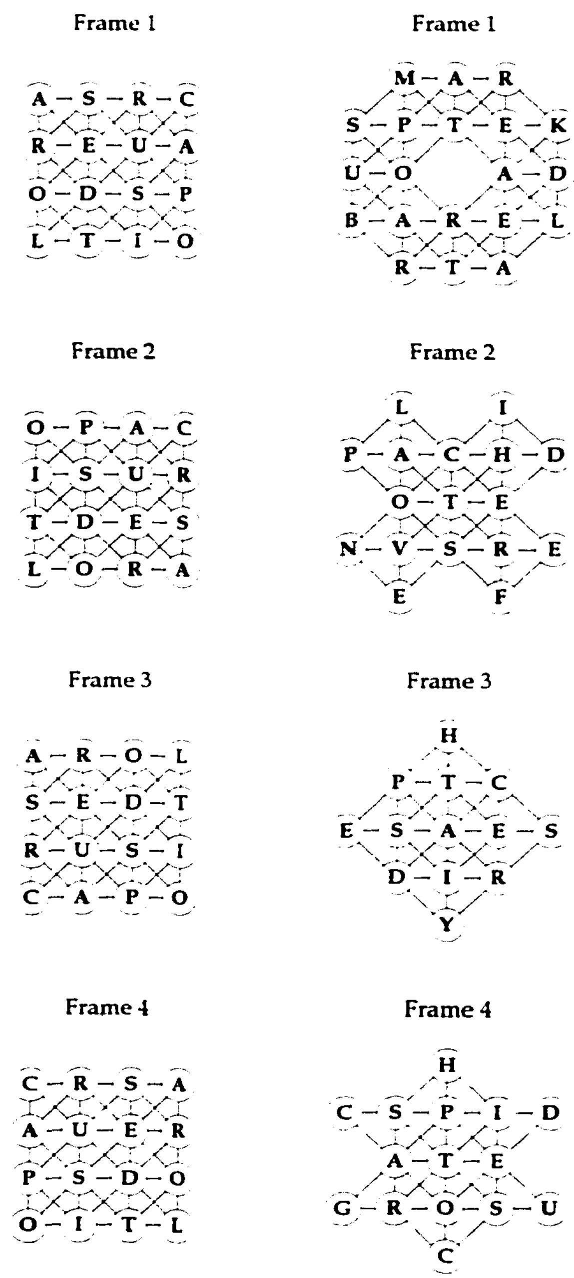
Figure 38

Summary of Task Uncertainty Treatments

Low Task Uncertainty

Repetitiveness
- High
- Identical letters, arranagement, and size (letters rotated)
- Same solution set for each frame
- Same time limit for each frame
- Constant opponent skill from frame to frame
- Random order of frames

Openness
- Low
- Constant number of words from frame to frame
- Frames not interrupted.
- Competition with an opponent



High Task Uncertainty

Repetitiveness
- Low
- Different letters, arrangement, and size
- Different solution sets from frame to frame
- Different time limit for each frame
- Varied opponent skill level from frame to frame
- Random order of frames

Openness
- High
- Variable number of words from frame to frame
- Frames interrupted (letters rotated after interruption)
- Competition with an opponent

- Frames in both treatments were presented in random order -

Table 4

Variables Summary

Variable	Type	Manipulation/Measurement/Control	Continuous/Discrete	Value
DEPENDENT				
■ Performance	Measured	Points accumulated by computer 6 points/word for long-word strategy 1 point/word for short-word strategy	Continuous	0 and up
INDEPENDENT				
■ Task Uncertainty:				
✤ Repetitiveness:				
Arrangement	Manipulated	Size, content & configuration of treatment frames not varied for low uncertainty or varied for high uncertainty	Discrete	Varied or Constant
Time on task	Manipulated	Time allowed for treatment frames not varied for low uncertainty or varied for high uncertainty	Discrete	4 min. each or 2,3,5,6 min.
Opponent	Manipulated	Skill level for each treatment frame (defined as % of total solution set) not varied for low uncertainty or varied for high uncertainty	Discrete	4 x 10% or 3,7,12,18% (avg. = 10%)
✤ Openness:				
Outside influence	Manipulated	Treatment frames not interrupted for low uncertainty or interrupted for high uncertainty	Discrete	Interrupted or not interrupted
Inside influence	Manipulated	Opponent skill for each treatment frame (% of total solution set) not varied for low uncertainty or varied for high uncertainty	Discrete	4 x 10% or 3,7,12,18% (avg. = 10%)
MODERATORS				
■ Goal difficulty	Manipulated	Best two practice frames x 0.8 (easy) Best two practice frames x 1.2 (hard)	Continuous	Easy/Hard
■ Subject ability	Measured Controlled	GMAT/GRE verbal percentiles Random assignment of subjects to treatments	Continuous	0 to 100
■ Goal commitment	Measured	Self-reported questionnaire items from Hollenbeck et al. (1989)	Continuous	0 to 200
■ Feedback	Controlled	Continuous analog & digital on-screen display of time remaining, words accepted, words not accepted, goal, frame points & accumulated points	Discrete	Always provided
■ Task difficulty/ complexity:				
✤ Possible words	Controlled	Same no. of short & long words for both treatments	Discrete	516 + 484 = 1000
✤ Letters	Controlled	Same number of vowels and consonants for both treatments	Discrete	low: 28/36 high: 24/41
✤ Time allowed	Controlled	Same total time for both treatments	Discrete	16 minutes

Table 4, Variables Summary (continued)

Variable	Type	Manipulation/Measurement/Control	Continuous/Discrete	Value
MEDIATORS				
■ Effort:				
✣ Duration	Measured	Point in time of last word attempt or early termination according to the computer internal clock	Continuous	0 to frame time limit
✣ Intensity	Measured	Self-reported questionnaire items from Earley and Wojnaroski (1987)	Continuous	0 to 200
✣ Direction	Measured	Included in strategy choice (see below)	n/a	n/a
■ Strategy choice	Measured	Forced selection between search for short words (1 point each) and long words (6 points each)	Discrete	Short/Long
■ Strategy appro-priateness	Measured	Comparison of strategy selected with most appropriate strategy based on practice period results	Discrete	Appropriate/ Inappropriate
■ Task Performance Reward	Measured	Meaningful goal-based monetary rewards based on accumulated points with bonus paid for goal achievement; same scheme for all subjects in both treatment groups	Continuous	$0.10/point $5.00 bonus

task knowledge was measured in essentially the same terms as the independent performance variable.

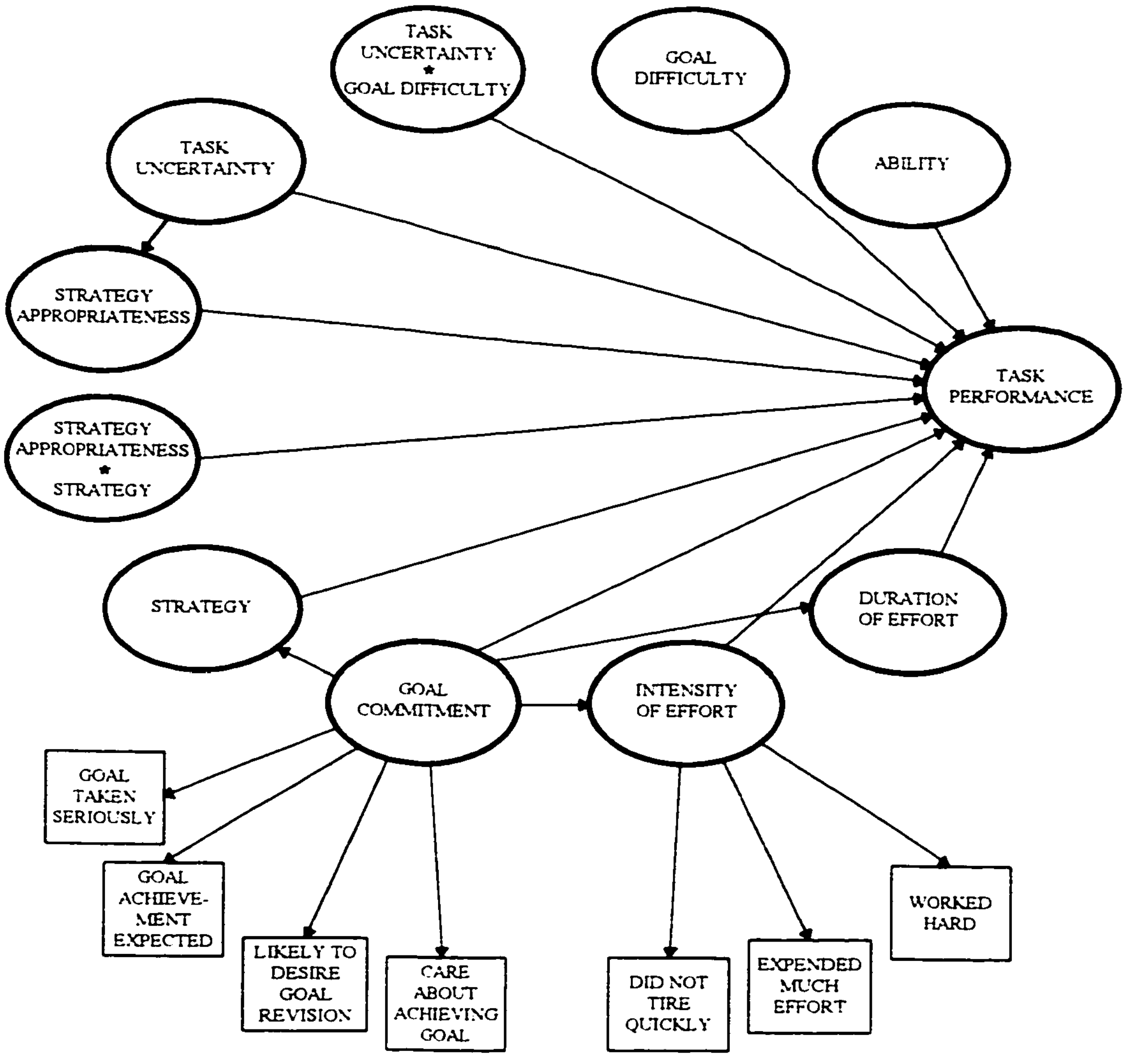
Figure 39 repeats the path diagram presented earlier that depicts the path relationships among the variables. It is the same as Figure 11 shown earlier, but with goal commitment and effort intensity indicators added. This was the path diagram used to analyze the data, the results of which are discussed in the next chapter.

As discussed in the theory section earlier, expectancy and performance are positively related within any given goal group. Accordingly, the design of the experimental task included the elements of expectancy theory described previously (Locke and Latham 1990). The practice period provided an opportunity for enactive mastery, the automated word examples shown in the demonstration frame provided a type of role modeling, feedback was provided directly and immediately on the computer screen, and both goals and incentives were provided. Persuasion (usually in the form of encouragement or information about the performance of others) was not provided.

As noted earlier, the experiment began in April of 1998 and extended through the end of the calendar year. The data collection process extended over this relatively lengthy period because the participation of the subjects was entirely voluntary. Although subjects were cautioned not to discuss the experiment with potential subjects, the validity threat is recognized. However, no evidence of any resulting bias was discovered. This and other threats to validity are discussed next.

Figure 39

Research Model Path Diagram



Threats to Validity

As with any experiment, there are several possible threats to the validity of the results. Several statistical conclusion validity, internal validity and external validity issues related to this experiment were recognized and addressed.

Statistical Conclusion Validity

One of the ways in which this study might be an insecure base from which to extrapolate is that the conclusion reached about the statistical hypotheses tested might be wrong. As Cohen (1983) and others have stressed, one of the most pervasive threats to the validity of statistical conclusions reached in the behavioral sciences is low power. According to Maxwell and Delaney (1990), studies typically have low power because sample sizes are too small for the situation. Accordingly, Maxwell and Delaney's (p. 27) recommendation is that "increasing the number of participants is the simplest solution, conceptually at least, to the problem of low statistical power." Consequently, every effort was made to attract an adequate number of participants in this study. The various methods described earlier included a personal invitation made to several classes, announcements distributed in the College of Business Administration newsletter, and follow-up e-mail messages to remind subjects of their appointments and reschedule when necessary. The other major obstacles to obtaining subjects were the restrictions imposed by limited financial resources available for subject compensation and the corresponding willingness for them to devote their time. The amount of compensation was set with the anticipation that it would be at least competitive with most hourly rates earned by graduate students working in part time jobs, which would also encourage participation.

Another reason for low power is the use of an unreliable dependent variable. A variable can be unreliable if it is inconsistent and/or inaccurate. Scores on variables are assumed to result from a combination of systematic (or true score) variation and random error variation. For example, scores on a multiple choice test are determined in part by the level of knowledge of the student. They also are affected by other factors such as motivation, luck in guessing answers not known by the student, and whether the student feels well or not. Variables are unreliable, in a psychometric sense, when the other factors cause the random error variation component to be large relative to the systematic score variation component (Maxwell and Delaney, p. 27). The lower the reliability of a dependent measure, the less sensitive it will be in detecting treatment effects.

The dependent variable in this study was performance determined by awarding points based on the number and length of words found. The random error component of the measurement was minimized in two ways. First, words only could be found by expending effort to look for them. The element of luck was minimal if not nonexistent. Furthermore, the performance measurement was entirely accurate. Only correctly and completely spelled words contained in a standard dictionary were accepted. Because the computer was programmed to make this determination, there was no room for measurement error. In contrast, the performance of some of the alternative experimental tasks considered that would have involved physical construction or assembly would have required evaluation according to a standard of quality as well as completion. Either or both determinations could have introduced errors associated with experimenter judgment. The design of this experiment eliminated experimenter judgment.

Another potential cause of unexplained variability in the dependent variable (and hence the probability of a Type II error of falsely rejecting the null hypothesis) was implementing the treatment in slightly different ways from subject to subject. A major benefit of using the computer to administer this experiment was that any unintended variability of treatment was eliminated. The manipulation and measurement of variables was exactly the same from one subject to the next: the type and time allowed for practice and subsequent task performance was controlled by the internal computer clock; each subject used the same type of computer keyboard and monitor combination; the instructions, demonstrations, and practice period were identical; the type and amount of feedback was identical; the measurement of performance, task strategy, and duration of effort was consistent and precise; the design and timing of the interruptions of high task uncertainty treatment subjects was precise; questionnaire responses were collected in an identical manner under identical circumstances, etc. Finally, testing an existing theory, combined with random assignment of subjects and treatments, minimized the omission of important explanatory variables.

Internal Validity

Internal validity threats arise because of the possibility that something other than the intended independent variable(s) may be responsible for either an apparent relationship or an apparent lack of a relationship with the dependent variable(s). The threat of selection bias increases with non-random selection of subjects (i.e., selection from different intact groups). In an attempt to minimize selection bias, subjects for this study were selected from among graduate students enrolled in masters level classes in the College of Business Administration. Most of the subjects were MBA students, but a few were working towards masters degrees in math and computer science. Also, the promise of a non-trivial monetary incentive for task performance also could have attracted a disproportionate number of subjects with immediate needs for cash relative to those with other reasons for participating. On the other hand, monetary incentives are of course a major source of motivation in virtually all employment situations to which this experiment is analogous.

Other threats to internal validity can occur when subjects are assessed repeatedly over time. The threat of mortality arises when different types of subjects withdraw from various conditions or stages of a study (e.g., the loss of subjects between pretest and posttest). Maturation occurs when physiological or psychological changes take place during the conduct of the experiment. History is the threat that subjects might be exposed to events outside the experimental setting that could potentially affect the dependent variable. The possibility of significant effects from maturation and history increases with longer duration experiments, especially if the subjects are allowed to leave the experimental setting. Because only one subject withdrew from this experiment, mortality was not an issue. The short duration of this study, approximately one to one and one-half continuous hours, minimized the effects of both maturation and history. Also, the experiment was conducted in an isolated setting to which no one other than subjects were admitted and subjects did not leave during the course of the experiment.

Because the study was conducted over a period of approximately eight months, communication between completed subjects and potential subjects was a possible problem. The primary counter measure was to specifically request that completed subjects not discuss the experiment with potential subjects until after its conclusion. Responses to the post-production questionnaire item addressing this issue indicate that subjects followed this request.

Other threats to interval validity included the possibility that subjects would have adjusted to the testing procedure, statistical regression effects of extreme scores from prior tests, and potential variability in the instrumentation used to observe the dependent variable. Although subjects were expected to learn during the practice period, there was no pretest conducted other than the practice period (testing and statistical regression). Because the entire experiment was conducted using the computer, instruments used to measure variables of interest were identical from subject to subject and trial to trial.

Construct Validity

Maxwell and Delaney (1990) state that construct validity threats are a pervasive and difficult problem in psychological research. The basic problem with construct validity is the possibility "that the operations which are meant to represent a particular cause or effect construct can be construed in terms of more than one construct, each of which is stated at the same level of reduction" (Cook and Cambell 1979, p. 59). For example, showing someone photographs of a dying person may arouse what one investigator interprets as death anxiety and another interprets as compassion. The Hawthorne Effect, which causes performance to change regardless of the treatment, is a potential problem of construct validity. A second threat is the experimenter-bias-effect.

According to Maxwell and Delaney (1990, p. 31), the two major pitfalls to avoid to minimize threats to construct validity are inadequate pre-operational explication of the construct and mono-operation bias. Explicating a construct involves consideration not only of the construct to be assessed, but also distinguishing from among other similar constructs. Mono-operation bias can arise from using only one set of operations to implement the construct.

In this experiment, every attempt was made to distinguish the performance-task uncertainty construct from others. For example, it was made clear to each subject that the only outcome of their task performance was the amount of cash earned (e.g., their course grade was in no way affected by their performance on the experiment). Also, each dimension of the Hirst theory was used to implement the construct (e.g., both dimensions of openness were operationalized).

External Validity

External validity refers to the stability across other contexts of the causal relationships observed in a given study. A central concern typically is the heterogeneity and representativeness of the sample of subjects participating in the study. One solution to the problem is the use of a heterogeneous group of subjects, settings, and times. However, such a strategy would be at odds with some of the threats discussed previously. What is good for the precision of the study, such as standardizing conditions and drawing a homogeneous sample of subjects, often is detrimental to the generalizabiltiy of the findings.

As explained earlier, the word search task was selected primarily because it included the best combination of features necessary to manipulate and measure the variables of interest. During the design phase it was acknowledged that attempts to find or create a task that represented reality fell somewhat short, as it does in most experiments. However, information obtained during subject debriefings provided some anecdotal evidence that indicated otherwise. Two subjects commented that the experimental task was analogous to their jobs as copy editors for local publishing companies. Others provided similar, less direct comments.

Beyond realism, with regard to both construct validity and external validity, the key principle for protection is heteromethod replication (Campbell 1969, p. 365ff.). Construct and external validity are strengthened if the details of a procedure deemed theoretically relevant are varied from one replication to the next. Simply stated (Martin and Manning 1995, p. 79): "A laboratory experiment is always subject to external validity constraints. The results here should be replicated in the field and most preferably among several types of tasks." Following that recommendation, it is hoped that this experiment will be the first of several investigations that explore the effect of task uncertainty on performance across a variety of settings and tasks.

Although population generalizablility always remains a threat when students serve as subjects, many of the subjects in this experiment have had at least moderate work experience. Presumably they have been employed in businesses in which goal-setting, task performance, and task uncertainty are relevant issues.

The effect of treatment-subject interaction was minimized by randomly assigning subjects to treatment groups and using multiple subjects per treatment. Multiple treatment interference was avoided by applying only one treatment per subject. Although external events during the experiment could have interacted with the treatment effect, the isolated setting of the experiment at least minimized, and potentially eliminated, any possible history-treatment interaction. Completion of questionnaire items before and after, rather than during, the treatment minimized measurement-treatment interaction. The absence of pretests avoided any pretest-posttest sensitization of subjects to posttests.

It is possible that the novelty of the task may have had some effect on subject responses. Although word search experimental tasks are not new (a few have even been specifically described as 4 x 4 matrices of letters), the automation of the task used in this experiment and the resulting variety of measurements and manipulations were at least somewhat unique. However, the hardware used in the experiment was the same or similar to that typically used outside the experimental setting and most of the subjects who participated in this experiment should have been at least familiar with, if not fully accustomed to, computer games. The commercial product from which this task was adapted would have been considered novel only a few years ago, but now it would be considered routine.

The various threats to validity are summarized in Table 5. Also included are brief descriptions of the various control measure incorporated into the experimental design.

Table 5

Threats to Validity

Threats	Description	Steps to Control
Statistical Conclusion		
Low power	Incorrect conclusion about hypotheses due to insufficient number of subjects or unreliable dependent variable	Maximize number of subjects; selected variables and design to maximize consistency and reliability
Internal Validity		
Selection bias	Selection of subjects from different intact groups (i.e., nonrandom)	Random selection of students enrolled in masters level CBA graduate courses
Mortality	Loss of subjects between pre tests and posttests	Short contiguous treatments (1 to 1.5 hours)
Maturation	Physiological or psychological changes in subjects over time that affect the dependent variable	Short contiguous treatments; multiple subjects per group
History	Exposure of subjects to outside events that could affect the dependent variable	Short contiguous treatments; experiment conducted in isolated setting
Communication	Different treatment effects due to information passed between subjects	Treatments not simultaneous; physical separation of subjects; subjects asked not to communicate
Testing	Subjects adjust to the testing procedure	No pretest other than practice
Statistical regression	Effects of extreme scores from prior tests	No pretest other than practice
Instrumentation	Effect of change in dependent variable observation technique	All measurements via computer
Construct Validity		
Hawthorne effect	Subject knowledge of experiment participation may affect behavior	Careful specification of performance-task uncertainty construct
Experimenter-bias effect	Experimenter imparts bias for desired results through verbal or nonverbal communication (unintended)	Entire experiment conducted by computer; minimal communication between subject and experimenter
External Validity		
Population generalizability	Subject sample cannot be generalized to the target population	Most subjects employed in business situations with goals and uncertainty
Treatment-subject interaction	Possible interaction between treatments and subject characteristics	Random assignment of subjects to treatments; multiple subjects
Multiple treatment interference	Results of subsequent treatments confounded with earlier treatments	One treatment per subject
History-treatment interaction	Historical events during experiment interacting with the treatment	Experiment conducted in an isolated setting
Measurement-treatment interaction	Measurement conducted during treatment may confound treatment effect	All measurements by computer; questionnaires completed before and after treatment, but not during
Pretest-posttest sensitization	Administration of pretest may sensitize subjects to the posttest	No pretest other than practice
Novelty	Novelty or innovative nature of the treatment affects subject responses	Interesting but not unusually novel task; used in prior psychology studies

Chapter IV

RESULTS

Two-way ANOVA ($\alpha = 0.05$) and nonparametric Kruskal-Wallis tests showed no significant differences on the basis of demographic data for subjects among the four experimental treatments. These data included verbal ability, math ability, age, gender, and amount of full-time and part-time work experience. This indicates a random assignment of subjects to the four treatments and consequently no systematic bias in the experimental results. The p-value test results are shown in Table 6.

Because of the number and variety of relationships among the variables, the model is well suited for path analysis. Accordingly, the partial least squares (PLS) approach was selected as the primary method for analyzing those relationships. A brief description of the partial least squares approach is provided next as an introduction to the discussion of the data analysis results.

Partial Least Squares

According to Chin (1998a), among structural equation modeling (SEM) techniques the covariance-based methods are by far the most familiar (e.g., AMOS,

Table 6

Tests for Random Assigment of Subjects

	P-Values	
Subject Variable	ANOVA	Kruskal-Wallis
Verbal ability	0.335	0.371
Math ability	0.124	0.223
Age	0.368	0.211
Experience	0.943	0.673
Gender	0.714	0.799

LISREL, etc.). Many researcher consider the covariance-based method to be synonymous with structural equation modeling. However, partial least squares (PLS) is a somewhat lesser known (at least for now) alternative method of structural equation modeling technique that also is available.

When used in the appropriate circumstances, PLS offers significant advantages over the more traditional approaches. In fact, Chin (1998a, p. 295) states that, "Depending on the researcher's objectives and epistemic view of data to theory, properties of the data at hand, or level of theoretical knowledge and measurement development, the PLS approach can be argued to be more suitable." PLS can be used for theory confirmation, and also can be used to suggest possible relationships and propositions for subsequent testing. Major advantages of PLS are minimal requirements for measurement scales (ordinal, interval, etc.), sample size, and residual distributions (Chin 1998a from Wold 1985). PLS also avoids the problems of inadmissible solutions and factor indeterminacy that can occur with the covariance approach. Because PLS generally consists of a series of ordinary least squares analyses, identification is not a problem for recursive models nor does PLS presume any form of distribution for measured variables (Chin 1998a).

Structural equation modeling has been described as the coupling of econometrics and psychometrics (Chin 1998a). The econometrics perspective focuses on prediction, while the psychometric perspective models concepts as unobserved latent variables that are indirectly inferred from multiple observed measures (also termed indicator or manifest variables). Some have described path analytic modeling as "a second generation of multivariate analysis" (Fornell 1987, p. 408). The advantage that structural equation modeling has over earlier procedures (e.g., principal components analysis, factor analysis, multiple regression) is the flexibility to rely on theory when it is strong or to let the data tell the story when the theory is less compelling.

SEM-based approaches afford the flexibility to model relationships among multiple predictor and criterion variables, construct unobservable latent variables, model measurement errors for observed variables, and statistically test assumptions with empirical data (i.e., confirmatory analysis). The covariance and PLS approaches estimate parameters for the measurement model (e.g., loadings) and the structural model (e.g., path coefficients) from a sample of observed indicators. Three distinctions between the covariance-based and PLS approaches are whether the underlying constructs are modeled as indeterminate or determinate, whether confidence in the theory model and the link between constructs and measures is low or high, and whether the research orientation is toward parameters or predictions. If (as in this study) the latter prevails, then the PLS approach is likely more suitable than the covariance-based approach. Furthermore, "under conditions of small sample size and violations in distributional assumptions, improper solutions" can often result with the covariance approach (Chin 1998a, p. 301).

The PLS approach is a method for directly estimating component scores for latent variables. It is partial in the sense that each step of the procedure minimizes residual variances for subsets of estimated parameters given proxies or fixed estimates for the other parameters. The objective of PLS is to aggregate indicators within blocks in a predictive sense. The extent to which a proposed theoretical model is valid is determined partly by the strength of the path relationships among latent variable component scores and loadings for reflective indicators as estimated by the procedure (Chin 1998a).

Consistent with the distribution-free predictive approach of PLS, evaluation of PLS models requires nonparametric measures. R-square measures for dependent latent variables (the interpretation is identical to that of traditional regression), the Stone-Geisser test for predictive relevance, and Fornell and Larkers average variance extracted measure are used to assess predictiveness. Resampling procedures (e.g., jackknifing and bootstrapping) are used to assess the precision of PLS estimates.

The graphical description of the theoretical model presented earlier (and again below) follows the suggestion of Chin (1998b, p. viii), who also recommends avoiding traditional hypothesis statements:

> Another practice that should be avoided is explicitly providing hypothesis statements for each structural path in the model. Whereas each proposed relation or path in a model (including zero or absent paths) should be theoretically justified and explained in the text of the article, the act of stating a null and/or alternative hypothesis for each path is not only redundant and wasteful of journal space, but can be confusing to the reader.
>
> In general, all statistical models tested can be easily described through graphical representation and simple language. What needs to be done is to clearly present the model paths and indicate which parameters are being estimated and which are fixed or constrained.

To summarize, as a least square alternative to covariance-based procedures, PLS is a less complex approach to model specification and interpretation of results. It is particularly applicable when the theoretical model or measures are not well formed, the model is complex with numerous indicators and/or latent variables, the relationship between latent variables and indicators are modeled in different modes (formative and reflective), the data conditions are not sufficient (normal distribution, independence, sample size), or greater modeling flexibility is required beyond what is available with first-generation techniques (Chin 1998a). PLS is well suited for this study because of its flexibility, the complexity of the model, and the lack of data normality. It offers the opportunity to address the research questions by allowing the researcher to "tell the story" contained in the data.

As discussed above, it is recommended that the practice of stating hypotheses for each path in the model be avoided. Accordingly, no formal hypotheses have been constructed. Instead, several research questions were used to guide the analysis. They were created from the central elements of the Hirst (1987) theoretical proposition which is the primary focus of this study. They were stated earlier and are repeated below:

1. Is the task performance of subjects performing a low uncertainty task greater than the performance of subjects performing a high uncertainty task?

2. Does the interaction between task uncertainty and goal setting affect task performance?

3. Is the goal commitment of subjects performing a low uncertainty task greater than the goal commitment of subjects performing a high uncertainty task?

4. Is the intensity of effort expended by subjects performing a low uncertainty task greater than the intensity of effort expended by subjects performing a high uncertainty task?

5. Is the duration of effort expended by subjects performing a low uncertainty task greater than the duration of effort expended by subjects performing a high uncertainty task?

6. Are the task strategies selected by subjects performing a low uncertainty task more appropriate than the task strategies selected by subjects performing a high uncertainty task?

7. Does the interaction between strategies and strategy appropriateness affect performance?

8. Is the task knowledge acquired by subjects performing a low uncertainty task greater than the task knowledge acquired by subjects performing a high uncertainty task?

9. What is the effect of ability on performance within a context of task uncertainty?

The questions are addressed in the data analysis presented next. Consistent with the partial least squares approach, rather than asking the data to answer each question individually, the questions will be used to guide the discussion of how the subjects in this study reacted to the presence or absence of task uncertainty as defined in this experiment.

Data Overview

Table 7 presents an overview of the data and provides some preliminary insight into the results. Overall (see the lower right corner of the table), subjects in the easy goal treatment groups found more words for more points and more cash compensation than did their counterparts in the hard goal treatment groups. Easy goal subjects found an average of 64.7 words for 102 points and $12.50 in cash compensation. Hard goal subjects found an average of 61.9 words for 91.9 points and $10.89 in compensation. Although not particularly meaningful, the average subject found 63.3 words for 96.9 points and received $11.69 in cash compensation. Overall, compensation ranged from $0.00[20] to $39.20.

A closer examination of the data reveals that subjects in the high task uncertainty treatment group chose equally from between the two strategy alternatives. Twenty-five

[20] Although each subject found words, four received zero compensation because the total of the points for words found was offset by the total of the points deducted for the computer cost.

Table 7

Data Overview

	Low Task Uncertainty			High Task Uncertainty			Combined Uncertainty		
	Easy Goal	Hard Goal	Total	Easy Goal	Hard Goal	Total	Easy Goal	Hard Goal	Total
Short-word strategy									
Subjects	10	9	19	13	12	25	23	21	44
Achieved Goal: No.	3	3	6	0	1	1	3	4	7
%	30.0%	33.3%	31.6%	0.0%	8.3%	4.0%	13.0%	19.0%	15.9%
Avg. Total Words	99.2	91.3	95.5	80.4	93.7	86.8	88.6	92.7	90.5
Avg. Total Points*	33.5	32.4	33.0	17.5	24.9	21.1	24.5	28.1	26.2
Avg. Cash Earned**	$4.85	$4.91	$4.88	$1.75	$2.91	$2.31	$3.10	$3.77	$3.42
Long-word strategy									
Subjects	15	16	31	12	13	25	27	29	56
Achieved Goal: No.	12	7	19	8	5	13	20	12	32
%	80.0%	43.8%	61.3%	66.7%	38.5%	52.0%	74.0%	41.4%	57.1%
Avg. Total Words	52.0	44.6	48.2	35.0	33.2	34.1	44.4	39.5	41.9
Avg. Total Points*	204.5	159.6	181.4	122.3	111.4	116.6	168.0	138.0	152.5
Avg. Cash Earned**	$24.45	$18.46	$21.36	$15.57	$13.06	$14.26	$20.50	$16.04	$18.19
Combined Strategies									
Subjects	25	25	50	25	25	50	50	50	100
Achieved Goal: No.	15	10	25	8	6	14	23	16	39
%	60.0%	40.0%	50.0%	32.0%	24.0%	28.0%	46.0%	32.0%	39.0%
Avg. Total Words	70.9	61.4	66.1	58.6	62.2	60.4	64.7	61.9	63.3
Avg. Total Points*	136.1	113.8	125.0	67.8	69.9	68.9	102.0	91.9	96.9
Avg. Cash Earned**	$16.61	$13.58	$15.10	$8.38	$8.19	$8.29	$12.50	$10.89	$11.69

* After deductions for opponent words and computer cost.

** Includes bonuses for goal achievement.

chose to find short words and twenty-five chose to find long words. Furthermore, the split was virtually equal within each of the two goal conditions. Thirteen subjects in the easy goal treatment elected to pursue the short-word strategy, while twelve selected the long-word strategy. Among hard goal subjects, twelve attempted to find short words and thirteen attempted to find long words.

Subjects in the low task uncertainty treatment group, however, did not exhibit the same behavior. For the combination of both goal conditions, the ratio of short-word strategy selections to long-word strategy selections was approximately 2 to 3. Nineteen subjects selected the short-word strategy and thirty-one selected the long-word strategy. The ratios of short-word strategies to long word strategies was approximately the same within the two goal treatments -- 10:15 and 9:16 for the easy and hard goal, respectively. Thus, it appears that subjects in the low task uncertainty treatment group felt somewhat more confident in choosing the riskier but potentially more productive (on a per word basis) strategy than did those subjects facing high task uncertainty.

Second, within both task uncertainty conditions and both goal difficulty conditions, subjects who selected the long-word strategy produced substantially more points on average (152.5) than did those who selected the short-word strategy (26.2), despite finding substantially fewer words (41.9 versus 90.5). This again reflects the choice between pursuing the riskier, but more productive long-word strategy (six points per word) and the less risky, less productive short-word strategy (one point per word).

Table 7 also shows that, for combined strategies, subjects in the low task uncertainty treatment group were more likely to achieve their goals (50 percent) than were subjects in the high task uncertainty treatment group (28 percent). Similar relationships existed within the two strategies, but the difference was far more pronounced among those subjects who chose the short word strategy (31.6 percent versus 4.0 percent) than it was among those who pursued the long-word strategy (61.3 percent versus 52.0 percent). Table 7 further shows that, for combined uncertainty and goal difficulty treatments, subjects who selected the long-word strategy achieved their goals substantially more often (57.1 percent) than did the subjects who selected a short-word strategy (15.9 percent). These results are preliminary indications of the possibility of instances of inappropriate strategy selections. That possibility was explored further as explained later.

Finally, higher goal difficulty appeared to have some interesting effects on average words found, average point production, and average cash compensation. Among the four combinations of task uncertainty and task strategy, only the combination of high task uncertainty and short-word strategy resulted in higher point production toward a hard goal (24.9) than toward an easy goal (17.5) as predicted by goal theory. Each of the other combinations resulted in generally higher production toward the easy goal than toward the hard goal. Thus it appears, at least preliminarily, that there is an interaction between task uncertainty and goal difficulty, but not necessarily in the direction predicted by Hirst (1987).

These are only preliminary results pointing to the in-depth analysis. The results of the partial least squares path analysis approach that was the centerpiece of the data evaluation are described below, along with the results of several supplemental procedures that were performed.

Data Analysis

As suggested by Chin (1998b), statistical models tested with PLS can be described through graphical representation and simple language. Furthermore, as mentioned previously, PLS is particularly appropriate when the data are non-normally distributed. Accordingly, measured data were tested for normality using the Anderson-Darling approach[21] (as well as for skewness and kurtosis) and found to be decidedly non-normal. The descriptive statistics and results of normality tests are shown in Table 8.

The graphical representation of the research model presented earlier (see Figure 11 and Figure 39) is presented again in Figure 40 in more detail. Latent variables are represented by ovals and indicator variables are represented by squares. Path coefficients appear along the lines connecting the variables. An adjacent star indicates significant path coefficients. A solid star (★) indicates significance at $\alpha = 0.05$. A clear star (☆)indicates coefficient significance at $\alpha = 0.10$. The bootstrapping feature of the PLS program was used to determine significance; results are shown in Appendix I. Loadings also are shown (in parentheses) for the indicator variables used to measure goal commitment and intensity of effort. For a summary of the primary variables, manipulations, and measurements, refer to Table 4 presented earlier.[22] The overall r^2 for the model was 0.654, which indicates that a substantial proportion of variance in performance was explained. Individual paths are discussed next.

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[21] Minitab statistical analysis software package default.
[22] As indicated in Table 4, two alternative measures of duration of effort were available. For data analysis purposes, the time of the last word attempt was used. Early termination was not used because only twenty-eight of four hundred production frames were terminated prior to expiration of the allowed time.

Table 8

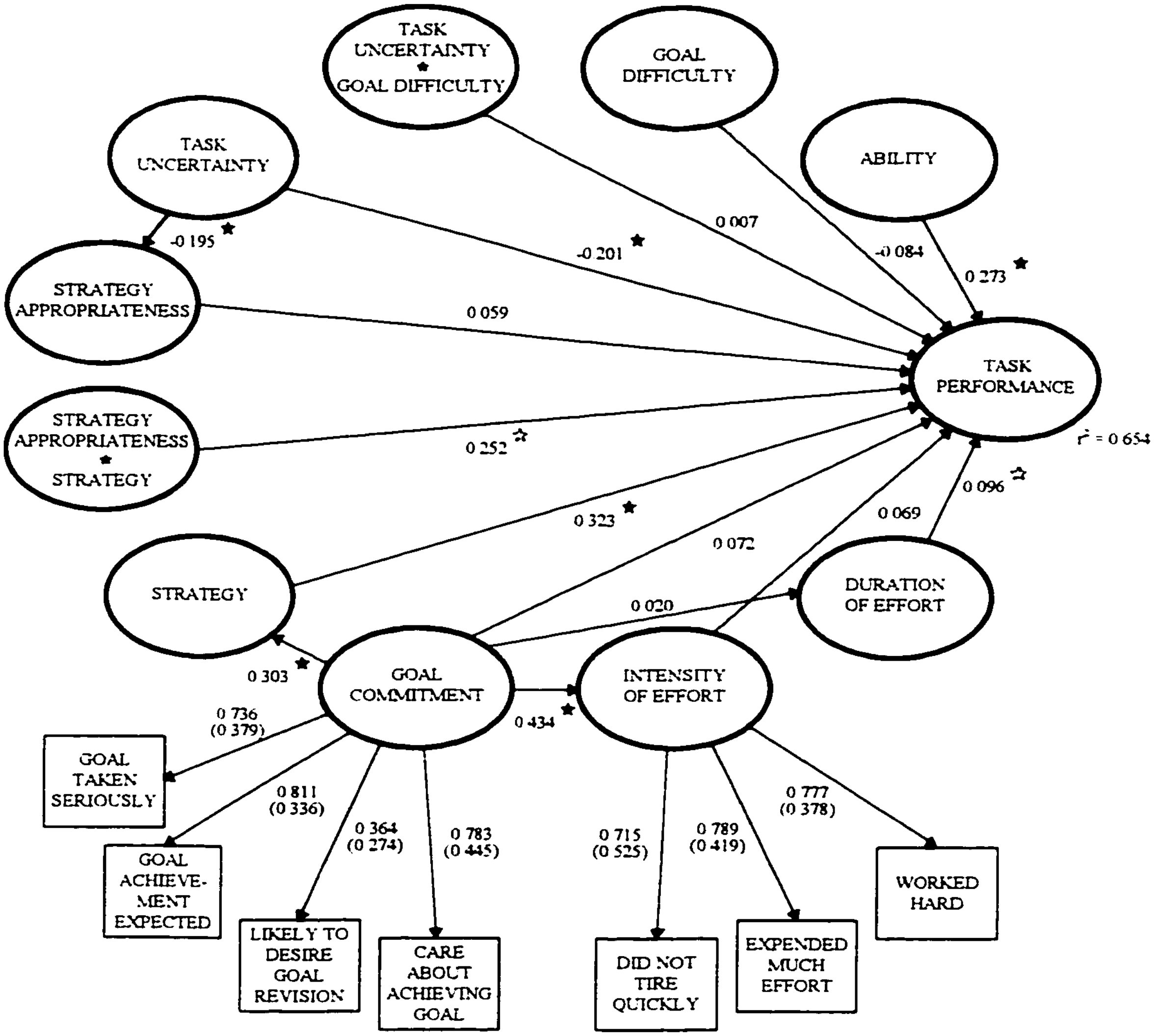
Descriptive Statistics and Tests for Normality
(Measured Variables)

	Performance	Ability	Goal Commitment	Intensity of Effort	Duration of Effort
N	100	99	100	100	100
Mean	96.9200	57.2020	113.9170	120.1300	445.5300
Median	55.5000	58.0000	113.3750	117.1650	457.3750
Min	0	3	1	6	262.25
Max	342	99	182	200	477.25
SE Mean	9.2470	2.5414	3.7615	3.7318	3.7948
St. Deviation	92.4703	25.2861	37.6150	37.3178	37.9477
Variance	8550.7600	639.3870	1414.8900	1392.6100	1440.0300
Skewness	1.0165	-0.3961	-0.5854	-0.4646	-2.6569
Kurtosis	0.0748	-0.7873	0.4717	0.4555	7.6011
Tests for Normality:					
$Z_{Skewness}$	4.1496	-1.6089	-2.3899	-1.8966	-10.8465
$Z_{Kurtosis}$	0.1527	-1.5991	0.9628	0.9298	15.5157
Anderson-Darling*:					
A-Squared	4.497	1.160	0.544	0.578	11.433
P-value	0.000	0.005	0.158	0.130	0.000

*Minitab default

Figure 40

Data Analysis Path Diagram



* indicates significance of path coefficients at a = 0.05.
☆ indicates significance of path coefficients at a = 0.10.
Path coefficients are shown along each path between variables; loadings for indicator variables (rectangles) are shown in parentheses.

The path coefficient between task uncertainty and task performance (-0.201) was significant ($\alpha = 0.05$) and in the expected negative direction. High task uncertainty appears to reduce task performance relative to low task uncertainty as predicted by Hirst. Of course this is not a surprise, because Hirst's primary focus was on why and how task uncertainty affects performance. Not surprisingly, ability had significant positive effect on task performance (0.273, $\alpha = 0.05$) as predicted by goal theory (and common sense).

The interaction between task uncertainty and goal difficulty (goal setting) was specifically hypothesized by Hirst (1987) to affect task performance. Contrary to his hypothesis, the path coefficient for that interaction (0.007) was not found to be significant. Neither was the coefficient for the path from goal difficulty alone to task performance found to be significant. As mentioned previously, however, task uncertainty was significant and in the expected direction. The direction of the effect of goal difficulty on performance was as predicted by goal setting theory, but the lack of significance was surprising. It is possible that the strength of the goal difficulty manipulation was not sufficient to achieve the expected results.

The interaction between strategy appropriateness and strategy recognizes that the strategy selection could uniquely affect task performance because of the point differentials between the two alternative strategies, but that the most productive strategy would be the long-word strategy provided that the subject has the ability to find long words. In this case, ability was not measured by the percentile scores on the GMAT and GRE admissions tests. Instead a more specific measure was created from the ratio of short to long words found by each subject during the practice period.

Strategy appropriateness was determined by comparing the selected strategy with the ratio of short words found to long words found during the practice period. Given the point values of one point for short words and six points for long words, a subject would appropriately select a short-word strategy for the production period if the ratio of short words found to long words found during the practice period was greater than six. In other words, that subject's ability to find short words outweighed the relative point scoring advantage of the long-word strategy. On the other hand, a practice period ratio of finding less than six short words for each long word would argue for selecting a long-word strategy. In other words, the subject's ability to find long words would allow that subject to take advantage of the greater point values for those words.

Figure 40 also reveals that strategy alone had a significant effect on task performance (0.323, $\alpha = 0.05$). This simply reflects the point differential between the short word and long word strategies. While strategy appropriateness alone (0.059) did not have a significant effect on task performance, the interaction between strategy and strategy appropriateness did (0.252, $\alpha = 0.10$). In other words, the best performance was obtained by those subjects who selected the long-word strategy provided that it was appropriately matched to their abilities.

As expected, goal commitment significantly affected the selection of strategy (0.303, $\alpha = 0.05$) and subsequent intensity of effort (0.434, $\alpha = 0.05$). It did not, however, have a significant direct effect on task performance (0.072). Intensity of effort (0.069) also failed to produce the anticipated direct effect on performance. In other words, working harder did not result in significantly greater point production regardless of the strategy chosen.

It is interesting to note that while goal commitment significantly affected intensity of effort, it did not significantly affect duration of effort (0.020). Unlike intensity, duration of effort had a moderately significant direct effect on task performance (0.096, $\alpha = 0.010$). Both of these results could have been affected by the previously discussed limitations of the measurement of the effort duration variable.

The portfolio of goal commitment, strategy, interaction of strategy appropriateness with strategy, effort intensity, and effort duration reveals additional, but not surprising, insight into task performance. The results for these variables can be summarized by the familiar adage that "it pays to work smarter rather than harder" as evidenced by the aforementioned significance of the strategy variable and the interaction of strategy appropriateness with strategy, along with the relative lack of effect of intensity and duration of effort (recall that the duration of effort coefficient was just 0.096 and significant only at the $\alpha = 0.10$ level). Of course, working smarter requires the availability of strategic alternatives.

As discussed in the earlier description of Hirst's (1987) theoretical framework, task uncertainty was predicted to affect the acquisition, and therefore the completeness, of task knowledge. Because the experimental task included only four iterations (production frames), a standard learning curve analysis was not appropriate. Instead, a procedure was patterned after the approach used by Slonim (1994) to test learning in a decision-making experiment. Following that approach, the performance for the first two production frames was compared with the performance for the last two production frames for each for each of the two strategy choices and each of the two task uncertainty treatments. In other words, performance by low task uncertainty treatment group subjects who selected a short (long) word strategy was compared with performance by high task uncertainty treatment group subjects who also selected the short (long) word strategy. The results of the one-way analysis of variance for each comparison are shown in Table 9. For both strategies the change (increase) in performance by the low task uncertainty treatment group subjects was significantly larger (p = 2.517E-06) than the change in performance by the high task uncertainty treatment group subjects, which implies that task uncertainty negatively affected the acquisition of task knowledge as predicted by Hirst.

The effect of task uncertainty on knowledge acquisition also was evaluated with the nonparametric two-sample Mann-Whitney test (also called the two-sample Wilcoxon rank sum test), which does not require a distribution assumption. [23] In the same manner described above, the effect of task uncertainty was found to be significant for the subjects who selected a short-word strategy (p = 0.0001) as well as for the subjects who selected a long-word strategy (p < 0.0001). The results are shown in Table 10.

Hirst (1987) also theorized that the completeness of task knowledge would affect the search for and selection of appropriate task strategies. Finding and selecting appropriate strategies is expected to be more difficult, and therefore should occur with less frequency, for tasks with high uncertainty. Conversely, appropriate task strategies should be more often discovered for tasks with low uncertainty.

The evidence shows that task uncertainty affected the selection of appropriate strategies (-0.195, $\alpha = 0.10$). Two chi-square analyses support the conclusion that subjects in the high task uncertainty treatment group made more frequent inappropriate

[23] As noted earlier, acquisition of task knowledge was not included in the path analysis because it was measured in essentially the same manner as the independent variable, performance.

Table 9

One-way ANOVA Test for Acquisition of Task Knowledge

SHORT-WORD STRATEGY SUBJECTS Anova: Single Factor alpha=.05

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
LO DIFF	19	231	12.157895	61.807018
HI DIFF	25	53	2.12	17.943333

ANOVA alpha=.05

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1087.7428	1	1087.7428	29.604843	2.517E-06	4.0726604
Within Groups	1543.1663	42	36.742055			
Total	2630.9091	43				

LONG-WORD STRATEGY SUBJECTS Anova: Single Factor alpha=.05

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
LO DIFF	30	2644	88.133333	2849.6368
HI DIFF	25	302	12.08	2819.91

ANOVA alpha=.05

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	78874.221	1	78874.221	27.810062	2.517E-06	4.0230077
Within Groups	150317.31	53	2836.1756			
Total	229191.53	54				

Table 10

Mann-Whitney Test for Acquisition of Task Knowledge

Point differences for individual subjects. frames 1 & 2 vs. frames 3 & 4:

Short-word Strategy		Long-word Strategy	
Low Task Uncertainty	High Task Uncertainty	Low Task Uncertainty	High Task Uncertainty
11	1	61	21
23	1	132	43
6	3	62	93
19	-5	194	85
1	4	106	28
7	4	174	18
0	-2	102	0
16	1	102	10
7	2	96	-55
13	-1	35	144
24	-8	130	61
8	0	23	22
18	0	107	22
0	6	128	22
21	-3	11	-10
18	2	161	-37
20	9	50	0
14	0	24	31
5	7	102	-30
	4	100	-18
	9	207	-43
	6	20	-120
	8	80	50
	5	9	-19
	0	60	-16
		125	
		35	
		72	
		47	
		89	
		114	

Minitab output for Mann-Whitney Confidence Interval and Tests:

Short-word Strategy

Col. 1: N = 19 Median = 13.000
Col. 2: N = 25 Median = 2.000
Point estimate for ETA1-ETA2 is 10.000
95.0 Percent CI for ETA1-ETA2 is (5.000,14.999)
W = 593.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2
is significant at 0.0001 (adjusted for ties)

Long-word Strategy

Col. 1: N = 31 Median = 96.000
Col. 2: N = 25 Median = 18.000
Point estimate for ETA1-ETA2 is 78.000
95.0 percent CI for ETA1-ETA2 is (45.99,103.99)
W = 1164.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2
is significant at 0.00001 (adjusted for ties)

strategy selections relative to those in the low task uncertainty treatment group. A 6:1 ratio was used for the first test. Ratios of less-than-or-equal-to 5:1 and greater-than-or-equal-to 7:1 were used in the to evaluate the sensitivity of the 6:1 ratio demarcation(i.e., recognizing that subjects with practice period ratios close to 6:1 would have difficulty distinguishing between the better of the two strategies). The results of the chi-square analyses are shown in Table 11. In both cases the null hypothesis that task uncertainty and strategy selection are independent was rejected ($X^2 = 9.3333$, $p = 0.002$ and $X^2 = 6.8398$, $p = 0.009$, respectively; $X^2_{.005,1} = 7.8794$). The conclusion is that the high task uncertainty treatment group subjects made inappropriate strategy selections more often than did the low task uncertainty treatment group subjects. Thus, the data provide evidence to support Hirst's (1987) proposition that task uncertainty interferes with the search for and selection of appropriate task strategies by impeding the acquisition of, and therefore the completion of, task knowledge.

To explore the issue of appropriate strategy selection further, a binary logistical regression (LOGIT) analysis was conducted.[24] The response variable, APPROPSTRAT, was categorized as either an appropriate strategy selection (value = 1) or an inappropriate strategy selection (value = 0). As described previously, appropriateness was determined by comparing the actual strategy selection with what should have been selected based on ratio of short words to long words found during the practice period. The model terms were those covariate and factor variables with potential for affecting strategy selection, including task uncertainty (UNCERT, factor), goal difficulty (GOALDIFF, factor), ability

[24] Minitab version 12 for Windows 95.

Table 11

Chi-square Test for Appropriate Strategy

A. Analysis Based on Ratios <6:1 and >=6:1

Task Uncertainty	Expected Strategy	Actual Strategy Long	Short
High	Long	17	14
	Short	8	11
Low	Long	31	8
	Short	0	11

Actual Task Uncertainty	Strategy Selection Inappropriate	Appropriate	
High	22	28	50
Low	8	42	50
	30	70	100

Expected Task Uncertainty	Strategy Selection Inappropriate	Appropriate
High	15.0000	35.0000
Low	15.0000	35.0000

$X^2_{calc} = 9.3333$
$X^2_{.010,1} = 6.6349$
$X^2_{.005,1} = 7.8794$
$p = .002$

B. Analysis Based on Ratios <=5:1 and >=7:1

Task Uncertainty	Expected Strategy	Actual Strategy Long	Short
High	Long	15	13
	Short	4	9
Low	Long	29	7
	Short	0	8

Actual Task Uncertainty	Strategy Selection Inappropriate	Appropriate	
High	17	24	41
Low	7	37	44
	24	61	85

Expected Task Uncertainty	Strategy Selection Inappropriate	Appropriate
High	11.5765	29.4235
Low	12.4235	31.5765

$X^2_{calc} = 6.8398$
$X^2_{.010,1} = 6.6349$
$X^2_{.005,1} = 7.8794$
$p = .009$

(ABILITY, covariate), goal commitment (GOALCOMMIT, covariate), the task uncertainty and goal commitment interaction (UNCERT * GOALCOMMIT, factor), age (AGE, covariate), experience (EXPERIENCE, covariate), and gender (GENDER, factor). The results of the LOGIT analysis, shown in Table 12, indicate that the data provided support for the assertion that high task uncertainty leads to more frequent inappropriate strategy selections than does low task uncertainty. The coefficient is in the expected direction (coefficient = -1.2057) and is at least moderately significant ($p = 0.075$). None of the other terms in the model is significant. The effect of goal difficulty was in the expected direction, but it was not marginally significant. Recalling that the difficult (easy) goal was determined by adding 20% to (deducting 20% from) the average practice period performance, it could be that the two goal levels were not sufficiently difficult or easy to induce irrational strategy selection behavior. Neither goal commitment nor the interaction between task uncertainty and goal commitment had a significant effect on strategy selection (recall that, according to the results of the PLS analysis, the task uncertainty-goal difficulty interaction did not have a significant effect on task performance as well). The data did not provide evidence that age, work experience, or gender affected task strategy selection, nor is there theory to suggest that they should.

Manipulation Checks

The questionnaire items presented on the last several screens of the experiment (see Figures 34-36) included several questions designed as manipulation checks. Subjects

Table 12

Binary Logistic Regression Test for Appropriate Strategy

Response Information:

Variable	Value	Count	
APPROPSTRAT	1	67 (Event)	98 cases were used
	0	31	2 cases contained missing values
	Total	98	

Logistic Regression Table:

Predictor	Coef	StDev	Z	P	Odds Ratio	95% CI Lower	95% CI Upper
Constant	-0.507	1.339	-0.38	0.705			
UNCERT							
1	-1.2057	0.6760	-1.78	0.075	0.30	0.08	1.13
GOALDIFF							
1	-0.1938	0.7161	-0.27	0.787	0.82	0.20	3.35
ABILITY	0.0025	0.0101	0.25	0.804	1.00	0.98	1.02
GOALCOMMIT	0.010302	0.006663	1.55	0.122	1.01	1	1.02
UNCERT*GOALCOMMIT							
1	0.5511	0.9354	0.59	0.556	1.74	0.28	10.85
AGE	0.0221	0.0431	0.51	0.609	1.02	0.94	1.11
EXPERIENCE	-0.0311	0.0575	-0.54	0.589	0.97	0.87	1.09
GENDER							
1	0.3369	0.4954	0.68	0.497	1.40	0.53	3.70

Log-Likelihood = -57.0480

Test that all slopes are zero: G = 8.221, DF = 8, p-value = 0.412

Goodness-of-Fit Tests:

Method	Chi-Square	DF	P
Pearson	101.892	89	0.165
Deviance	114.096	89	0.038
Hosmer-Lemeshow	3.852	8	0.870

responded to each question by moving a button along a horizontal slide bar on the computer screen. The question about frame repetitiveness was anchored by Not Very Repetitive/Very Repetitive. Each of the other questions was anchored by Strongly Disagree/Strongly Agree. Although intermediate points were provided along the slide bar, no descriptions of those points were provided (e.g., Agree, No Opinion, Disagree, etc.). The slide bars made it possible to measure responses on a continuous scale rather than on a discrete scale typical of hard copy responses. Values for all responses ranged from a minimum of 1 to a maximum of 200 (in increments of 1).

Standard t-tests and nonparametric tests (Wilcoxin signed rank and Mann-Whitney) were conducted to evaluate the effectiveness of the manipulations. Responses for each task uncertainty treatment group were compared with a mean (median in the case of the nonparametric tests) of 100 and compared with each other. The results of those tests are summarized in Table 13. Standard t-tests and nonparameteric tests provided virtuallly the same results. Accordingly, the discussion that follows will focus on the standard t-tests.

Responses to the first item, "The frames of letters were ____ from frame to frame (Not Very Repetitive/Very Repetitive)," indicate that the low task uncertainty treatment subjects did in fact find their production frames to be very repetitive (mean = 155.10, p = 0.0000). On the other hand, the high task uncertainty treatment group did not view their production frames to be particularly nonrepetitive, although the responses were in the expected direction (mean = 98.7, p = 0.42). More importantly, the comparison test showed that the difference between the mean responses of the two treatment groups was

Table 13

Analysis of Subjects' Responses to Manipulation Checks

Abbreviated Questionnaire Item	Low Uncertainty Subjects Mean	Test	P-values[2] Std. T-test	Wilcoxin	High Uncertainty Subjects Mean	Test	P-values[2] Std. T-test	Wilcoxin	Comparison P-values[3] Std. T-test	Mann-Whitney
Frames were _____ (NVR/VR)[1].	155.10	>100	0.0000	0.000	98.70	<100	0.420	0.407	0.0000	0.0000
Opponent affected effort (SA/SD).	131.24	>100	0.0005	0.000	116.92	>100	0.023	0.034	0.240	0.155
Opponent affected perfomr-ance (SA/SD).	129.24	>100	0.0003	0.001	99.56	<100	0.480	0.447	0.009	0.014
Opponent affected strategy choice (SA/SD).	139.00	>100	0.0000	0.000	139.34	>100	0.0000	0.000	0.970	0.920
Frames shape, content, order affected strategy choice (SA/SD).	115.82	>100	0.023	0.016	106.70	>100	0.220	0.172	0.440	0.404
Frames shape, content, order affected effort (SA/SD).	107.90	>100	0.170	0.157	96.26	<100	0.320	0.356	0.310	0.240
Effort affected perform-ance (SA/SD).	68.12	<100	0.0001	0.000	68.98	<100	0.0000	0.000	0.940	0.697
Strategy affected perform-ance (SA/SD).	61.36	<100	0.0000	0.000	49.90	<100	0.0000	0.000	0.270	0.278
Would select strategy again (SA/SD).	68.18	<100	0.0004	0.001	80.30	<100	0.030	0.100	0.380	0.372
Compensation affected perfomr-ance (SA/SD).	78.58	<100	0.0018	0.004	113.90	>100	0.060	0.043	0.002	0.005
Instructions were clear and complete (SA/SD).	31.16	<100	0.0000	0.000	32.08	<100	0.0000	0.000	0.920	0.820
Would participate again (SA/SD).	34.62	<100	0.0000	0.000	46.06	<100	0.0000	0.000	0.300	0.376
Interruptions affected perform-ance (SA/SD).	n/a	n/a	n/a	n/a	70.42	<100	0.0003	0.002	n/a	n/a

1 Anchors: NVR/VR = not very repetitive/very repetitive; SA/SD = strongly agree/strongly disagree.
2 Test of mean for std. t-test, median for Wilcoxin.
3 Test of unequal means, medians for Mann-Whitney.

significant (p = 0.0000). Thus, it appears that a significant difference in task repetitiveness was perceived between low and high task uncertainty treatment group subjects.

The next three items were designed to evaluate the effect of the opponent manipulation. Responses to "The skill of my opponent affected the amount of effort I expended on the task (Strongly Agree/Strongly Disagree)," indicated that the low task uncertainty treatment group subjects did not believe that the opponent affected their effort (mean =131.24, p = 0.0005). The effort expended by high uncertainty subjects also was not affected by the opponent (mean = 116.92, p = 0.023). No significant difference between the responses of the two treatment groups was detected (p = 0.240).

Responses to "The skill of my opponent affected my performance (Strongly Agree/Strongly Disagree)," by subjects in the low task uncertainty treatment group indicated that they did not believe that the opponent affected their performance (mean = 129.24, p = 0.0003). Subjects in the high task uncertainty treatment group also did not believe that the opponent had a significant effect on their performance, but their responses were slightly in the expected direction (mean = 99.56, p = 0.48) and there was a significant difference between the responses of the two groups (p = 0.009).

Responding to "The skill of my opponent affected my choice of point scoring strategy for the task (Strongly Agree/Strongly Disagree)," subjects in both treatment groups strongly indicated that the opponent affected their strategy choices (low task uncertainty: mean = 139.00, p = 0.0000; high task uncertainty: mean = 139.34, p = 0.0000). A comparison test indicated no significant difference between the two groups.

Taking the responses to the three questions together, it can be concluded that the opponent manipulation had at least a moderate effect on both subject groups. The effect on the low task uncertainty subjects was somewhat more dramatic than on the high task uncertainty subjects, each taken separately. However, what is most important is that the opponent manipulation did create a difference between the two groups on the more important of the measures, effect on performance and effect on strategy selection. Also, given that task uncertainty is a combination of repetitiveness and openness, the opponent element was only a part of the overall task uncertainty manipulation.

The next two questionnaire items were included to evaluate the effect of the difference in production letter frame appearance between the two treatments. Frame design and order of appearance appeared to have had the expected effect on strategy choices made by low uncertainty subjects but not by high task uncertainty subjects. Responses to "The shape, content, and/or presentation order of the letter frames affected my choice of point scoring strategy for the task (Strongly Agree/Strongly Disagree)" were in the expected direction (did not affect) and significant for the low task uncertainty group (mean = 115.82, $p = 0.023$). Responses by the high task uncertainty treatment subjects were not in the expected direction (did affect), but they were not significantly in the wrong direction (mean = 106.70, $p = 0.220$). Neither was there a significant difference between the responses of the two groups ($p = 0.440$).

Taking these results together with the previous question, it does appear that strategy choices were in fact affected by a combination of frame configuration and order (repetitiveness) and opponent skill (openness). This is entirely consistent with Hirst's (1987) theory. Also, it is important to evaluate these manipulation check results in conjunction with the previously discussed tendency for high task uncertainty subjects to make more frequent strategy selection errors. A reasonable explanation is that high task uncertainty treatment group subjects made inappropriate strategy selections without realizing that they had done so.

Responses to "The shape, content, and/or presentation order of the letter frames affected the amount of effort I exerted on the task (Strongly Agree/Strongly Disagree)" by both treatment groups were not significant. Responses by the low uncertainty treatment group subjects were in the expected direction (i.e., frame configuration and order did not affect effort) but not significantly so (mean = 107.9, p = 0.17). Responses by the high uncertainty subjects also were in the expected direction (i.e., frame configuration and order did affect effort) but also not significantly so(mean = 96.26, p = 0.32). The difference between the two groups was not significant (0.31). Thus it appears that the frame presentation did have at least some of the intended effect, but it was not strong.

Responses to "My effort affected by performance (Strongly Agree/Strongly Disagree)" were interesting. The low task uncertainty subjects believed significantly that their efforts had a substantial affect on their performance (mean = 68.12, p = 0.0001). The high task uncertainty subjects believed significantly that their efforts substantially affected their performance as well (mean = 68.98, p = 0.0000). Furthermore, the difference between the two groups also was not found to be significant (p = .94). Thus, both treatment groups believed that their performances were significantly affected by their efforts. However, the results of the partial least squares path analysis described earlier showed that the data did not provide solid evidence that effort significantly affected performance (recall that the path coefficient for intensity of effort was not significant and the path coefficient for duration of effort was significant only at the 0.10 level).

Consequently, what subjects in both treatment groups believed about the effect of their efforts was not supported by the actual outcomes.

Responses to "My point scoring strategy affected my performance (Strongly Agree/Strongly Disagree)" and "If I were asked to find words in a similar sequence of frames, I would select the same point scoring strategy again (Strongly Agree/Strongly Disagree)" were as expected. Subjects in the low task uncertainty treatment group indicated that their strategy selection did affect their performance (mean = 61.36, p = 0.0000) as did subjects in the high task uncertainty treatment group (mean = 49.90, p = 0.0000). Both groups also said they would select the same strategy again (mean = 68.18, p = 0.0004 and mean = 80.30, p = 0.030, respectively). Neither item produced a significant difference between the two groups (p = 0.270 and p = 0.380, respectively). These sets of responses are consistent with the PLS path analysis results presented earlier that showed that strategy and the interaction between strategy and strategy appropriateness were important factors affecting task performance. They also indicate that subjects generally were not aware of the extent to which strategy selection errors were made.

Low task uncertainty subjects indicated agreement (mean = 78.58, p = 0.0018) with the questionnaire item "The amount of monetary compensation I earned was sufficient to affect my performance (Strongly Agree/Strongly Disagree)" while the high uncertainty subjects did not (mean = 113.90, p = 0.060). The difference was significant as well (p = 0.002). This more likely reflects post-production reactions to the $15.10 average compensation earned by low uncertainty subjects and $8.29 earned by high uncertainty subjects, rather than any pre-production assessments of the potential for earning cash under the two task uncertainty conditions.

The low task uncertainty subjects indicated that "The instructions were clear and complete" (mean = 31.16, p = 0.0000) as did the high uncertainty subjects (mean = 32.08, p = 0.0000). Both groups also indicated that they "would be willing to participate in a similar experiment in the future (Strongly Agree/Strongly Disagree)" (mean = 34.62, p = 0.0000 and mean = 46.06, p = 0.0000, respectively). Neither item produced a significant difference between the two groups (p = 0.920 and p = 0.300, respectively).

Finally, and very importantly, high task uncertainty treatment group responses (this item was not applicable to the low uncertainty condition) to the item "The interruptions for file maintenance affected my performance (Strongly Agree/Strongly Disagree)" were in the expected direction and significant (mean 70.42, p = 0.0003). These results indicate that the interruptions programmed to represent the outside influence component of task openness were effective manipulations for the high uncertainty subjects.

Taken as a whole, which is how the components of Hirst's theory are expected to operate, the manipulations were adequately effective to represent degrees of task uncertainty in the laboratory. There is no question that the manipulations could have been strengthened. Shortcomings are addressed in the limitations discussion that follows.

Limitations

No experiment is without limitations. The major limitations discussed below are related to the strength of the manipulations of the major variables.

Task Repetitiveness

A significant design challenge was to create a highly repetitive experimental task that also could be modified to be highly non-repetitive while maintaining the same task difficulty and complexity. It is acknowledged that the word search task chosen for this experiment was neither as repetitive nor as non-repetitive as the many tasks found in business organizations. For example, U.S auto-production consists of highly repetitive assembly line tasks. It is not unusual for an auto worker to perform the same simple assembly task over and over without change or variation. On the other hand, Sweden's Volvo has designed auto production systems around teams of production workers who produce an entire car by performing a variety of different tasks. Similarly, brick laying and computer programming are at opposite ends of the repetitiveness spectrum. The word search task used in this experiment was neither as simple and repetitive nor as varied and non-repetitive as these examples.

The strength of the low task uncertainty repetitive task treatment also was somewhat limited by the number of iterations. Although more than four iterations would have added to the repetitiveness of the treatment (e.g., five three-minute production frames), the number of iterations was limited for several reasons. First, the scoring opportunities had to be the same for both the low task uncertainty treatment letter frames (highly repetitive) and the high task uncertainty treatment letter frames (highly non-repetitive). It would have been very difficult, if not impossible, to find additional high task uncertainty letter frames of still different shapes and sizes such that entire frame sequence would contain the same number of possible long and short words as the 4 x 4 low task uncertainty letter frames (see Appendix E for a description of the very complex procedure required to find letter frame solution sets). Second, even if it were possible to find additional non-repetitive letter frames, the increased repetitiveness from adding more 4 x 4 frames might have been offset by a reduction in non-repetitiveness from adding more non-repetitive frames. In other words, adding more non-repetitive frames to the sequence might actually make them more repetitive.

The final reason for selecting four frames for each treatment was to achieve the objective of a total of one to one-and-a-half hours required of the subjects. Additional frames with average time limits of four minutes (plus time to review the results at the end of each frame) would have increased the total time required beyond what would be reasonable to attract sufficient subjects without significantly increasing what was already substantial cash compensation. The alternative of including more frames with average shorter time limits (e.g., three minutes instead of four) was discarded because it was feared that average time limits shorter than four minutes would interfere with the measurement of duration of effort. As is discussed below, the measurement of duration of effort already was a recognized limitation.

Duration of Effort

The time allowed for the experimental task was controlled in order to achieve the one to one-and-a-half hour time commitment objective. An alternative design considered was to have the subjects search for words to accumulate a specified point total for each frame with no imposed time limit. Goals and performance would be defined in terms of the amount of elapsed time required to reach the specified point total. The choice of either a short-word strategy or long-word strategy would be required in the same manner as described above (with the same related point values). Point totals would determine cash payments. A bonus would be paid for achieving the elapsed time goal.

The primary advantage of this design is that it permits a direct measure of duration of effort. Because there would be no time limit, subjects willing to continue to search for words would be allowed to do so until choosing to stop. Pressing the <ENTER> key would indicate continued physical effort. Evidence of cessation of mental effort would be provided when the subject presses the QUIT key to stop working on a frame. A secondary advantage of this approach is that performance in elapsed time could be measured as a continuous variable.

A prohibitive disadvantage of this approach is that the time to complete the experiment is completely open-ended. Furthermore, performance is defined along two dimensions, points and elapsed time, instead of one. Also, duration of effort and performance are somewhat confounded. For these reasons, this alternative design was not selected.

The primary disadvantage of the design chosen was the possible reduction in strength of the measurement of duration of effort. Those subjects willing to continue expending effort were prevented from doing so by the time limit. However, an adequate time allowed for each frame should have provided ample opportunity to measure perseverance. Previous experience with this type of task (Radtke and Stinson, 1999) indicates that most subjects find the most obvious words quickly and that additional effort is required well before four minutes have elapsed. Vance and Colella (1990) observed similar behavior among student subjects performing an anagram experimental task. Subjects asked to list as many words as they could during a three minute period generated words continuously for about one-and-a-half minutes, and then wrote sporadically for the remainder of the time.

Openness Manipulations

Hirst (1987) was not entirely clear about what was meant by the inside and outside influence dimensions of openness. Presumably, however, good examples are provided by businesses attempting to achieve budgeted sales goals. The effect of the overall economy would be an outside factor. The size, skill, and motivation of the sales force would be an inside factor, as would the ability of the firm to produce the output required to achieve the desired sales. Examples of factors affecting the performance of an individual might include interruptions originating from outside the organizational unit (either from outside of from within the firm) and competition with colleagues within the focal organization unit. As explained earlier, the manipulated interruption for file maintenance and the opponent skill levels were designed to represent these two types of influence on a individual attempting to achieve a task performance goal. It is acknowledged that each or both may not have been exactly what Hirst intended or they may not have been as effective as intended.

Individual vs. Normative Goals

It is common to establish normative goals in experimental goal-setting research. This approach is particularly relevant when the experimenter is interested in investigating group or organizational behavior. Examples include goals for overall sales, return on assets, inventory turnover, days sales in accounts receivable, market penetration, market position, employment turnover, new product introductions, etc.

However, there also are many organizational situations in which unique goals are established for each individual. Sales quotas, production goals, employee development objectives, and goals specified in individual professional sports contracts are just a few. Individually set goals are appropriate when the task performed by one person is not exactly the same as the task performed by another, or if the task is the same but the opportunity to perform is not. For example, a sales employee charged with developing a new territory or new product might not be required (at least initially) to achieve the same sales goals as a fellow employee assigned to an area in which the firm is more established. Likewise, a new, inexperienced production employee often is not held to the same production standards as the more experienced workers (again, at least initially). At higher organizational levels, the manager of a start-up division of a multi-division firm would not be responsible for the same operating profits, return on assets, cash flow, etc. as the manger of a more established division. This experiment was designed to represent those situations for which individually set goals are appropriate.

Thus, each subject worked toward achievement of his or her own unique goal rather than toward a goal established for all subjects. The primary benefits of establishing individual goals for each subject was to ensure that the goal was easy or challenging for each subject and the enhancement of the control for ability that resulted from the random assignment of subjects to treatments. A secondary, although certainly not essential, benefit was the elimination of the need to conduct a pretest solely for the purpose of establishing an overall point total goal to be assigned to all subjects (which would have added to the already substantial demand for subjects and the cost of obtaining them).

Ability

It is recognized that verbal percentile scores on GMAT and GRE admissions exams probably are relatively broad measures of ability. Actual performance on the same task with different letter frames a week or so prior to the experiment would have been a better measure, but at the potential cost of preconditioning the subjects. Standard psychological measures also were considered, but not used because of the substantial added time required. Nor is it certain that such tests would have been superior to the verbal percentiles measure used.

It also is recognized that other factors may affect the success of finding words from letters arranged in a two dimensional framework. For example, spatial ability might have an effect. These measures were not included, however, because of the absence of theory directly relevant to this study.

Task Strategy

As described earlier, task strategy was measured in this study by forcing subjects to chose between two mutually exclusive alternative point-scoring options. Subjects who selected the strategy of searching for short words decided to attempt to amass points by focusing on forming the easier to find three and four-letter words, but at the cost of a low point value (one point) for each word. Subjects opting for the long-word strategy received more points per word (six points), but at the risk of finding significantly fewer of the more difficult to locate five-letter and longer words. Subjects were not allowed to change strategies once they had made their selection.

The selection of one of two point scoring strategies has parallels outside of the laboratory. For example, academic researchers pursuing tenure who select a strategy of attempting to publish in the best journals probably do so with the understanding that the number of acceptances probably will be low. The value of articles published in the better journals, however, will be high. On the other hand, a strategy of publishing in lesser quality journals would require more acceptances of lower value articles. While the two strategies are certainty not necessarily mutually exclusive, such choices are real.

Another example is the choice of strategies by those employed in marketing whose compensation includes commissions based on sales or profits. If the product offering includes more than one product at different prices or margins, one strategy would be to attempt to sell proportionately more of the lower price (or margin) items. The alternative would be to pursue customers interested in the higher price (or margin) items, recognizing that sales opportunities are fewer. From a broader perspective, business organizations often find it necessary to select from among production and marketing strategies that provide uniquely different revenue and profit opportunities.

It is acknowledged that the prohibition on switching strategies in this study probably was somewhat more restrictive than the actual strategy choice situations the experiment was designed to represent. Frequently, however, strategy choices by individuals and organizations are effectively permanent because of the limitations of time, capital, and other resources.

No attempt was made to evaluate word-finding strategies. An example is the strategy of examining all combinations of letter strings beginning with each letter in the frame, starting at one letter position and proceeding systematically to all other connected letters. Other word finding strategies include searching for plurals after finding singulars and searching for words spelled both backwards and forwards (e.g., "tip" and "pit" in Figure 3-2). None of these was deemed to be amenable to direct measurement. Although subjects could have been asked via questionnaire which, if any, strategies they used, it is unclear if some word finding strategies are better than others.

The word length strategy measurement that was made in this experiment has some precedent in the psychology goal-setting literature. Rosswork (1977) used a sentence construction task in a goal setting study involving strategy selection. The results of the investigation showed that subjects selected a strategy of generating significantly shorter sentences when working toward a specific, challenging goal. Subjects working toward easy or do-best goals constructed significantly longer sentences. A similar approach was utilized in this investigation. Because longer words were awarded proportionately more points than shorter words, subjects who worked toward a specific, challenging goal in a condition of low task uncertainty might have been expected to select a strategy of attempting to find longer words in a manner similar to the subjects working toward easy or do-best goals in Rosswork's study. Alternatively, subjects who worked to achieve a specific, challenging goal in a condition of high task uncertainty might be expected to select a strategy of searching for shorter words. Thus, despite the apparent limitations, word length as a measure of task strategy was used in this study because of the clarity of the strategy choices and because there was some precedent in the literature.

Generalizability of the Results

The generalizablity of the results of all research to other settings is open to question. The generalizability of experimental research to other tasks and subject populations is particularly limited due to the nature of most experimental tasks and subject pools. This study is no exception, although every effort was made to broaden the application of the results to other tasks and subjects.

Although the experimental task seems not to represent a real task that might be encountered in an organization, it actually may be somewhat more realistic, and therefore more generalizable, than it first appears. Two subjects provided anecdotal evidence to that effect by commenting during their debriefings that the task reminded them of their work as copy editors for local magazine publications. Otherwise, the limitations of the experimental task are acknowledged. As noted earlier, however, the task used in this study was quite similar to tasks used by other researchers.

Generalizing the results to broader populations also is a recognized limitation of experimental research. However, the subjects in this study probably were at least somewhat representative of the general business population because they were graduate students in business and computer science and had at least moderate work experience.

Conclusion

Overall, the data provide support for Hirst's (1987) hypothesis that high task uncertainty can have a negative effect on task performance. Specifically, the PLS analysis produced a coefficient for the path between the manipulated task uncertainty variable and the level of task performance by the subjects in this experiment that was negative and significant. Hirst's ideas about the mechanisms through which task uncertainty affects performance also were largely supported. High task uncertainty was found to reduce the acquisition (i.e., completeness) of task knowledge relative to low task uncertainty. In turn, Hirst theorized that incomplete task knowledge would increase the incidence of inappropriate strategy selection. The data generated by this experiment show that subjects in the high task uncertainty treatment group did make inappropriate strategy selections more often than their low task uncertainty treatment group counterparts, and that strategy and the interaction of strategy with strategy appropriateness were significant.

Interestingly, goal commitment affected strategy choice and intensity of effort as expected, but intensity of effort did not have a significant effect on performance. Thus, it appears that the subjects in this experiment were following the familiar "work smarter rather than harder" philosophy. This is somewhat in contrast to the Hirst hypothesis, because Hirst modeled performance as a result of effort and effort as a result of strategy (see Figure 9); his model did not include a separate direct effect of strategy on performance.

The only element of Hirst's proposition that received no support was the hypothesis that task uncertainty would interact with goal difficulty (i.e., goal setting) to affect performance. One possibility is that the goal difficulty manipulation used in this experiment was not sufficiently strong. Future studies might discover a significant interaction by increasing the relative difference between the easy and the difficult goal.

Finally, one factor found to significantly affect task performance, but not specifically included in the Hirst model, was individual subject ability. However, this significance should come as no surprise since it is well documented in the goal setting literature.

Chapter V

FUTURE RESEARCH

This investigation of the effect of task uncertainty on the performance of individuals offers several possible avenues for future research. These opportunities are described here in brief. Broadly speaking, most of the entire spectrum of goal setting research could be repeated within a context of task uncertainty, which, at least as defined by Hirst (1987), has largely been omitted from prior consideration. One of the most obvious approaches would be to investigate which of the various goal setting styles (specific challenging, specific easy, do-best, no goal, work hard, etc.) results in the best performance with a highly uncertain task. While the research on this question is complete with respect to highly certain tasks, highly uncertain tasks have been left unexplored.

A second possibility would be to examine the effect of task uncertainty on goal commitment for subjects who set personal goals before receiving assigned goals. Prior research has shown that having subjects set their own goals before being assigned goals leads to lower commitment than not setting personal goals first (Erez, Earley, and Hulin 1985). However, task uncertainty has not been included. Similarly, Hollenbeck, Williams, and Klein (1989) found that public commitment induced stronger goal commitment than private commitment. Again, the effect of task uncertainty has not been examined.

Another general approach would be to examine the same issues of task uncertainty included in this study, but with groups instead of individuals. Group decision making and task performance are likely to be substantially different from that of individuals. Group experiments present substantial measurement, control, and subject acquisition challenges.

Another general area that would seem to be open for investigation is the effect of task uncertainty on budget slack with and without participation and information asymmetry. Although this issue also has been well researched, few if any studies have incorporated task uncertainty into the model. In particular, an extension of Radtke and Stinson (1999) is contemplated. The budget slack model could be expanded still further by including task uncertainty along with such personality differences as locus of control, need for control, need for achievement, and fear of appearing incompetent. An interesting avenue of inquiry would be to investigate how each of these might affect the introduction of budget slack when facing tasks of varying uncertainty. Standard psychological scales have been developed to measure each of these personality variables.

A final area for future research that comes to mind is that of compensation combined with task uncertainty. An interesting avenue might be to investigate how the various compensation schemes affect performance in the presence of task uncertainty, along with the related goal commitment, effort, and strategy selection variables.

These ideas are far from exhaustive. They do, however, offer some possibilities for additional inquiry. It is anticipated that at least some could be investigated using a variation of the task developed for this first study.

APPENDIX

A. Other Experimental Tasks Considered

B. Experiment Appointment Form

C. Information Release Form

D. Informed Consent Form

E. Word Frame Solution Generation Procedure

F. Word Frame Solution Sets

G. Practice Frame Opponent Word Sets

H. Production Frame Opponent Word Sets

I. Bootstrapping Results

Appendix A

Other Experimental Tasks Considered

Task Description	Comments	Literature Reference
In-basket exercise	Not a production task	Numerous
Business simulation	Significant learning curve for subjects; extensive time required to administer; presumes substantial specific knowledge of numerous disciplines by the subject; too complex; difficulty not readily controllable; inadequate CBA computer capability	Earley & Wajnaroske (1987) Campbell (1984) Numerous others
Punched card decoding	Openness difficult to manipulate; repetitiveness manipulation not strong; not computer controlled; weak strategy; difficulty not readily controllable	Chow (1983), Fatseas & Hirst (1992), Farh, Griffeth & Balkin (1991), Chow, Cooper & Waller (1988)
Mastermind (computer decoding similar to above)	Openness difficult to manipulate; simple repetitiveness manipulation; good strategy; good measurement of duration of effort; difficulty not readily controllable	None
Soma (commercial game)	Openness difficult to manipulate; good; repetitiveness manipulation; strategy unclear; effort difficult to measure	Shapira (1989)
Air traffic control (computer simulation)	Significant learning curve for subjects; good openness and repetitiveness; requires far too much subject time; very complex; much too difficult to reprogram effort difficult to measure; difficulty not readily controllable	Johnson & Perlow (1992)
Assembly (Legos, Tinker Toys Erector set, etc.)	Good nonrepetitiveness, difficult to manipulate & control openness; strategy choices not clear; quality an issue for performance; doesn't afford the control of computerized tasks; difficult to run more than one subject at a time	Terborg & Miller (1978) Mossholder (1980) Weingart (1992)
Circling vowels in letter rows	Acceptable nonrepetitiveness; openness difficult to manipulate; control issues similar to assembly tasks	Gellanty & Meyer (1992)
Stock investment simulation	Good measures of effort, strategy & feedback, openness & repetitiveness difficult to manipulate	Early, Northcraft, Lee & Lituchy (1990)
Spreadsheet simulation	Adapted from Challenger newspaper puzzle; good external validity; acceptable repetitiveness;openness difficult to manipulate; limited strategy;effort difficult to measure	None

Appendix B

Experiment Appointment Form

EXPERIMENT DATES/TIMES

RETURN TO JIM STINSON 390.M MELCHER HALL

Name: **E-mail:** **Phone:**

Check ONE box for your date/time preference:

Time/Date	Mon 11/9	Tues 11/10	Wed 11/11	Thu 11/12	Fri 11/13
9:00 AM					
10:00 AM					
11:00 AM					
12:00 PM					
1:00 PM	NO TIMES		NO		
2:00 PM	AVAILABLE		TIMES		
3:00 PM			AVAILABLE		
4:00 PM					
5:00 PM					
6:00 PM					
7:00 PM					

Time/Date	Mon 11/16	Tues 11/17	Wed 11/18	Thu 11/19	Fri 11/20
9:00 AM	NO		NO		
10:00 AM	TIMES		TIMES		
11:00 AM	AVAILABLE		AVAILABLE		
12:00 PM					
1:00 PM					
2:00 PM					
3:00 PM					
4:00 PM					
5:00 PM					
6:00 PM					
7:00 PM					

Appendix C

Information Release Form

WHAT During the next several weeks, an experiment in decision making will be conducted in the College of Business. Participants in the experiment will have an **opportunity to earn** approximately **$10 to $15 for one hour** of their time. Some may earn more, while others may earn less.

The experiment will be done entirely on the computer. The computer and related programs and disks will be provided. The task is simple and requires no special abilities, knowledge or skills. In fact, many of those who have served as pilot test subjects have said it is fun.

WHERE The experiment will be conducted in the behavioral lab, room 224, located on the second floor of Melcher Hall along the east hallway across from the Finance Department offices (and behind RICS lab 2, room 223). If you walk down the short hallway to the left of the Office of Student Services at the top of the central stairs, you will see the Finance Department. Take a left to room 224.

HOW Appointments are recommended. Please indicate your date and time preference on the separate sign-up sheet and return it to my mail box outside 390.M Melcher Hall.

To participate, you must permit access to your GMAT or GRE scores that are a part of your student records. I will use this information only to control for subject variability. The scores will not be used for any other purpose, nor will they be distributed in any way. Your social security number will be used only to obtain your GMAT/GRE score. It will be eliminated from the records of this experiment upon completion. Also, **the results of this experiment will be entirely confidential**.

If you would like to participate in this study, please provide the information below and bring this form with you. If you have any questions, please contact me by e-mail at **jims@phoenix.net** or by phone at (office) **713-743-4855** or (home) **713-783-0183**. Thanks for your help!

Jim Stinson
E-mail: jims@phoenix.net
Office: 713-743-4855
Home: 713-783-0183

PERMISSION TO ACCESS GMAT/GRE SCORES

I hereby permit access to my GMAT/GRE scores as contained in my student records at the University of Houston. I understand that such scores will not be used for any purpose other than for the above experiment and they will not be distributed in any way.

Name____________________________ Social Security Number ________________
(please print)

Signature__________________________ Date________________________

Appendix D

Informed Consent Form
(page 1 of 2)

THE UNIVERSITY OF HOUSTON

CONSENT BY SUBJECT FOR PARTICIPATION IN A RESEARCH PROJECT

Title:	The Effect of Task Uncertainty on Performance in a Goal Setting Environment	
Principal Investigator:	Jim Stinson Doctoral Candidate	Department of Accountancy & Taxation 390.M Melcher Hall 713-743-4820
Faculty Sponsor:	Dr. Janet Meade Associate Professor	Department of Accountancy & Taxation 380.G Melcher Hall 713-743-4841

I am being asked to participate in the above-mentioned project. My participation in this study is entirely voluntary and I may refuse to participate, or I may decide to cease participation once begun. Should I withdraw from the study, which I may do at any time, or should I refuse to participate in the study, my decision will involve no penalty or loss of benefits to which I am otherwise entitled. I am being asked to read the consent form carefully and will be given a copy of it to keep, if I decide to participate in this study.

I was told that the purpose of this research is to examine how individuals respond to certain task performance and goal setting situations. **I was also informed about the following research procedures:** approximately 100 graduate students enrolled in the College of Business Administration will be asked to participate. Participants will perform a game-like word finding task on a personal computer. I have been advised that the task requires only that I use a standard computer keyboard and mouse to enter words found among letters on the screen. There will be an opportunity for each participant to earn a cash reward for performance of the task. Rewards will be determined according to the number of words found and by comparing actual performance with a predetermined goal. In addition, each participant will complete a questionnaire that includes questions about attitudes and choices relevant to performance, as well as some brief personal information. **I have been advised that the total anticipated time commitment will be approximately one hour.**

I have been advised that there will be no direct, personal benefit from participating in this study. However, my participation could allow social scientists to better understand processes that affect task performance.

Every effort will be made to maintain the confidentiality of my record of this study. I have been specifically told that the information gathered in this study will be coded so as to protect my privacy and confidentiality. This will be done through a procedure whereby the data I will provide will be referred to by my subject number alone. Any list, pairing subject names and subject numbers, will be kept separate from the data and will only be available to the principal investigator. **I have been advised that the data collected from the study will be used for educational and publication purposes; however, I will not be identified by name.**

I am aware that participation in this study provides an opportunity for, but no guarantee of, a cash reward for task performance upon and at the time of full completion of the experiment. **I have been told that the investigator has the right to withdraw me from this study at any time for due cause. The investigator has offered to answer all my questions about the experiment. If I have additional questions during the course of the experiment or about any related problem, I may contact the Principal Investigator, Mr. Jim Stinson in 390.M Melcher Hall or at 713-743-4820.**

I have been advised that there are no foreseeable risks associated with my participation in this study. **My signature below acknowledges my voluntary participation in this research project. Such participation does not release the investigator, institution or sponsor from their professional and ethical responsibilities to me.**

Appendix D
(page 2 of 2)

I HAVE READ THE INFORMATION PROVIDED ABOVE AND HAD BY QUESTIONS ANSWERED TO MY SATISFACTION. I VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY. AFTER IT IS SIGNED, I WILL RECEIVE A COPY OF THIS CONSENT FORM.

____
Name (Please print)

______________________________ ______________
Signature of Research Subject **Date**

______________________________ ______________
Signature of Principal Investigator **Date**

ANY QUESTIONS REGARDING YOUR RIGHTS AS A RESEARCH SUBJECT MAY BE ADDRESSED TO THE UNIVERSITY OF HOUSTON COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (713-743-9204). ALL RESEARCH PROJECTS THAT ARE CARRIED OUT BY INVESTIGATORS AT THE UNIVERSITY OF HOUSTON ARE GOVERNED BY REQUIREMENTS OF THE UNIVERSITY AND THE FEDERAL GOVERNMENT.

Appendix E

Letter Frames Solutions Generation Procedure

The solutions to all word frames were computer generated using a computer game program called Word Hunt (Gillogly 1984) in which words are formed from arrangements of letters in a manner very similar to the task used in this experiment. The Word Hunt program includes a feature that finds complete solutions to letter frames created by the user. Complete solutions for the 4 x 4 practice period and low task uncertainty letter frames were generated directly by the Word Hunt program. The program was used to find all words of three letters or more that could be formed from selected 4 x 4 frames of letters. The letters were changed on a trial-and-error basis, usually one letter at a time, until the desired set of 125 short words and 125 long words was achieved. This procedure was used to create solution sets for three 4 x 4 practice period frames and one 4 x 4 production period frame. Only one production period frame was required because it was used for all four repetitions.

Word Hunt letter arrangements are limited to 4 x 4 and 5 x 5 squares.[25] There fore, a special procedure was required to find complete solutions to the non-square designs of the high task uncertainty production frames. The procedure was complicated by a second element of the Word Hunt programming. The program generates solutions for 4 x 4 letter frames that include all words of three letters or more, but it generates only words of four letters or more for 5 x 5 frames. Consequently, a combination of both sizes

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[25] Word Hunt also included the capability to produce 3 x 3 letter frames, which were not useful for this experiment.

was required to develop complete solution sets for the high task uncertainty letter frames. In fact, the various non square configurations (donut, cross, star, diamond) were modifications of a basic 5 x 5 square so that the Word Hunt solution generation capability could be used.

In contrast to the 4 x 4 practice and low task uncertainty frames, the procedure to generate a complete solution for each of the non-square high task uncertainty frames required several steps. The steps were applied to each frame separately. This procedure is described below using the donut shaped letter arrangement as an example.

Step 1. In the first step, the donut-shaped letter frame was created by placing an "X" in each corner and in the middle of the 5 x 5 matrix as shown in Figure 41-a. Because the Word Hunt program required that each location in the matrix contain a letter (i.e., the program would not accept blanks), "X" represented an empty location. Next, the program was run to generate a partial solution set that consisted of all possible words of four letters or more, including those that contained an "X" (again, the Word Hunt program was not designed to generate three-letter words for a 5 x 5 letter frame). Finally, all words containing an "X" were deleted, which left a complete set of acceptable words four or more letters long. Four-letter words were classified as short words and words of five or more letters were classified as long words.

Step 2. Generating a list of three-letter words contained in the frame was a bit more of a challenge. The approach first required partitioning the 5 x 5 frame into four sub frames or size 4 x 4 beginning with the upper left sub-frame as shown in Figure 41-b. The Word Hunt program was run to generate a list of acceptable words three or more letters in

Figure 41

High Task Uncertainty Production Frame Solution Generation Example

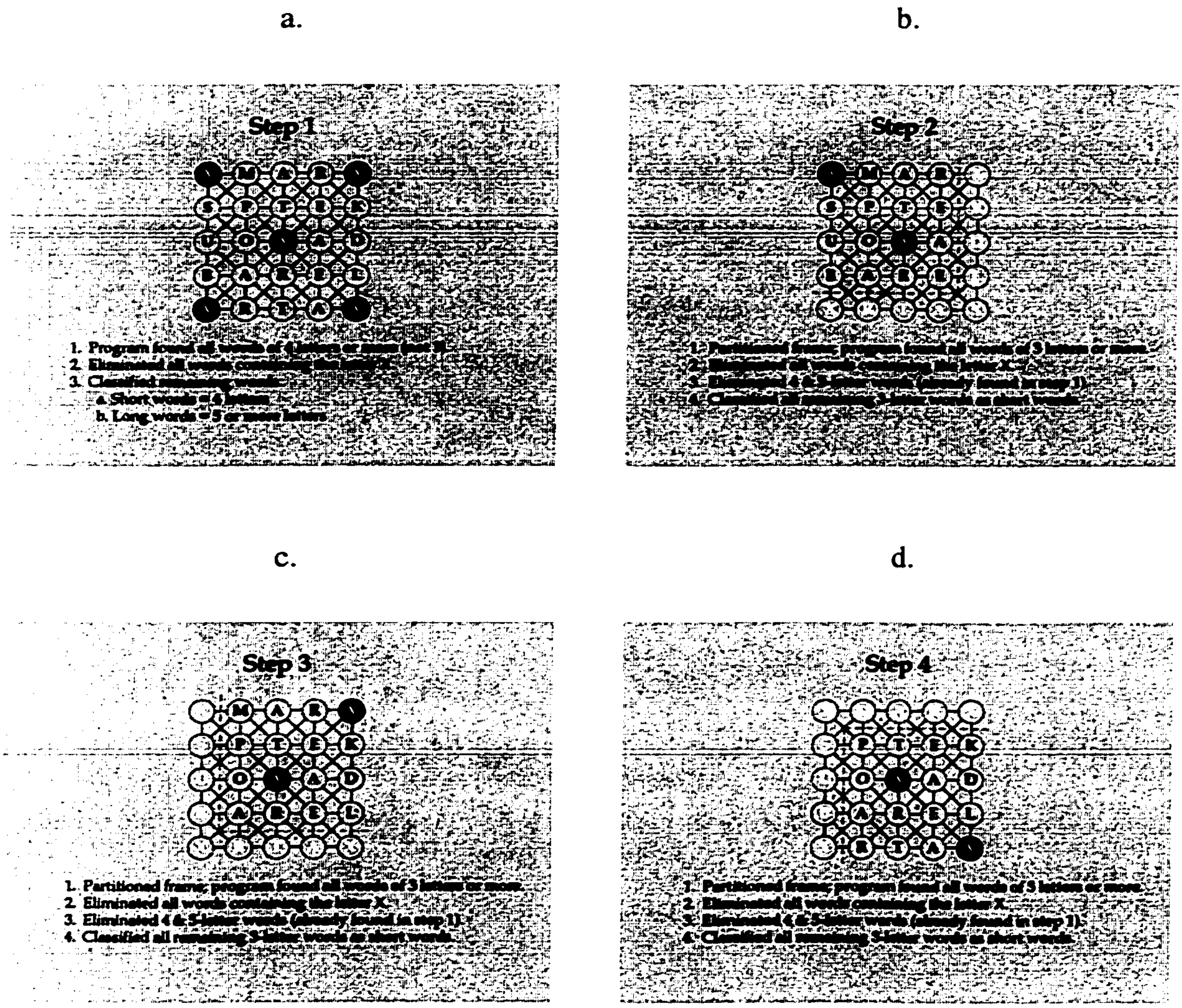
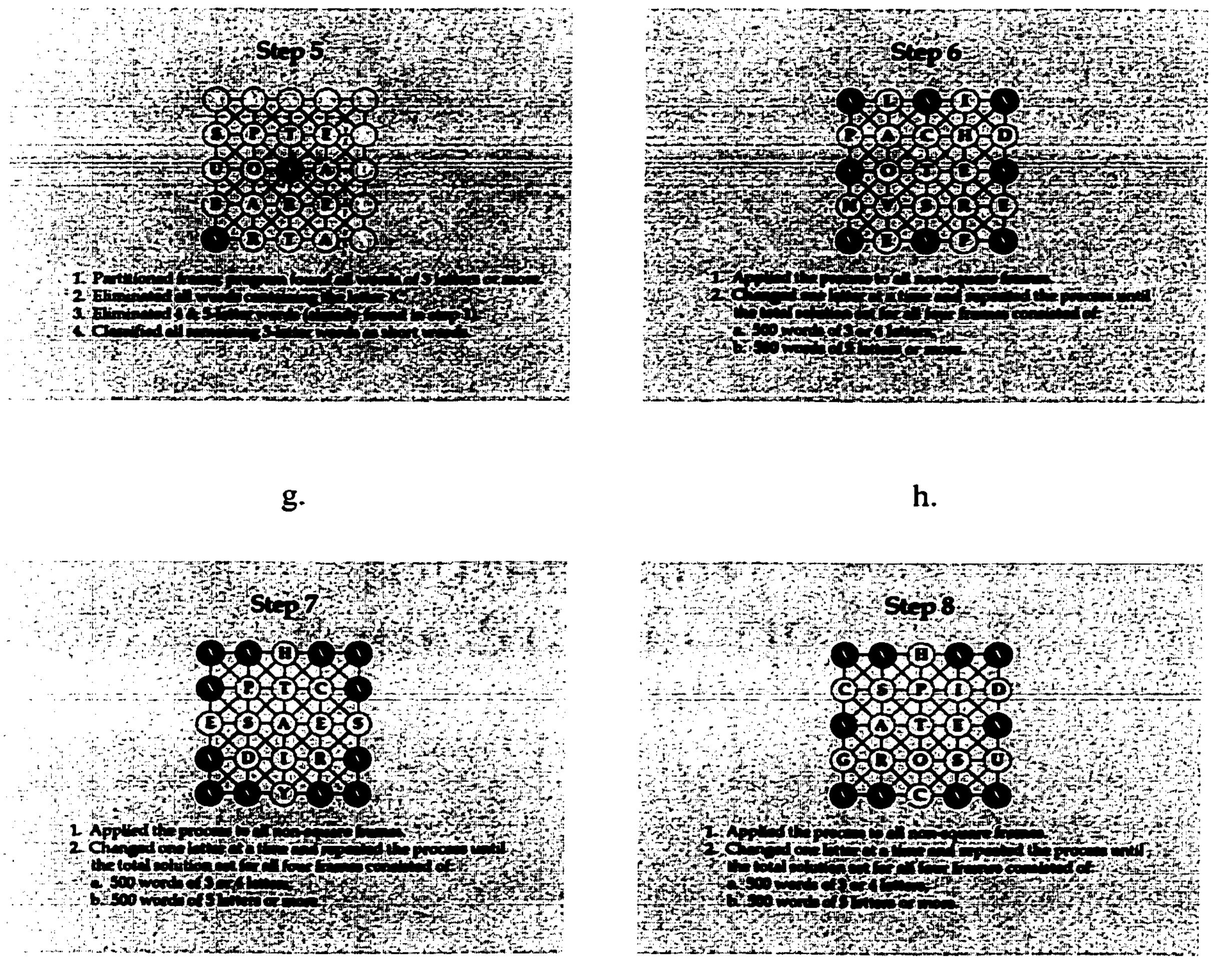


Figure 41

Solution Generation Example (continued)

e. f.

g. h.



length for this sub-frame. All words containing an "X" were deleted. Next, all words four or more letters in length were omitted because they were duplicates of those found in step 1. The remaining three-letter words were added to the short-word list.

Steps 3-5. The next three steps were repetitions of step 2 for the other 4 x 4 sub-frames as shown in Figures 41-c, 41-d, and 41-e (upper right, lower right, and lower left sub-frames, respectively). After eliminating duplicates, the final result was a list of all valid three-letter words that could be formed from the frame of letters.

Steps 6-8. The remainder of the procedure was a repeat of steps 1-5 for the other non-square letter frames. These frames are shown in Figures 41-f, 41-g, and 41-h. Once the procedure was completed for the particular letters in each of the four non-square frames, lists of short words (three and four letters) and long words (five or more letters) were complete for those frames. However, the entire process was for a from complete because the lists had to consist of five hundred total short words and five hundred total long words in order to match the same totals for the four 4 x 4 low task uncertainty frames.

By far the major challenge was to repeat the process on a trial-and-error basis until equivalent solution sets could be found for the four 4 x 4 square low task uncertainty frames and the four non-square high task uncertainty frames. The first phase was to find one 4 x 4 letter frame which contained exactly (or at least as close as possible) 125 short words and 125 long words. Only one frame was required because it was repeated four times during the low task uncertainty treatment for a total of 500 possible short words and 500 possible long words (4 x 125 = 500, 2 x 500 = 1000). The process was to change individual letters in the frame and use the Word Hunt program to generate solutions again and again until the objective was achieved. Needless to say, the time required was substantial.

The second phase was the most difficult. It required applying steps 1-8 described above to each of the four non-square high task uncertainty frames. Again, the process was to change individual letters in each frame, usually one letter at a time, and use the Word Hunt program to generate solutions again and again until a combined solution set of 500 short words and 500 long words for all four frames was achieved.

To say that the application of this trial-and-error process to four frames simultaneously was time consuming is an understatement of enormous proportions! The task of finding equivalent solution sets for the low and high uncertainty frames required almost two months of continuous effort.

Appendix F

Word Frame Solution Sets

Demonstration Frame Solution Set

ace	con	emits	lode	nor	pond	sip
acne	cone	enact	lone	ocean	ponder	sit
act	cop	enacts	lop	ode	pone	site
action	cope	encode	lope	once	pore	sty
acts	copy	encore	lord	one	pored	stymie
and	copyist	encored	lore	onetime	pro	tea
anode	cord	end	melon	ore	prod	ten
can	core	enol	mica	pica	prone	tend
candor	cored	eon	mice	pie	red	tender
cane	doe	epic	mien	piety	redo	tenor
canoe	doer	ice	mist	pion	redone	tic
canoed	dole	icon	misty	pit	roc	tie
canopy	don	imp	mite	pits	rod	time
cite	done	impel	mystic	pity	rode	tip
city	dope	implode	net	plod	roe	type
cod	drone	implore	nets	pod	role	typic
code	drop	implored	nod	poi	rope	typo
coder	elm	ion	node	pole	sic	yip
coed	emit	loci	noisy	polemic	simple	

Practice Frame 1 Solution Set

ace
aces
acme
acmes
acre
acres
aegis
agate
agates
age
ages
agile
ail
aim
air
ale
alert
ales
alias
arc
arcs
are
aria
arias
arise
art
ate
atria
cage
cages
cam
came
car
carat
care
cares
caries
cart
cartage
cartages
case
cat
cigar
circa
crag
crags
cram
crate
crates
crime
crimes
ear
earl
eat
egis
emigre
emir
era
eras
erase
erg
ergs
eta
gal
gale
gales
gam
game
games
gamier
gar
garlic
garlics
gas
gat
gate
gates
gear
gem
get
gilt
girl
grace
graces
grail
gram
grate
grates
grim
grimace
grimaces
grime
grimes
ice
ices
image
images
irate
ire
ires
lag
lags
large
larges
lariat
lei
leis
liar
lice
lie
lies
ligate
ligates
lime
limes
lira
liras
lire
mace
maces
magi
magic
mail
mailer
mar
maraca
maracas
mare
mares
mart
mat
mate
mates
meat
mesa
mescal
met
mica
micas
mice
migrate
migrates
mil
mile
miler
miles
milt
mirage
mirages
mire
mires
miser
race
races
rag
rage
rages
rags
rail
raise
rale
rales
ram
ramie
ramies
rascal
rat
rate
rates
relic
relics
rice
rices
riel
rig
rigs
rile
riles
rim
rime
rimes
rise
sac
sacra
sacral
sacs
sag
saga
sage
sail
sailer
same
sari
saris
sat
sate
scale
scaler
scales
scar
scare
scares
scat
scram
scrim
sea
seam
sear
seat
sera
serge
serges
set
sic
silage
silages
silt
sir
sire
tag
tags
taiga
tail
tailer
tale
taler
tales
tam
tame
tames
tar
tare
tares
target
tart
tea
team
tear
teas
trace
traces
tragic
trail
tram
trice
trig
trim

Practice Frame 2 solution Set

ace
aces
aft
ale
alert
ales
aloe
aloes
aloft
also
apace
apart
ape
aper
apes
are
area
areas
areola
areolas
arose
art
asp
bar
bare
bares
barf
bat
brace
braces
brat
bum
bump
bumper
bumps
bus
cap
cape
caper
capes
caps
car
carafe
carafes
carat
care
cares
carol
carols
carp
carpel
carpels
carps
carpus
cart
clap
claps
clasp
clasper
clear
clef
cleft
close
closer
ear
eft
era
eras
far
fare
fares
faro
faros
fat
fear
fecal
foe
foes
for
fore
fort
fro
froes
ice
ices
lace
lacer
laces
lap
laps
lea
leap
leaps
leas
left
loft
lore
lores
lose
loser
muscle
muscles
music
musical
musicale
musicales
musicals
oft
oracle
oracles
oral
orb
ore
ores
pace
pacer
paces
pal
pale
paler
pales
pals
par
para
paras
pare
pares
parole
paroles
part
pat
patrol
patrols
pea
peal
peals
pear
peas
per
pert
peso
precis
prefab
pro
pros
prose
psi
pub
pus
race
races
raft
rale
rales
rap
rape
rapes
raps
rasp
rat
real
reals
reap
reaps
recap
recaps
rep
reps
roe
role
roles
rose
sac
sale
sales
sap
scale
scaler
scales
scar
scarab
scare
scares
scarf
scaup
scauper
sea
seal
sear
seas
sepal
sera
serf
sic
slap
slaps
sloe
sofa
soft
sol
solace
solacer
solar
sole
sora
soras
sorb
sore
sort
spa
space
spacer
spaces
spar
spare
spares
spat
spear
special
specials
sub
subarea
sum
sump
sup
super
superb
supra
tab
tabu
tap
tapa
tapas
tape
taper
tapes
taps
tar
tare
tares
taro
taros
tarp
tarps
trace
traces
trap
traps
umbra
umbras

Practice Frame 3 Solution Set

able	car	estated	leas	rets	slate	tables
abler	cart	estates	led	sac	slated	tablet
ace	carted	ester	let	sacs	slater	tablets
aces	cartel	esters	lets	sag	slates	tabs
act	cartels	eta	race	sale	slats	tact
acted	carter	gal	races	sat	slatted	tag
acts	carters	gale	rag	sate	sled	tale
ale	carts	gales	rale	sated	stab	taler
alert	case	gals	rales	sates	stable	talers
alerts	cased	gar	rat	scale	stabled	tales
ales	cat	garter	rate	scaled	stabler	tar
altar	cater	garters	rated	scaler	stablers	tart
alter	caters	gas	rater	scalers	stables	tarter
alters	cats	gat	raters	scales	stag	tarts
arc	cattle	gate	rates	scar	stale	tat
arcs	cattles	gated	rats	scarlet	staler	tater
art	crag	gates	ratted	scat	star	taters
arts	crate	gats	ratter	scatted	starlet	tats
ate	crated	glace	ratters	scatter	start	tea
attar	crater	grace	rattle	scatters	started	teal
bale	craters	graces	rattled	sea	starter	tear
baled	crates	grate	rattler	seal	starters	teas
baler	deal	grated	rattlers	sear	statable	teat
balers	deals	grater	rattles	seat	state	teats
bales	dear	graters	react	seats	stated	test
bat	delta	grates	reacts	sect	stater	tested
bate	deltas	lab	real	set	staters	tester
bated	detest	labs	reals	sets	states	testers
bates	drear	lace	rear	setter	steal	trace
bats	ear	laces	red	setters	steals	traces
batter	earl	lag	reds	settle	stela	treat
batters	earls	laser	relate	settled	stelas	treats
blat	eat	late	relates	settler	stet	
blats	eats	later	ret	settlers	strata	
bleat	elate	latest	retest	settles	tab	
bleats	elates	latter	retrace	slag	table	
bled	estate	lea	retraces	slat	tabled	

Low Task Uncertainty Treatment
<u>Production Frames 1-4 Solution Set</u>
(rotated to create frames)

acre	crap	dip	old	posers	rued	storer
acres	craps	dips	older	poses	rues	stores
apse	credit	disuse	opus	poseur	ruse	sucre
apses	creditor	doe	order	poseurs	ruses	sucres
arc	creditors	doer	orders	posit	rust	suds
are	credits	doers	ordure	post	sac	sue
area	credo	does	ordures	pseudo	sacred	sued
areas	crest	dolt	ore	psi	sap	suer
aside	crud	dolts	ores	pure	sea	suers
asides	crude	dot	otiose	purer	sear	sues
asp	cruder	dots	par	purse	sears	sup
audio	crust	due	pare	pursed	seas	sups
audit	cud	dues	pared	purser	sera	sure
auditor	cuds	dust	parer	purses	side	surer
auditors	cue	ear	pares	pus	sides	tide
audits	cued	ears	pars	rap	sip	tides
cap	cues	edit	parse	rapid	sit	tip
capitol	cup	editor	parsed	rapids	sop	tips
capo	cups	editors	parser	rapist	spa	toe
caps	cur	edits	parses	raps	spar	toed
car	cure	era	past	rasp	spare	toes
care	cured	eras	pastor	rear	spared	told
cared	curer	idea	pastors	rears	sparer	tor
cares	curers	ideas	pause	red	sparers	tore
cars	cures	ides	paused	redo	spares	tors
case	curs	idol	pauses	reds	spars	tsar
cased	curse	lode	pistol	rest	sparse	upside
cases	cursed	lodes	pit	rod	sparser	upsides
cast	curser	lord	pits	rode	spider	urea
castor	curses	lords	poi	rods	spiders	use
castores	cusp	lore	poise	roe	spit	used
castors	cuspid	lores	poised	rot	spud	user
cause	cuspidor	lot	poises	rots	spur	users
caused	cuspidors	lots	pose	rude	spurs	uses
causers	dear	ode	posed	ruder	store	
causes	dears	odes	poser	rue	stored	

High Task Uncertainty Treatment
"Star" Production Frame Solution Set

ape	coat	gaped	oar	raps	septs	sties
aped	coated	gapes	oat	rapt	set	stoa
apes	coats	gaps	oats	rash	sets	stoas
aphid	coed	gar	orate	rasp	shied	strap
aphides	cos	gas	orated	rasped	ship	straps
apt	cost	gash	orates	rat	soap	sue
arc	costs	gasp	par	rate	soaped	sued
arcs	cot	gasped	part	rated	soaps	suet
arose	cote	gat	parted	rates	soar	tag
art	cotes	gate	parts	rats	sora	tap
arts	cots	gated	past	roast	soras	tape
ash	crag	gates	paste	roasted	sort	taped
asp	crap	gats	pasted	roasts	sorted	tapes
ate	crape	grape	pastes	roc	sortie	taps
cap	craped	grapes	pastor	rocs	sortied	tar
cape	crapes	graph	pat	roe	sorts	taro
caped	craps	graphite	pate	rose	sot	taros
capes	crash	graphites	pated	rot	sots	tepid
caps	crate	graphs	pats	rote	spa	tide
captor	crated	grasp	pest	rotes	spar	tides
car	crates	grasped	pests	rots	spat	tie
carotid	depart	grate	pet	sac	spate	tied
cart	departs	grated	pets	sag	spates	ties
carted	die	grates	phi	sap	spats	tip
carts	dies	groat	pie	sat	sped	tips
cash	diet	groats	pied	sate	spied	toe
cast	diets	hid	pies	sated	spies	toed
caste	dip	hide	pit	sates	spit	toes
castes	dips	hides	pita	scar	spite	tor
castor	edit	hie	pitas	scat	spites	trap
casts	editor	hied	pits	scats	spits	traps
cat	edits	hies	rag	scrap	stag	trash
cate	escort	hip	rap	scrape	staph	tsar
cats	escorts	hips	rape	scraped	star	use
coast	eta	hit	raped	scraps	stash	used
coasted	gap	hits	rapes	sept	step	
coasts	gape	ides	rapid	septa	steps	

High Task Uncertainty Treatment
"Donut" Production Frame Solution Set

abort
aborted
aerate
aerated
alder
ale
alert
amp
aorta
aport
apt
arbor
arboreal
are
area
ark
art
ate
atop
bar
bare
bared
barred
barrel
barter
bate
bated
boa
boar
boat
boater
bop
bops
bora
borate
bore
boreal
bored
brat
bus
dale
dare
dart
data
date
dater
deal
dealer
dear
ear
eared
eat
eater
elate
elated
elater
elder
era
err
errata
eta
kale
karat
karate
lad
lade
lake
laker
late
later
lea
lead
leader
leak
leaked
led
let
map
maps
mar
mare
mark
marked
market
mart
mat
mate
mated
oar
oared
oat
opt
opted
opus
oral
orate
orated
ore
our
par
pare
pared
park
parka
parked
part
partake
parted
pat
pate
pated
pore
pored
port
portal
ported
pot
pub
pus
rad
rake
raked
raker
rale
ram
ramp
ramps
rams
rap
raps
rapt
rare
rat
rate
rated
rater
read
reader
real
ream
reams
reap
reaps
rear
reared
red
relate
related
relater
ret
retort
retorted
roar
rob
roe
rot
rote
smart
smarted
soar
soared
sob
sop
sora
sore
sort
sorted
sot
sou
soup
spa
spar
spare
spared
spark
sparked
spat
spate
spore
spored
sport
sported
spot
sub
subarea
sup
tabor
tabu
tad
take
taker
tale
taler
tam
tamp
tamps
tams
tap
taps
tar
tare
tared
taro
taros
tarot
tarred
tart
tartar
tau
tea
teak
teal
team
teams
tear
teared
teat
teated
toe
top
tops
tor
tore
torr
tort
torte
trade
trader
tram
tramp
tramps
trams
trap
traps
tread
treader
treadle
treadler
treat
treated
treater
trek
trot
uptake

High Task Uncertainty Treatment

"Cross" Production Frame Solution Set

ace	ciders	estop	latch	others	poachers	steer
aced	clap	eta	latched	oven	poaches	stoa
aces	coal	etch	latcher	pace	pone	stone
acetone	coat	ethic	latches	paced	pones	stop
acetones	coated	ethical	late	pacer	pose	stove
ache	coats	fee	later	pacers	posed	taco
ached	con	feed	lath	paces	poser	tacos
aches	cone	fees	lathe	pact	post	talc
acid	cones	feet	lathed	pacts	postal	tap
act	cop	free	lather	pal	posted	tee
acted	cos	freed	lathers	pat	poster	terse
acts	cost	frees	lathes	patch	pot	the
alcove	cot	freest	nest	patched	pother	thee
alcoves	cote	fret	nested	patcher	pothers	there
alp	cotes	frets	nester	patches	pots	these
ate	cots	her	nose	pate	recap	ton
atone	cove	here	nosed	pated	rectal	tone
atones	coven	hers	not	pates	recto	tones
atop	coves	hid	notch	path	rectos	top
cap	decal	hide	notched	pats	red	tree
capo	deer	hider	notcher	place	reed	treed
capon	detach	hiders	notches	placed	reef	trees
cat	dice	hides	note	placer	reefs	vest
cate	dicer	ice	noted	placers	rest	vestal
cater	dicers	iced	noter	places	ret	vested
caters	dices	ices	noters	placid	retch	vocal
cats	dicot	icon	notes	plat	rets	vote
cheer	dicots	ides	oat	plate	sect	voted
cheers	dicta	lace	oath	plated	see	voter
chert	eclat	laced	oats	plater	seer	voters
cherts	edict	lacer	ocher	platers	serf	votes
chest	edicts	lacers	octal	plates	set	
chi	ere	laces	one	plats	soap	
chide	erect	laches	ones	poach	son	
chides	erects	lactose	opal	poached	sop	
cider	ester	lap	other	poacher	sot	

High Task Uncertainty Treatment
"Diamond" Production Frame Solution Set

ace	cares	diet	pad	rapt	sates	spars
aces	caret	dietary	pads	rased	scar	sparse
act	carets	diets	paid	rasp	scare	spat
acts	caries	dire	pair	rasped	scary	spate
adept	cars	direct	pairs	rat	scat	spates
adepts	case	directs	par	rate	scats	sped
aery	cased	dispatch	pare	rates	sea	staid
aid	cast	each	pares	rats	sear	stair
aide	caste	ear	pars	reach	seas	stairs
aides	caster	ears	parse	react	seaside	staph
aids	casters	ease	parsec	reacts	seat	star
air	castes	eased	past	read	seats	stare
airs	cat	east	paste	reads	sect	stares
airy	cate	eat	pastes	ready	sects	stars
ape	cater	eats	pat	reap	sedate	stead
aped	caters	era	patch	reaped	sedates	steady
apes	cats	eras	pate	reaps	sept	tad
apse	cease	erase	pates	recap	septa	tads
apt	ceased	erased	path	recaps	sera	tap
are	cerise	escape	pats	recast	serape	tape
arid	dairy	escaped	pest	ret	seraph	taped
arise	dais	escapes	pester	retch	set	tapes
aside	dare	ester	pesters	rets	sets	taps
asp	dares	esters	psi	rid	side	tar
aster	date	eta	race	ride	sir	tare
asters	dater	etch	races	rides	sire	tares
ate	dates	ides	rad	rids	sires	tars
cad	depth	irate	raid	rise	sirs	tea
cads	desire	ire	raids	sac	spa	teach
cap	desires	ires	raise	sacs	space	tear
cape	despair	pace	raised	sad	spacer	tears
caped	despairs	pacer	rap	said	spaces	teary
capes	despatch	pacers	rape	sap	spade	teas
caps	diary	paces	raped	sari	spar	tease
car	die	pact	rapes	sat	spare	teased
care	dies	pacts	raps	sate	spares	tsar

Appendix G

Practice Frame Opponent Words

Practice Frame 1	Practice Frame 2	Practice Frame 3
age	alert	arcs
air	aloes	bled
are	bumper	cater
cares	carp	estate
circa	clasper	estated
era	eft	gate
gam	fare	laces
gamier	fort	lag
garlics	loser	laser
gem	oracles	latest
girl	pales	rate
grace	pat	rates
grime	real	ratted
liras	reps	rear
lire	sear	sacs
mailer	sic	settle
mares	slap	statable
mates	slaps	stater
met	sole	stelas
mire	specials	tag
rice	sub	tale
riel	sum	taler
seam	super	tats
serges	tabu	teats
target	taros	treats

Appendix H

Production Frame Opponent Words

Low Task Uncertainty Frames 1-4		High Task Uncertainty Frames					
4 x 4 Square		Star		Donut	Cross	Diamond	
arc	tsar	arc	pits	aerated	aces	adepts	rides
are	upside	ash	raped	are	ached	aery	sac
aside	urea	ate	rapes	ate	acts	aids	sad
audit	used	cape	rash	barrel	alp	air	seraph
cap		caped	rasped	bored	atones	apse	set
care		caps	roc	date	capo	arise	sire
cares		car	rose	laker	cats	care	space
cased		carotid	rots	maps	cheer	cares	spaces
castor		cat	scat	mare	coat	case	spar
cause		cot	scats	opus	coated	cast	spars
crest		cote	sets	parka	cot	caste	staid
crude		cotes	ship	part	cotes	cerise	staph
cruder		cots	soaped	pated	dices	despatch	stare
cuspid		crap	sort	portal	eclat	die	stars
dolts		crape	spar	ram	ere	dies	taped
editor		crapes	spat	raps	estop	dire	teary
eras		craps	spate	rear	free	direct	teas
idea		crate	spit	relater	fret	ease	
idol		depart	stoas	spare	hider	eased	
lodes		dies	straps	spore	ices	eat	
lord		dip	sue	sub	later	erased	
lords		escort	taped	tad	noter	eta	
odes		escorts	tapes	trader	ocher	irate	
opus		gap	taros		ones	ire	
past		gape	tepid		pact	pacer	
pause		gapes	tide		pacts	pacers	
poised		gasp	tie		patcher	pad	
poseurs		gasped	tied		patches	pare	
post		gated	tip		pated	pate	
pure		grape	tips		pates	pest	
rest		graphs	tsar		place	races	
rods		grasp			placid	rape	
rude		grated			plate	raps	
rue		groat			poacher	rapt	
sap		hies			reef	rased	
spared		hips			stone	rasp	
sparse		hit			there	rat	
sparser		oat				rates	
spurs		orate				reach	
stored		part				react	
sucres		parts				reacts	
sued		pasted				read	
sure		pastes				reads	
tide		pastor				reaps	
tides		pate				rets	
told		phi				rid	

Appendix I

PLS Bootstrapping Results

Table 13

Outer Model Weights and Loadings

Output results with Construct Level sign change preprocessing:

Number of cases in full model: 100 Number of samples generated: 500

Number of cases per sample: 100 Number of good samples: 500

	Outer Model Weights:				Outer Model Loadings:			
	Entire sample estimate	Mean of subsample	Standard error	T-Statistic	Entire sample estimate	Mean of subsample	Standard error	T-Statistic
performa:								
PERFORM	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
uncertai:								
UNCERT	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
goal diff:								
GOALDIFF	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
ability:								
ABILITY	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
strategy:								
STRATEGY	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
comitme:								
PRESERIO	0.3787	0.3730	0.0854	4.4367	0.7358	0.7152	0.0948	7.7601
PREEXPEC	0.3364	0.3362	0.0798	4.2164	0.8114	0.7996	0.0616	13.1673
PREREVIS	0.2741	0.2792	0.1323	2.0714	0.3640	0.3667	0.1826	1.9929
PREACHIE	0.4453	0.4283	0.1003	4.4403	0.7829	0.7566	0.1073	7.2948
intensit:								
TIRED	0.5250	0.5339	0.1726	3.0421	0.7146	0.7045	0.1552	4.6046
EFFORT	0.4193	0.4259	0.1082	3.8766	0.7890	0.7716	0.1529	5.1617
HARD	0.3782	0.3271	0.1441	2.6241	0.7774	0.7181	0.1920	4.0480
duration:								
DURATION	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
uncer*di:								
UNCERT*G	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
appropri:								
APPROPST	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000
appro*st:								
APPRO*ST	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	0.0000

Table 14

Path Coefficients

Path Coefficients Table (Entire Sample Estimate)

	performa	uncertai	goal dif	ability	strategy	commitme	intensit	duation	uncer*di	appropri	appro*st
performa	0.0000	-0.2010	-0.0840	0.2730	0.3230	0.0720	0.0690	0.0960	0.0070	0.0590	0.2520
uncertai	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
goal dif	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
strategy	0.0000	-0.1060	0.0000	0.0000	0.0000	0.3030	0.0000	0.0000	0.0000	0.0000	0.0000
commitme	0.0000	-0.0490	-0.0450	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
intensit	0.0000	0.0000	0.0000	0.0000	0.0000	0.4340	0.0000	0.0000	0.0000	0.0000	0.0000
duation	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
uncer*di	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appropri	0.0000	-0.1950	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appro*st	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Mean of Subsamples)

	performa	uncertai	goal dif	ability	strategy	commitme	intensit	duation	uncer*di	appropri	appro*st
performa	0.0000	-0.1788	-0.0581	0.2809	0.3278	0.0761	0.0720	0.0900	-0.0161	0.0663	0.2505
uncertai	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
goal dif	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
strategy	0.0000	-0.0843	0.0000	0.0000	0.0000	0.3100	0.0000	0.0000	0.0000	0.0000	0.0000
commitme	0.0000	-0.0431	-0.0334	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
intensit	0.0000	0.0000	0.0000	0.0000	0.0000	0.4223	0.0000	0.0000	0.0000	0.0000	0.0000
duation	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
uncer*di	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appropri	0.0000	-0.1764	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appro*st	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error)

	performa	uncertai	goal dif	ability	strategy	commitme	intensit	duation	uncer*di	appropri	appro*st
performa	0.0000	0.1000	0.1144	0.0769	0.1327	0.0809	0.0867	0.0611	0.1226	0.0550	0.1600
uncertai	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
goal dif	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
strategy	0.0000	0.0950	0.0000	0.0000	0.0000	0.0875	0.0000	0.0000	0.0000	0.0000	0.0000
commitme	0.0000	0.1217	0.1057	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
intensit	0.0000	0.0000	0.0000	0.0000	0.0000	0.1240	0.0000	0.0000	0.0000	0.0000	0.0000
duation	0.0000	0.0000	0.0000	0.0000	0.0000	0.1034	0.0000	0.0000	0.0000	0.0000	0.0000
uncer*di	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appropri	0.0000	0.0977	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appro*st	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	performa	uncertai	goal dif	ability	strategy	commitme	intensit	duation	uncer*di	appropri	appro*st
performa	0.0000	-2.0110	-0.7344	3.5518	2.4332	0.8905	0.7954	1.5724	0.0571	1.0736	1.5755
uncertai	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
goal dif	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
strategy	0.0000	-1.1155	0.0000	0.0000	0.0000	3.4644	0.0000	0.0000	0.0000	0.0000	0.0000
commitme	0.0000	-0.3943	-0.4258	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
intensit	0.0000	0.0000	0.0000	0.0000	0.0000	3.4999	0.0000	0.0000	0.0000	0.0000	0.0000
duation	0.0000	0.0000	0.0000	0.0000	0.0000	0.1933	0.0000	0.0000	0.0000	0.0000	0.0000
uncer*di	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appropri	0.0000	-1.9957	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
appro*st	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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