THE EFFECTS OF FEEDBACK FREQUENCY AND GOAL SETTING ON DATA PROCESSING PERFORMANCE

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Dissertation submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

DOCTOR of PHILOSOPHY

in

Psychology

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December 1986

Blacksburg, Virginia

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(ABSTRACT)

Electronic surveillance of employee performance is a common practice in the workplace today. Despite the fact that electronic monitoring is an inexpensive and objective technique for recording productivity figures, much resistance to the technique exists.

The current study was conducted to determine if user acceptability and productivity could be improved in performance monitoring systems. It was hypothesized that frequent performance feedback would enhance productivity and task satisfaction as long as the feedback was not too frequent and the performance standard was not too difficult.

The results of this experimental investigation did not support this hypothesis indicating that productivity (in terms of the amount of data entered into computer files) was actually higher when the performance standard was difficult and the performance feedback frequent. In addition, subjects assigned to the Difficult Goal/Frequent Feedback condition were more satisfied with the task and per-

formance feedback than other subjects. Results are discussed in light of current viewpoints in applied psychology and human-computer interaction.

ACKNOWLEDGEMENTS

I would like to express sincere appreciation to my committee chairman and advisor, Dr. E. Scott Geller for his skillful guidance through the course of this project. His expertise, support, encouragement, and friendship during the last four and a half years have contributed immeasurably to my professional development.

Gratitude is also extended to the other members of my committee: Drs. John Casali, Roseanne Foti, Joseph A. Sgro, and Robert C. Williges. Their keen insight and helpful suggestions contributed significantly to this research. I would also like to thank Drs. Gene Stone and Shanta Kerkar for their valuable contributions during the early phases of this study.

One of the best experiences during my graduate school years was the cultivation of many rewarding friendships in the lab. I will greatly miss the many stimulating discussions that I shared with

and others. Perhaps someday we'll all be together again making a difference.

I would also like to extend heartfelt thanks to and for their support and friendship during these last four and a half years. I will miss the great fun we had together. In addition, I am indebted to for providing expert advice on many segments of this research as well as taking photographs of many portions of the study materials.

Finally, I would like to acknowledge the most important person in my life, my wife . Her love, support, encouragement, and (above all) patience has made everything worthwhile.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

More than 13 million Americans use computer terminals in their job today and the number of terminal users is expected to triple by the end of the decade (Koepp, 1986). With the use of computer technology, more businesses than ever are turning to software engineers for the development of software systems that not only facilitate overall productivity but also monitor the performance of their employees (Tobin, 1985). The U.S. Labor Department estimates that nearly two-thirds of the 13 million workers using video display terminals (VDTs) are electronically monitored in their work (Sheridan, 1986).

The exact technique of monitoring depends on the job to be supervised, but monitoring requires only the installation of specially written software into the central computer that handles the work of many individual users. Thus equipped, the master computer will not only process information from each employee's terminal, but also measure, record, and tabulate dozens of details about how efficiently the worker is putting information into the machine.

Airline-reservation computers, for example, closely measure how long individual clerks take to handle each customer and the amount of time the employee spends between calls. The computer can take note of any idle moment and measures lunch hours, coffee breaks, and even trips to the bathroom (Archer, 1986). At grocery stores, some optical scanners not only ring up prices but also tell a central computer how many items per minute a clerk is handling. In data processing offices, a data-entry typist's every keystroke can be recorded. Even in

industries where employees operate complex electronic machine tools rather than keyboards, computer systems can monitor the equipment and alert management about slow or absent workers. Many workers, particularly the hardest working ones, prefer the new evaluative technique because they see it as a matter-of-fact measurement of their output as opposed to a boss's subjective personal opinion (Henriques, 1986). Managers often see these monitoring programs as a means of making better, quicker decisions based on facts, not emotions.

The move toward electronic supervision has ignited a boom for performance monitoring software (Koepp, 1986). For example, one program called AUDIT® records and instantaneously evaluates every single keystroke by a data entry operator. Often companies use monitoring software to reward positive performance for new and veteran workers. For example, a Ford Motor plant in Ohio keeps a running record of absenteeism and perfect attendance can bring a prize of $500. Unfortunately not all applications of this technology produce beneficial effects among workers.

The pressure of being monitored every second can sometimes produce undesirable side effects among employees. For example, Pacific Southwest Airlines recently implemented a performance monitoring system where the master computer records exactly how long reservation clerks spend on each call and how much time elapses before they pick up their next one. Workers earn infractions for repeatedly spending in excess of 109 seconds on any one call. Employees earning 37 infractions can lose their jobs. Negative reaction to the system has

been strong. So strong, that a number of PSA workers have taken disability leave because of the increased level of work stress produced by the system (Archer, 1986). Another software package berates newly hired job trainees with messages that say "You're not working as fast as the person next to you".

The landmark study on stress among clerical workers using VDTs was conducted by researchers for the National Institute of Occupational Safety and Health (NIOSH) in 1981 among 250 professional and clerical VDT operators (Smith, Cohen, Stammerjohn, & Happ, 1981). The findings indicated that clerical VDT operators identified stress problems almost identical to those affecting machine-paced (assembly line) workers. In particular, workers complained about too great a work load, too great a pace, with little individual control over job autonomy or career decisions.

Labor groups have gone on the offensive against electronic monitoring. More than 20 unions, including autoworkers and communications workers, have negotiated provisions in their contract to limit the practice. Indeed, in late 1984, a labor conference held in Geneva, Switzerland, co-sponsored by the International Confederation of Free Trade Unions and 14 international secretariats of unions representing VDT workers, set guidelines for VDTs. Among the guidelines adopted was one opposing all automatic performance and behavior monitoring of VDT operators. "No [VDT-based] system should be used to collect or store individually identifiable arrival or departure times, work breaks, keyboard speeds, corrections made, or other performance or behavior-related data"

(Sheridan, 1986, p.52). In the last two years, bills have been introduced in seven states that would prohibit computer monitoring (Henriques, 1986).

Despite this resistance to the use of electronic monitoring for job performance, the fact remains that for jobs in which productivity depends largely on dealing with data in a fairly routine way, computers accurately and fairly record individual productivity figures. Furthermore, monitoring also helps to establish fair performance expectations and saves vast numbers of managerial hours by tabulating production automatically.

Vico E. Henriques, president of the Computer and Business Equipment Manufacturers Association and an expert on electronic performance monitoring, suggests that to prevent computer monitoring from being used in an irresponsible and thoughtless manner, the following guidelines be followed:

- Employees should know they are subject to monitoring and that the statistics produced will be used in performance evaluation,
- The period over which employees are monitored should be long enough to allow for normal up-and-down energy cycles, and
- Employees should have access to their personal statistics and be provided with *regular feedback regarding their performance* [italics added] (Henriques, 1986, p. 14).

It is clear that many electronic monitoring systems have ignored important psychological considerations in their design and implementation. Problems of user

acceptance and productivity could be attenuated or even avoided through the application of principles derived from research in the area of applied motivation theory and human-computer dialogue. The purpose of this study is to investigate some of the parameters which would not only improve performance under such systems but also impact user's acceptability and satisfaction with performance monitoring software.

It was hypothesized that two components which may be very important in improving the performance of data processing operators are: 1) frequent and regular feedback regarding data processing performance and 2) challenging, yet attainable production standards. Most performance monitoring software designers do not use these principles when designing their software. In fact, operators often receive no feedback regarding their day-to-day performance; instead they are reprimanded or rewarded when their bi-weekly or bi-yearly performance evaluations occur. Thus, it is not surprising that persons consider their working conditions to be less than satisfactory under such systems.

The main question of interest was whether frequent feedback in conjunction with a specific performance goal will increase performance in a data processing task. A secondary question was what feedback schedule will result in optimal performance when combined with a performance goal. In other words, can performance feedback that is too frequent be detrimental under certain goal-setting conditions?

To date, no study in the psychological literature has examined the interactive effects of frequent response feedback and goal difficulty in free-responding situations (such as data processing). The aim of the present study was to investigate systematically the effects on data processing of different frequencies of performance feedback and different goal difficulties. A review of the applied psychological literature indicated that frequent feedback and difficult, specific performance goals, in most cases, provide for optimal levels of performance (Locke, Shaw, Saari, & Latham, 1981; Tubbs, 1986). However, with too frequent feedback and too difficult a performance goal, the literature indicates that an individual's perceptions of control over the task may diminish as a function of excessive feedback; and as a result, a decline in performance results (Ilgen, Fisher, & Taylor, 1979).

The remainder of this paper takes the following form. First, relevant literature addressing this problem is reviewed. Second, a rationale is presented for the hypothesized relationships between the variables to be studied. Then, empirically testable hypotheses are presented regarding the effects of performance goals and feedback on task performance. Next, a method for testing these hypotheses is provided and finally, results are presented and these outcomes discussed in terms of their practical significance and stimulation of future research.

Goals and Feedback

According to Locke (1968), a goal is what an individual is trying to accomplish; it is the object or aim of an action. The concept is similar in meaning to the

concepts of purpose and intent (Locke, 1969). Other frequently used concepts that are also similar in meaning to that of goal include *performance standard* - a measuring rod for evaluating performance, *quota* - a minimum amount of work or production, *work norm* - a standard of acceptable behavior defined by a work group, *objective* - the ultimate aim of an action or series of actions, *deadline* - a time limit for completing a task, and/or *budget* - a financial goal or limit, (Locke et al., 1981). The basic assumption of goal-setting research is that goals are immediate regulators of human action. However, a one-to-one correspondence of goals and action is not assumed because people may make errors, or lack the ability to attain their objectives (Locke, 1968).

Over the past several decades, substantial knowledge has accumulated regarding the positive effects of setting goals as a powerful motivational technique for improving task performance (Locke et al., 1981; Tubbs, 1986). A survey of this literature, referred to as goal theory, indicates overwhelming support for the effectiveness of goal setting in motivating task performance in both laboratory (e.g., Erez & Zidon, 1984; Locke, Frederick, Lee, & Bobko, 1984) and field (e.g., Kim, 1984; Latham & Baldes, 1975; Latham & Kinne, 1974) settings, and across a wide range of performance tasks and behaviors (Locke et al., 1981). Indeed, it seems safe to agree with Locke and his colleagues that "the beneficial effect of goal setting on task performance is one of the most robust and replicable findings in the psychological literature" (1981, p.145).

As a result, interest in goal theory has flourished in the last decade as evidenced by the fervent investigation of many boundary conditions of the goal-setting phenomenon. For example, recent studies have investigated the effects of self-set goals on task performance (e.g., Latham & Steele, 1983), the importance of goal acceptance (e.g., Frost & Mahoney, 1976; London & Oldham, 1976), and the role of task strategies on goal choice and task performance (Bandura & Simon, 1977; Terborg, 1976).

Personality and demographic variables have also received attention in the goal-setting literature, with researchers investigating the moderating effects on the goal setting process of gender, education (Ivancevich & McMahon, 1977; Latham & Yukl, 1975), and job tenure (Latham & Yukl, 1976; Steers, 1975). Other studies have investigated the role that personality differences play in moderating the effects of goal setting. For instance, personality variables such as need to achieve (Steers, 1975), need for independence (Latham & Yukl, 1976), and self-esteem (Dossett, Latham, & Mitchell, 1979; Yukl & Latham, 1978) have been investigated as determinants of the goal setting phenomenon.

Goals Only

In general, research has indicated that specific, challenging goals lead to higher output than do vague, easy goals, such as "do your best." However, early studies (mid-1960s) made little attempt to separate the effects of feedback from the effects of goal setting in order to determine if goal setting directly influences performance or whether the effects are mediated by feedback. More recent

studies have attempted to partition the effects of goal setting and response feedback.

Becker (1981) investigated the effects of feedback and goal setting on performance in a field study of residential energy conservation. Eighty families were asked to set a goal to reduce their residential energy consumption for several weeks during the summer, half of them by 20% (a difficult goal) and half by 2% (an easy goal). Within each of these groups, half of the families were given feedback three times a week about their consumption. The results indicated that the 20%-feedback group conserved the most energy (13.0%-15.1%) and was the only one that consumed significantly less electricity than a control group. The goal groups that received no feedback regarding their energy consumption did not differ significantly in energy consumption than the control group.

Strang, Lawrence, & Fowler (1978) examined the effects of feedback and assigned goals on arithmetic computation. One hundred female university students either received or did not receive explicit feedback while under easy or challenging goal assignments. A control group (n = 50) received neither feedback nor goal assignments. Subjects receiving performance feedback under a challenging goal assignment significantly increased their computational speed at no apparent cost in accuracy. Using time to finish as a criterion, there were no differences between the performance of the goals-only subjects and the control subjects. In terms of number of errors, however, the control group's performance was significantly

better than that of the goals-only group, suggesting that goals without performance feedback may even inhibit accurate performance.

In a case study of the positive effects of industrial behavior modification ("At Emery Air Freight", 1973), employees in the customer service department and on the shipping docks at Emery Air Freight were given a group-performance goal. Progress toward the goal was posted and each employee kept a personal record of performance. Performance levels increased markedly, but when the performance feedback was removed and self-reports were not kept, employee performance returned to baseline levels. Through the implementation of this program, Emery Air Freight realized an annual saving of $650,000.

Summarizing the results of these studies, it is concluded that an individual needs both feedback and goals to perform at high levels. A difficult goal alone will not have an optimum effect on performance. The next section reviews in more detail the interactive effect of performance feedback and goal setting on work performance.

Feedback and Goal Setting

Locke et al. (1981) reviewed a number of studies which examined the effects of feedback on goal-setting. One set of studies consisted of comparisons between: (1) a specific, difficult goal and feedback condition, (2) a feedback condition with no goals, and (3) a no goals and no feedback condition (Bandura & Simon, 1977; Latham, Mitchell, & Dossett, 1978; Nemeroff & Cosentino, 1979). In general,

these studies indicated that feedback without goals does not improve performance to the extent as feedback *in combination with* goals.

More recently, Erez (1977) examined the effects of feedback and self-set goals on performance. Using a multiple regression analysis where the variables were entered in a step-wise fashion, Erez found that the Feedback-Goal interaction significantly increased variance explained over and above the previously entered main-effect variables of feedback and goal setting alone. The goal-performance correlation was .60 in the feedback group and .01 in the no feedback group. These findings led Erez to conclude that feedback is necessary for goals to affect performance.

Given Erez's findings, Locke et al. (1981) concluded that both feedback and goals are necessary to benefit performance. However, Locke et al. indicated that the literature lacks a definitive study regarding the importance of feedback in the goal setting paradigm (1981, p.133).

Since the Locke et al. review, a more recent study of the combined effects of feedback and goal setting was conducted by Matsui, Okada, and Inoshita (1983). In a laboratory experiment, Matsui et al. assigned subjects to either a hard goal condition or an easy goal condition in which subjects solved arithmetic problems for ten minutes. Halfway through the exercise, subjects received feedback regarding their progress. To the extent that goal progress was low, subjects felt less satisfied, more involved, and worked faster than they had previously. In addition, it was suggested that these subjects expended more effort than those subjects in

the high progress group. These results led Matsui et al. to conclude that the beneficial impact of feedback on performance was a negative function of goal progress. The authors suggested that this finding may explain previous findings, where only hard goals and feedback benefitted performance compared with conditions of either easy goals and feedback or hard goals and no feedback. Since the no feedback condition may not provide exact knowledge of progress, subjects who were low in progress could not correct their performance.

Other recent studies have focused on generalizing the phenomenon of the feedback-goal setting relationship to organizational settings. For example, Reber and Wallin (1984) evaluated the possible reciprocal relationship of feedback and goal setting in a farm machinery manufacturing plant. Citing previous field experiments that confounded feedback and goal setting, Reber and Wallin attempted to conduct a "pure" test of the effects of goal setting and knowledge of results. A multiple baseline design was employed consisting of a total of four phases: (1) baseline, (2) training only, (3) training and goal setting, and (4) training, goal setting and knowledge of results. An analysis of variance revealed significant main effects for both goal setting and feedback. The authors concluded that feedback plus goal setting improves performance more than does goal setting alone (p. 557).

In another recent field experiment, Kim (1984) investigated the effects of goal setting, behavioral feedback, and outcome feedback on performance. Outcome measures included "sales in dollars per hour", whereas behavioral measures in-

cluded "greeting customers," "determining customer needs," and "suggestive selling." Kim hypothesized that goal setting and feedback involving the behavioral measures in addition to the outcome measure would have a higher positive impact on performance than that involving either behavioral or outcome feedback alone. The study was conducted in a large, non-union, retail organization where one group received goal setting and behavioral feedback, a second group received goal setting and outcome feedback, a third group received goal setting and both forms of feedback, and a control group received neither goal setting nor any type of feedback. Kim found that groups receiving both behavioral and outcome feedback simultaneously performed better than groups receiving either behavioral or outcome feedback alone. The author suggested that this effect may be due to an increase in subject's commitment (Salancik, 1977) when both behavioral and outcome feedback are provided (p. 147).

Despite this recent research regarding the role of feedback in goal setting, experimental studies investigating dimensions along which feedback can vary (such as amount, type, specificity, timing, source, sign, and recency) are still lacking (cf. Ilgen, Fisher, & Taylor, 1979; Locke et al., 1981; Prue & Fairbanks, 1981). Indeed, a recent meta-analysis of the goal-setting literature indicated that few well-designed studies have investigated the feedback/goal-setting relationship in depth, even though it is assumed to be a generally accepted phenomenon (Tubbs, 1986).

One parameter of the goal-setting/feedback effect which has not been investigated is that of performance feedback frequency. Specifically, it is not clear how

frequently performance feedback should be provided in a goal-setting paradigm in order to optimize performance. What follows is a review of studies investigating the effects of feedback alone in improving performance.

Performance Feedback

Like information theory and the theory of signal detection, feedback theory has its roots in engineering, in particular, that branch of mechanical engineering known as control theory (Moray, 1981). Formally, a system is said to contain a feedback loop when the output of that system interacts with its input in such a way as to modify the subsequent activity of the system as it continues to generate an output. The actual output of the system is compared with the desired output. If there is a discrepancy between them, the sign and magnitude of that discrepancy is used to modify the output so as to reduce the discrepancy. The desired output functions as a goal which the system tries to attain, a criterion toward the satisfaction of which the system strives. The system as a whole is oriented toward the future rather than toward a past stimulus (Moray, 1981).

In general, there are two types of feedback (Annett, 1969). Intrinsic feedback or proprioceptive feedback is that which is normally present in a person and is not often subject to experimental manipulation. For example, driving a car and keeping the vehicle on the roadway is an example of a task with abundant intrinsic feedback. When the driver approaches the edge of a roadway, he can see that his vehicle is not traveling along the desired path. He has made a steering error. As he corrects this error he can see whether he has compensated correctly,

overcompensated, or undercompensated. The driver receives natural sight and touch feedback from the task itself.

In contrast to intrinsic feedback, extrinsic or augmented feedback is feedback that is provided to the subject or operator through artificial means. For example, providing a runner or swimmer with his or her lap times is an example of presenting augmented feedback.

Feedback is assumed to serve two functions: 1) the direction of behavior through information and 2) a reinforcement (or punishment) function (Ilgen, Fisher, & Taylor, 1979). Whether feedback serves in an informational role or reinforcement role has been an issue of debate for years (e.g., Annett, 1969; Bilodeau & Bilodeau, 1969; Gray, 1979; Komaki, 1980; Locke, 1977; 1979; 1980, Newell, 1976). While it is not the purpose of this paper to engage in paradigm debates, it is unlikely that feedback plays simply a reinforcing role in influencing performance. Specifically, although performance feedback may be reinforcing (i.e., increases the frequency of behavior), it is conceptually distinct from reinforcement, per se. The reason, of course, is that information fed back can also serve to reduce the frequency of behavior, thereby qualifying for the formal definition of punishment in some situations. Thus, it is best to think of feedback as serving an informational *and a consequence* function.

The influential effect of feedback on performance is one of the best established findings in psychology (Ammons, 1956; Annett, 1969; Bilodeau & Bilodeau, 1961; Prue & Fairbanks, 1981). Indeed, no study has shown that ac-

quisition of skill can occur without some form of feedback (Newell, 1976). Furthermore, the applied literature is replete with studies showing the beneficial impact of feedback techniques for improving performance. For example, feedback has been shown to be effective in improving food preparation sanitation of cafeteria workers (Geller, Eason, Phillips, & Pierson, 1980), decreasing truck turnaround time in materials transportation (Runnion, Johnson, & McWhorter, 1978), improving worker performance associated with machine-paced tasks (Frost, Hopkins, & Conrad, 1981), decreasing delays in appraising and reporting automobile damages by automobile appraisers (Rowe, 1981), and improving employee safety Hopkins et al. (1986). Other studies have examined explicitly the role that different levels of feedback frequency can have on performance.

Frequency of Feedback Alone

In general, studies investigating frequency of feedback alone have indicated that frequency of feedback is positively correlated with improvements in task performance (Ilgen, Fisher, & Taylor, 1979). In one of the earliest laboratory studies investigating the role of feedback frequency in improving performance, Bilodeau and Bilodeau (1958) varied both absolute (total number of feedback presentations) and relative frequency (feedback for some but not all responses) in a simple tracking task. The results indicated that performance was independent of relative frequency and a direct function of absolute frequency. The authors

concluded that more frequent feedback lead to greater improvements in performance.

In an applied study, Hundal (1969) assessed the pure effects of knowledge of results in a repetitive industrial task. He found a direct relationship between the frequency of accurate information regarding task output and workers' rate of output.

In another study, Cook (1968) showed that attitudes and performance results of participants in a business simulation were directly related to the frequency of feedback on performance. Specifically, she found that interest in and satisfaction with the task, as well as actual performance, were highest for the group receiving feedback on a quarterly basis during the simulation as compared to the group that received feedback on an annual basis, or a group that received no feedback at all.

In a study investigating the effects of a management by objectives (MBO) program at two large industrial organizations, Ivancevich, Donnelly, and Lyon (1970) found that the MBO group that received the highest frequency of performance feedback also perceived higher levels of need satisfaction. Unfortunately, actual performance levels was not one of the dependent variables in the study.

Komaki, Barwick, and Scott (1978) investigated the effects of frequent, low-cost feedback on the practice of safety behaviors in a food manufacturing plant. The authors found an increase in safety performance for the employees, from a

baseline rate of 74% to 98% during the feedback condition. Unfortunately, behavioral training was also provided during the feedback condition, thus confounding the feedback intervention and frequency of feedback during the baseline phase.

In another investigation by Komaki and her colleagues (Komaki, Heinzmann, & Lawson, 1980), feedback was provided either on a daily basis or three times a week. In this case, performance was higher when feedback from supervisors was provided on a daily basis as compared to when the feedback was provided only three times per week. The authors indicated that the frequency with which feedback was provided was a critical factor in the study and suggested that "a systematic investigation of frequency of feedback would benefit future programs in work settings" (p. 268).

In spite of the general support for the position that frequent feedback facilitates task performance, some theoretical models and empirical evidence suggest that this relationship may not always occur. Chapanis (1964) presented subjects with a repetitive digit punching task and then provided them with varying levels of feedback. Despite varying levels of performance feedback, no differences were found between groups. Chapanis suggested that the results may have been obtained because the importance of feedback lies in its informational value, and since frequent feedback in mundane tasks seldom produces increments in information over the last information presentation, no improvement in performance resulted.

It seems to this author that there may be instances in which increasing the frequency of feedback presentations may not only fail to improve performance but may actually be detrimental. For example, in cases where goal attainment is nearly impossible, as is the case in some production tasks, very frequent feedback could serve to instill a sense of learned helplessness, thus leading to decrements in performance (Maier & Seligman, 1976; Seligman, 1975). In this case, feedback would serve a punishing function rather than a reinforcing function. The next section outlines the role of perceptions of learned helplessness in moderating the feedback-performance relationship.

Learned Helplessness

The term "learned helplessness" was originally used by Overmier & Seligman (1967) to interpret their observation that dogs exposed to inescapable/unavoidable shock in a restraining harness were later retarded in learning a shuttle-box avoidance task. Unlike dogs not previously exposed to uncontrollable shock, these animals initiated few attempts to escape the shock (motivational deficit). Indeed, they were not likely to follow an occasionally successful response with another (learning or cognitive deficit) and did not evidence much overt emotionality while being shocked (emotional deficit).

These deficits were interpreted in cognitive terms (Maier, Seligman, & Solomon, 1969; Seligman, Maier, & Solomon, 1971). During exposure to the electric shocks, the dogs learned that shocks were independent of responses. Re-

gardless of what the dogs did or did not do, the shocks occurred. This learning was represented as an expectation of future response-outcome independence that was generalized to new situations to produce the observed effects.

Learned helplessness has also been demonstrated with human subjects (e.g., Albert & Geller, 1978; Gatchel, Paulus, & Maples, 1975; Gatchel & Proctor, 1976; Krantz, Glass, & Snyder, 1974; Thornton & Jacobs, 1971; Thornton & Jacobs, 1974). Experimental studies with humans usually paralleled in experimental design those studies with animals. For example, Hiroto (1974) presented one group with aversive loud noise which it could escape by button pressing. A second group received inescapable noise, and a third group received no treatment. All groups then received controllable noise in a two-way shuttlebox. As with animals, the inescapable group tended to sit and take the noise without responding, while the escape and no pretreatment groups escaped readily. In other studies, subjects have been tested in the post-treatment condition with situations different from those received during the condition. For example, Hiroto & Seligman (1975) trained their subjects in instrumental helplessness using aversive noise and then tested them with insoluble cognitive tasks. Usually different post-treatment tasks are used to test the generality of the debilitation produced by the learned helplessness phenomenon.

Perceived personal control is a concept closely related to that of learned helplessness and refers to the extent to which an individual feels he or she has chosen freely to emit some behavior or set of behaviors. It is a psychological

construct reflecting an individual's beliefs at a given point in time, and reflects one's ability to effect a change on the environment in a desired direction. Personal control is highest when individuals engage in a behavior solely because they like to engage in the behavior (Greenberger & Strasser, 1986).

According to Deci's cognitive evaluation theory (1975), it is believed that as feelings of personal control increase, intrinsic motivation will increase as well. Ilgen et al. (1979) hypothesized that frequent feedback is beneficial up to the point that the person perceives his behavior to be externally controlled. At this point, motivation should decrease, feelings of helplessness increase, and a performance decrement should result. The basis of this view is that when an individual's behavior is monitored more often, the individual will feel particularly controlled by the external environment, and as a result, the individual will perceive a loss of personal freedom.

Reactance theory (Brehm, 1966) also predicts that if a person perceives a loss of control, motivation to perform decreases. Brehm suggests that when individuals experience a loss of control, they are motivated to renew attempts at mastery of the task. When persons attempt, but are unable to regain control over task events, then these persons eventually will become convinced that the outcomes cannot be controlled by their actions. Wortman and Brehm (1975) suggest that if the behaviors are beyond control, helplessness will occur and the motivation for control will cease.

With respect to a goal setting paradigm, this author suggests that up to a point, frequent feedback will not adversely affect feelings of personal control. Thus, task performance will not be hindered but actually facilitated, regardless of the goal level. However, it is hypothesized that with very frequent feedback related to very difficult (nearly unattainable) goals, the individual will experience helplessness and a loss of personal control since the frequent feedback is providing the individual with evidence that he/she is not meeting the task demands. Thus, a person's perceptions of personal control and performance would be expected to be at its lowest level when goals are difficult and feedback is frequent. In effect, rather than motivating performance, feedback is serving as a punisher for continued task vigilance. Put another way, it is suggested that goal difficulty moderates the relationship between frequency of feedback and intrinsic motivation.

Previous Research

This section details the sole study prior to the current research which attempted to investigate the relationship between feedback frequency, goal difficulty, and learned helplessness.

In a field experiment, Chhokar and Wallin (1984) provided 58 male machine shop employers with a training and goal setting treatment package in an attempt to increase the frequency of safe work behaviors (such as materials handling and housekeeping). The training consisted of showing workers slides of safe and unsafe ways of performing various activities. The researchers then set a specific,

difficult, yet attainable goal of "95% safe behaviors" as measured by a behavioral observation scale. This intervention package (i.e., training plus goal setting) increased performance from a baseline of 65.2% to 80.9% safe behaviors. The next phase consisted of a feedback condition juxtaposed on the training and goal setting package. Specifically, weekly average safety performance was posted in a public area once a week for seven weeks. This additional intervention increased safety performance to an average of 94.6%. In a third sequential treatment condition which lasted four weeks, the frequency of feedback was reduced to once every two weeks with everything else remaining the same. The percentage of safety behaviors increased to a mean of 96.8% during this condition. In a fourth treatment phase lasting five weeks, feedback was withdrawn completely but training and goal setting were continued. Average safety performance during this condition fell to 89.1%. During a final intervention phase lasting nine weeks, feedback was reinstated once every two weeks along with the training/goal-setting package. Average safety performance during this period rose to 93.9%. The authors concluded that the frequency at which feedback is presented in a goal-setting paradigm does not make a difference in regard to its effects on performance.

It is the position of this author that the findings of this study can be questioned on both conceptual and methodological grounds. Specifically:

1) The authors' finding that there was little difference in performance between weekly and biweekly feedback may have been a result of poor instrumentation

or ceiling effects. Specifically, no effects may have been found with more frequent feedback simply because there was so little room for improvement. This is the most serious problem with this study.

2) Since there was no return to a non-goal setting/training baseline, the results obtained in the study may be a function of some historical event (e.g., a new company president who emphasizes safety, Cook & Campbell, 1979). In addition, this type of design does not allow for the ruling out of any carry-over effects from one condition to the next.

3) It is likely that a "confounding of constructs and levels of constructs" occurred (Cook & Campbell, 1979). Specifically, this type of experimental confound occurs when an experimenter concludes that intervention A has no effect on dependent variable B when, in fact, A-at level-one does not affect B, whereas A-at-level-four might well have affected B if the experimenter had manipulated A as far as level four (p.67). In the context of this experiment, it may be that to see an effect, subjects would have had to receive feedback on a daily or hourly basis rather than on a once-a-week basis. The best control for this threat is to conduct parametric research in which many levels of the independent variable (*viz.*, feedback frequency) are manipulated.

4) Another problem is in regard to the manipulation of goal setting. Although the study was presented in a goal setting paradigm, in actuality, only one goal level was presented and this presentation was confounded with the simultaneous presentation of training. Specifically, to obtain a veridical measure of the effec-

tiveness of goal setting in motivating performance, many levels of goal difficulty should have been manipulated and this manipulation should have occurred independently of the training intervention. Thus, it is simply incorrect to argue that this investigation provided for a true test of the effects of frequency of feedback and goal setting on task performance.

5) Another major threat to the internal validity was the implementation strategy for the frequency of feedback conditions. That is, it may be that the treatments were unobtrusive to the subjects. The subjects may not have perceived any difference in the frequency of feedback (from once a week to once every two weeks), particularly if they were not prone to observe the public feedback board on a regular basis. In fact, Chhokar and Wallin indicated that subjects did have trouble in discriminating between the different feedback frequency conditions (p. 527-528).

In general, it is concluded that the Chhokar and Wallin study was not a particularly strong test of the relationship between frequency of feedback, goal setting, and task performance because of the presence of numerous threats to internal and external validity.

Advantages of the Present Study

Given that the Chhokar and Wallin study is the only published study to date which attempted to test the moderating effect of feedback frequency on the goal-performance relationship, it is evident that further research is needed regarding this important practical question. This author suggests that a more ap-

propriate test of this relationship should occur in a laboratory setting, where a high degree of experimental control can be maintained and variables can be reliably manipulated (cf. Fromkin & Streufert, 1976). Indeed, when the goal of the research is to test predictions about what ought to happen (as in this case) rather than to "generalize to the real world," the laboratory is the more appropriate place for the research. (Mook, 1983). In this case, a laboratory study provides a cost-effective means for determining if hypothesized relationships occur and further research is worth pursuing. Once reliable effects are found, field studies can be conducted to test the generalizability of the findings.

A laboratory-based, data-processing task lends itself readily to an investigation of the effects of feedback frequency and goal setting on performance. First, computer object code can be generated to provide reliable feedback and goals on a standardized basis, thus eliminating any possible confounds resulting from the unreliable implementation of the independent variables. Second, experimenter expectancy effects (Rosenthal, 1966) can be eliminated since the task can be completely automated in a free-responding situation. There is no need for an experimenter to intervene, provide feedback, and potentially bias a subject's performance. Indeed, a number of researchers have indicated that since augmented feedback from a computer-driven task itself is simple, direct, and impersonal, it seems to be a more powerful means of providing motivating information than is feedback received from personal sources (Ilgen, Fisher, & Taylor, 1979; Ivancevich & McMahon, 1982). In addition, the potential for confounding feed-

back frequency with feedback sign (sign refers to whether the feedback is provided in a positive or negative manner) and feedback specificity (specificity refers to how detailed the feedback information is) is eliminated since these dimensions can be controlled via the type of message displayed. Finally, since data-processing is a task germane to any business environment, high levels of "mundane realism" (Berkowitz & Donnerstein, 1982) can be maintained even though the study is conducted in a laboratory environment.

Study Overview and Hypotheses

The purpose of the present experiment was to investigate the effects different levels of goal difficulty and feedback frequency n data-processing performance with a 3 (Goal Difficulty: Hard, Medium, Easy) x 3 (Feedback Frequency: Feedback delivered after 15, 30 or 120 sec of work) fully randomized experimental design. Specific hypotheses are:

Hypothesis 1a: Based on the goal setting literature, an increasing monotonic relationship will be found between levels of goal difficulty and task performance (Locke et al., 1981).

Hypothesis 1b: Based on the feedback frequency literature, a direct monotonic relationship will be found between feedback frequency and task performance.

Hypothesis 2: A significant interaction will occur between the factors of feedback and goal setting. That is, in addition to specific, hard but

attainable goals, feedback is needed to perform at high levels. Either feedback or a hard goal alone will not have the optimal effect on performance.

Hypothesis 3: Based on the learned helplessness literature, it is hypothesized that the power component of feedback frequency will significantly increase explained variance above and beyond the linear combination of the two main effects of feedback frequency and goal setting and their interaction. In this case, the values found for the feedback frequency variable are raised to a power of two to show a quadratic (parabolic) relationship between feedback frequency and performance. Specifically, it is predicted that the effect of varying levels of feedback on performance will be in the form of an inverted-U function, with more frequent feedback improving performance until an optimal level of feedback is reached (as determined by pilot studies). At that point, however, greater frequencies of feedback will lead to decrements in performance.

Hypothesis 4: Finally, it is hypothesized that goal difficulty will moderate the effect of the frequency of feedback power component. That is, performance decrements will be greater in conditions of very frequent feedback and very difficult goals than in conditions when feedback is frequent but the goals are easy.

Figure 1 illustrates these hypothesized effects.

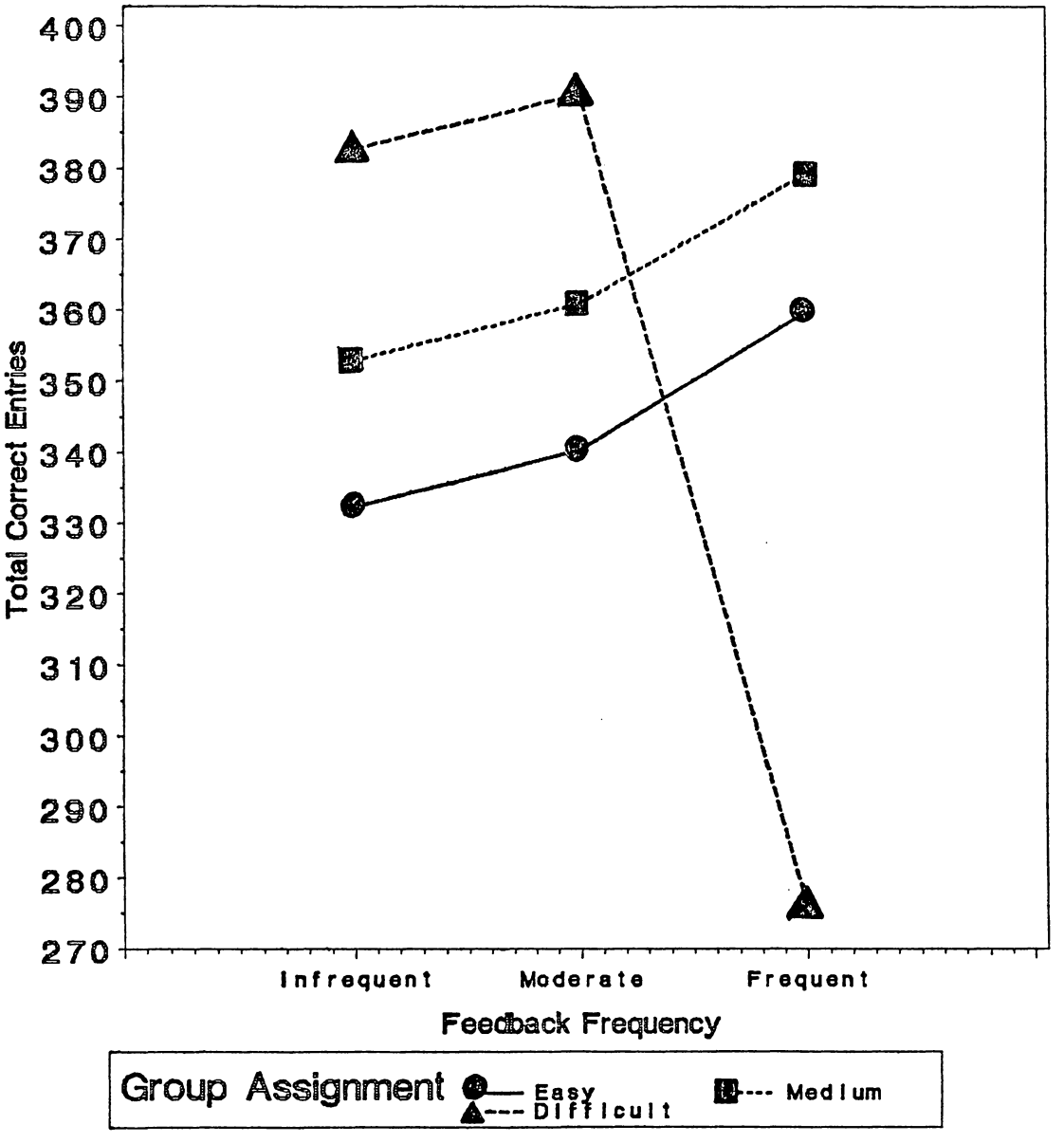

Figure 1. Proposed results for 35-minute typing test.

Method

Overview of Design

The present research employed a 3 (Goal Difficulty: Easy, Medium, Difficult) x 3 (Feedback Frequency: Feedback delivered after 120, 30 or 15 sec of work) completely randomized factorial design. Subjects performed a data-processing task for 35 min, during which time they received feedback regarding progress toward their assigned goal. The data processing task consisted of typing zip codes into a data file. After the 35-min typing task, subjects participated in the same data-processing task for 10 min, this time without receiving either feedback or goal information. Following the 10-min data-processing task, subjects were then given a three min anagram test, and directly following the anagram test, subjects completed a five-item questionnaire querying them on their perceptions of the usefulness of the feedback and their satisfaction with the task. The 10-min typing task and the anagram test were administered to assess whether learned helplessness had occurred as a function of the 35-min typing task for those subjects in the very frequent feedback condition with a difficult goal.

Power Analysis

A power analysis was conducted prior to the beginning of the study (Cohen, 1977). Based on the relevant literature and data collected during the pilot study, it was determined that to test Hypothesis 4 with an alpha level of .05 and an effect size (**f**) of .4 (a large effect size), twelve subjects per cell were needed in each treatment condition to test Hypothesis 4 with a power of .80.

Because this was the first study to examine explicitly the effects of frequent feedback and goal setting on performance, it was not possible to compute an exact value for **f**. Rather, the estimate for **f** was based on information collected during pilot studies research. Cohen (1977) recommends that it is better to estimate **f** and obtain a ball park appraisement of β than to ignore the power issue completely. Because of scheduling problems, data for only 10 subjects per cell were collected.

Pilot Studies

Pilot studies were conducted to determine normative levels of performance and to identify feedback frequency parameters which would provide the subjects with meaningful increments in feedback information. These pilot studies are documented below.

Identifying Normative Levels of Performance

One pilot study was conducted to identify normative levels of performance for a 35-min data processing task. Specifically, subjects were brought into the test situation and asked to enter zip codes into a computer file. Subjects were told to enter data at their own speed. Twenty-four subjects participated in this aspect of the study. Data analysis indicated that average performance over the 35-min test period for the 24 subjects was 388 zip codes (SD = 54.3). In addition, min-by-min data were obtained for the subjects' typing speed, thus providing a normative performance curve of subjects' responding for use in the actual experiment. The acquisition of the normative performance curve for use in the exper-

iment was important because it provided a more precise goal level for the subjects throughout the 35-min typing task (The program took into account fluctuations in performance through the 35-min period. In general, subjects typed slower at the beginning and then leveled off after 2 min. The performance curve data allowed the computer program to model this typical typing behavior).

Determining the Presentation of Feedback Information

A second pilot study was aimed at identifying optimal ways in which to present the feedback information. After experimenting with various feedback formats (e.g., providing subjects with absolute levels of performance in terms of *number* of zip codes typed and number of min passed vs. providing subjects with relative information regarding performance such as *percentages* of time elapsed and goal reached), it was decided to provide subjects with relative feedback information. Thus, the feedback consisted of progress in terms of percentage of the goal reached and percentage of time elapsed. The pilot study showed that displays of relative information minimized the potential for subjects setting their own goals.

This pilot study also provided data regarding the optimal time interval for feedback presentation. Pilot data indicated that 8 sec was an adequate amount of time for subjects to read the information that was provided via the feedback presentation.

Another purpose of this second pilot study was to identify levels of feedback frequency which would be meaningfully different to subjects. After many itera-

tive trials it was determined that feedback intervals of 15 sec, 30 sec, and 120 sec (i.e., feedback provided after one of these three intervals of typing performance had taken place) would provide three meaningfully different feedback levels for subjects.

In all, 46 different subjects took part in this second pilot study.

Subjects

Subjects were 90 right-handed, undergraduate students enrolled in various psychology classes at Virginia Polytechnic Institute and State University who volunteered for participation in the study. Subjects received optional class credit for their participation.

Materials and Apparatus

Subjects typed four sets of five randomly combined digits (described ostensibly to subjects as "zip codes") one line at a time as displayed via a cathode ray tube (CRT) for a given time period. IBM personal computers equipped with 256K of memory, two diskette drives and monochrome monitors were used to present stimuli and time-stamp and error-check responses.

Of the 90 subjects who participated in the experiment, 87 were tested in groups of 8 to 16 in a campus PC Lab classroom. The classroom was a 14′ x 39′room with six rows of three IBM PCs (18 total) assembled. The PCs were located approximately 1.5 feet apart from each other and afforded the subjects relative privacy during testing. Each of the subjects was also provided with an

adjustable chair. No subject complained of being uncomfortable during the 105 min testing session.

The last three subjects were tested on three similarly equipped PCs in another campus location. This room is approximately 10 feet by 10 feet in size. Each of the PCs were spaced far enough apart to provide relative privacy for these three subjects. Each of the subjects was provided with adjustable chairs. None of these subjects complained of being uncomfortable during their testing session.

Data collection was spread over 10 separate testing sessions of a nine week interval during the Summer of 1986.

Design

The design was a 3 x 3 between groups factorial experiment incorporating the variables of *feedback frequency* (performance feedback provided after every 120 sec, 30 sec, or 15 sec of typing) and *goal difficulty* (85% of normative performance = 329 zip codes, 100% of normative performance = 388 zip codes, or 115% of normative performance = 446 zip codes). The number of subjects per cell was 10.

Subjects were assigned randomly to one of the nine cells. Feedback was presented on a fixed interval (FI) rather than fixed ratio (FR) schedule so that subjects within conditions received the same absolute level of feedback. (With a fixed ratio schedule, subjects who typed faster would receive greater absolute amounts of feedback. By implementing a fixed interval schedule, feedback was delivered on the basis of time instead of the subject's speed in data entry).

Procedure

Introduction to the test situation.

Subjects reported to the experimental location and were asked to wait quietly until all subjects who had signed up for the experiment had time to arrive. During this time, those subjects who had arrived early were asked to not read or touch any material until the rest of the participants had arrived. The PCs at this time showed an animated screen which displayed in a central box: "Welcome to the World of Data Processing" during which eight other boxes displayed randomly appearing lines of alphanumeric characters.

Once all the subjects were assembled, they were asked to look to a handout which was provided to each of them. Included in this handout was an informed consent form. Participants were instructed to read the informed consent form and, if they consented to the conditions put forth in the agreement, sign the informed consent (see Appendix A) and answer in writing two questions regarding their level of typing skill. One question was aimed at assessing whether or not the participant could type, and if so, how many words per min he/she could type. If a subject could type but did not know their exact typing speed, they were asked to estimate.

Subjects were also asked if they were right or left handed and whether or not they ever had a data processing job (e.g., data entry, check processor, bank teller, or book keeper).

After completing the informed consent, subjects were then advised to press the return key on the computer keyboard after which they were presented with a screen displaying the following message:

"Welcome to the World of Data Processing"

> "This is a study designed to test a number of hypotheses regarding data entry techniques. You will be learning to enter data using the number pad on the right hand side of the keyboard.
>
> If you have any questions. . . Don't be afraid to ask. In fact, it is better to ask questions when you have them -- Before you begin the test, you need to answer a few questions about yourself.
>
> Please press the return button"

Demographic Questionnaire

After pressing the return key, subjects were presented with an on-screen demographic questionnaire. The program asked subjects the following questions.

1. *Name*
2. *Age*
3. *"Have you ever entered data on a keyboard (Answer Yes or No)"*
4. *Education Level* - The subject could respond in one of seven ways: i) High school graduate, ii) freshman, iii) sophomore, iv) junior v) senior, vi) college graduate, or vii) post graduate
5. *Gender*
6. *"Have you ever had formal typing lessons? (Answer Yes or No)"*
7. *"What is your race?" (Subjects could respond black, white, or other).*
8. *"Have you ever used a personal computer before (Answer Yes or No)".*

Subjects were asked to answer truthfully the questions in the questionnaire. The questionnaire was "bullet-proofed" so that each of the questions (except for name and age) needed to be answered before moving on to the next question.

After having answered these questions and checking to make sure they hadn't made any keying mistakes, subjects were asked to wait for further directions.

Keyboard Instructions

After all subjects had completed the demographic questionnaire, the experimenter asked the participants to turn to pages two and three of their handout. These two pages described basic steps to follow when performing the data entry task. These steps included directions pertaining to the placement of hands on the keyboard as well as tips to make data entry more efficient. Subjects were asked to read these directions silently to themselves. If subjects had any questions, they were instructed to make a note of them and ask the experimenter after everyone had had a chance to read the two page description.

The two page handout read as follows:

Instructions

"Today you will be learning to enter zip codes into a file using the number pad (located on the right hand of your keyboard). You will not be allowed to look at the keyboard while you are entering the zip codes. There is a certain procedure that you need to follow ***EXACTLY*** in order to make this worthwhile for both you and me. Please read the directions

and listen to Jim (the Experimenter) carefully when he goes through the procedure.

1. First, study the number pad on the right of the keyboard. You will be using the following keys: 1,2,3,4,5,6,7,8,9, and 0. You will also be using the "+" key. It has been reprogrammed to serve as a backspace key (in case you make mistakes). You will also use the Return key, and the space bar.

2. You will ***not*** be using the PrtScr key, the "." key, the DEL key the "-" key, or any other key on the keyboard.

3. I want you to use your ***right*** hand for the number pad. I also want you to use specific fingers for a few of the numbers. Specifically:

   - Use your thumb for the 0 key.
   - Rest your middle finger on the 5. It will help you get a feel for the keyboard and help guide the rest of your fingers to the appropriate keys.
   - Use your pinky for the backspace (when you make a mistake).
   - After you have entered an entire line of data (four zip codes), use the index finger of your right hand to hit the return key.
   - Use your left hand to push the space bar to space between zip codes.

4. There will be three windows on your screen. A set of four zip codes and a picture of the number pad will appear in one of the windows.

5. Once you know where all the keys are and where your fingers are suppose to go, slide the base of the grey hood under the keyboard from the right. Position the hood so that you cannot see any of the numbers.

6. To aid you in finding the keys, the number pad is displayed on the screen.

7. The way to do this task then is as follows:

   - Look at the first zip code ('91921') and memorize it. Look over to the number pad displayed on the screen. Use the displayed number pad to feel your way around the number pad and enter the zip code. The number you enter will be displayed on the

screen as you enter it. To fix mistakes use the + key to back space and re-enter the number.

- With your left hand hit the space bar once to move over to the next zip code.
- Memorize the next zip code ('26418') and use the displayed number pad to enter this zip code. Space over to the next zip code.
- Continue this procedure until you have entered the four zip codes. Then hit the return key and the next set of numbers will be displayed..

8. ***Do not look at the keyboard!***
9. ***IF YOU DO NOT USE THE NUMBER PAD ON THE SCREEN AND FOLLOW THE PROCEDURE CLOSELY, YOU WILL NEVER GET GOOD AT ENTERING THESE ZIP CODES.***
10. If you make a mistake use the + key to back up.
11. If you hit the return key by mistake, don't worry -- the next set of zip codes will be displayed.
12. ***The computer only gives credit for correctly typed zip codes.*** Therefore, you need to type as accurately as you can without sacrificing too much speed.
13. You will be typing zip codes for 35 minutes. It takes that long to get good at this.
14. When you are typing, do not let anyone bother you. This will ruin your performance.
15. In order to facilitate your learning of this task, feedback will be provided regarding your performance. You will be given a goal (based on how most people do) and then you will be given feedback regarding your progress towards that goal. If you meet your goal you will be awarded a third extra credit point and a chance to win $100. We will talk about that next."

After each of the subjects had ample time to read the two page description (approximately 9 to 11 min), the experimenter read the directions aloud to the test participants. Questions were invited from the test participants at this time.

The experimenter described the nature of the task and had subjects place their fingers over the keys as the description of finger placement was read. After each of the subjects was familiar with the keyboard, the experimenter instructed each subject to pick up the grey hood sitting next to the keyboard and position the hood so that seeing the keyboard number pad was possible. If any of the subjects needed help in positioning their keyboard hoods, the experimenter helped position the apparatus.

After each participant had his/her hood positioned appropriately, the experimenter detailed the sequence of events which were to be followed when entering a line of data (as described in the "Instructions"). The experimenter then reminded subjects that they would not be allowed to look at the keyboard once the test began and that anyone caught looking at the keyboard would be dismissed from the study. The experimenter also reminded subjects that they were to use the number pad which would be displayed on the screen, since performance would be better for those who used this visual aid.

The experimenter also reminded subjects that the program only provided credit for correctly typed zip codes and, therefore, it was important to be as accurate as possible during the typing task. However, the experimenter also made it clear to the subjects that it was up to them to determine how they wanted to balance speed with accuracy. The subjects were also reminded that the "+" key had been reprogrammed as a backspace key and it should be used when necessary.

Finally, subjects were told that they would receive performance feedback during the test. If they performed well, they would be eligible to receive an extra credit point and earn a chance to win $100.

Feedback Tutorial

After all task relevant questions were answered, the subjects were advised to press the return key, which initialized a tutorial on the use of performance feedback in this task. The screen images for this tutorial are shown in Appendix B. The experimenter read aloud the information contained in this tutorial as the subjects read the information.

After pressing the return key, the format of the screen during the actual typing task was displayed. The screen consisted of three windows: one window was dedicated to the typing task (i.e., subjects were presented with zip codes in this window and the results of their input appeared in this window. This window also displayed the number pad.

A second window provided feedback, and a third window was dedicated to providing task-exogeneous information (e.g., "Your answers are being processed". . . ."Please Continue . . . ").

The subjects were instructed to press return and the second screen shown in Appendix B appeared. As subjects read the material for themselves, the experimenter instructed the subjects that they would receive feedback regarding three items: time left, percentage of time elapsed, and percentage of goal reached.

After pressing the return key, subjects were told that they would receive information regarding the amount of time elapsed. They were told that this would help the subjects pace themselves, especially at the end of the task. After pressing return, another screen appeared showing subjects how to interpret the percentage of time elapsed information. The next screen showed subjects how to interpret the percentage of goal elapsed information. The subjects then pressed the return key and were instructed to use the percentage of time elapsed information and the percentage of goal reached information to pace themselves. In this example, the screen showed the subject to be particularly ahead of his/her goal. The next screen showed the subject to be especially behind the goal.

The subjects were then instructed to press the return key and the tutorial then informed subjects that they would also receive a general "AHEAD" or "BEHIND" schedule message which they could use as a quick method for assessing their goal status.

The subjects were then instructed to press the return key, after which the tutorial presented them with information regarding the third window. The third window provided subjects with information unrelated to the task, such as whether the subject should halt typing so that answers could be processed or whether they could continue. The subjects were informed that the beginning and end of each time-out period would be signalled with a beep. The subjects were informed that these breaks were installed in the program to make sure that every subject had an equal opportunity to type.

After the tutorial was complete, subjects were asked if they would like to repeat the tutorial. (None of the 90 subjects said that they needed to have the tutorial repeated.) After subjects were asked if they would like to repeat the tutorial, they were advised to press the return key in order to receive their goal. The next screen displayed their goal, and then subjects were again prompted to press the return key. At this point, subjects were queried regarding their acceptance of the goal. Specifically, the program asked subjects if they accepted the goal and were instructed to type Y (for yes) or N (for no) depending on their opinion of the goal.

Second, subjects were queried as to their level of commitment to the goal on a scale of one to five, with one being "not very committed" to five being "very committed." After answering these two questions (the program would not continue unless the subject had entered appropriate data), the subjects were once again reminded that they would receive an extra credit point (in addition to the two points already offered) and a chance to win $100 if they exceeded their goal.

Subjects were then instructed to press the return key and, at this point, the actual test screen (which consisted of the three previously described windows) was displayed before them. At this juncture, subjects were instructed to look one last time at the positioning of their fingers so that they were placed satisfactorily on the number pad keys. Once positioned, the subjects were allowed to press "y" and the return key and enter the test condition. They were reminded that after this point, they would not be allowed to look at the placement of their right hand.

Thirty-Five Min Test Condition

During the next 50 min, the subjects were provided intermittently with information regarding progress toward the goal. Although the actual typing task was 35 min, the presentation of feedback screens (which were 8 sec in duration) and program pauses (which were also 8 sec in durations) caused the amount of time the subjects were seated in front of the terminal to increase to approximately 50 min. The feedback window was located on the upper left hand portion of the screen and the comments window occupied the upper right hand portion of the screen. The window dedicated to typing was located across the bottom portion of the screen. The program pauses consisted of a blank feedback screen and a Comments screen which stated "Please wait your answers are being processed." The program pauses were inserted into the program to allow subjects an equal access time of 35 min to the typing task. For example, without the program pauses, subjects who received feedback after every 15 sec would receive approximately eight times more chances to "rest" during the typing task than those subjects who received feedback after every 120 sec. The program pauses controlled for the confounding effects of *pauses during typing* and *feedback frequency.*

Program Characteristics

After the subject entered a line of zip codes and pressed the return key, the program assessed the accuracy of the four zip codes. Each zip code was individually evaluated and scored, such that it made no difference how many errors occurred within a zip code. The zip code was scored as one

incorrect entry regardless of how many errors were made. The program then cumulated the number of correctly typed zip codes, the total number of zip codes typed, the amount of time passed since a feedback (or program pause) screen was presented, the average zip codes typed per min, and the total amount of time in which the individual had to type. In computing the total amount of time in which the individual had to type, the total time used for program pauses, and presentations of feedback screens were subtracted from the total time the subject had been seated at the terminal. Thus, the computer kept track of the actual amount of time the subject had as an opportunity to type.

If 15 sec had passed since the last time a feedback screen had been presented and withdrawn, one of two events occurred. If the feedback frequency schedule to which the subject was assigned was either 30 sec or 120 sec, the program delivered a 50 msec 3000-Hertz beep and a program pause screen which appeared in the comments window and stated "Please Wait . . . Your Answers Are Being Processed." After 8 sec had elapsed, a second 50 msec 3000-Hertz beep was sounded, and the Comments Screen displayed the message "Continue . . .". At this point, the program allowed the subject to begin typing zip codes again. This process was repeated until either 30 or 120 sec elapsed since the presentation of the last feedback screen.

If 15 sec (or 30 or 120 sec) had elapsed since the presentation and withdrawal of the last feedback screen -- depending on subject's feedback

frequency level, a 50 msec 3000-Hertz beep sounded and the feedback screen appeared with four items of information. The first line of information stated the amount of time that the subject had been typing (e.g., Total Time Elapsed: 24.9 Min). The second line of data displayed the percentage of time that had elapsed since starting the test (e.g., Percentage of Time Elapsed: 71.1%). A third line of information displayed the percentage of goal that had been reached by the subject as a function of correctly typing zip codes (e.g., Percentage of Goal Reached: 73.2%). A fourth line of data provided general feedback regarding whether the subject was behind or ahead of his/her goal (e.g., You are ahead of schedule).

All of the information presented was current; that is, it was computed on the basis of the subject's performance just prior to the presentation of the feedback screen.

This feedback information was presented for a total of 8 sec, after which the feedback window went blank and a second 50 msec 3000-Hertz beep sounded.

The subject continued with the task, receiving feedback and/or program pauses as scheduled until 35 min of actual typing time had elapsed.

Ten-Min Posttest

After completing the 35-min performance task, subjects were instructed to relax, stand up and stretch, or get a drink from the water fountain. After subjects had had a chance to "unwind" from the performance test (3-7 min), they were

instructed that they would participate in a second performance task of 10 min in duration. Unlike the performance task, the subjects would not receive feedback information, program pauses or 3000-Hertz beeps. Rather, they would be typing without interruption for the 10-min period.

At this point, subjects were reminded that the 10-min typing test would not affect whether they received extra credit points or had a chance to win $100. Rather they were told to type at their own pace. If subjects asked how fast they should type, they were told: "type as fast or slow as you want -- it is totally up to you."

Once subjects had their right hands correctly positioned under the keypad hood, they were instructed to type 'y' press return and begin the typing task.

The layout of the 10-min posttest CRT screen was different than that of the screen during the 35-min typing task. The typing window occupied the top five-eighths of the screen and was exactly like the typing screen during the 35-min performance task. At the bottom of the screen, however, a windowed message was shown which stated: "Remember . . . You only get credit for correctly typed data! If you make a mistake simply go on. Do not correct your error." The 10-min typing task screen is shown in Appendix C.

After 10-min had elapsed, the typing screen went blank and a message appeared for 6 sec stating "End of the Ten Minute Typing Task." Another screen was then presented which displayed summary performance information for the subject (e.g., average zip codes typed per min during the 35-min performance task

and the 10-min typing task, proportion of correctly typed zip codes for the 35-min task, etc). In addition a message was displayed at the bottom of the screen which stated "You did not meet your goal. You will receive two extra credit points" if the subject did not meet his/her goal, and "Congratulations . . . you met your goal! You will receive three extra credit points and a chance to win $100."

Anagram Test

Once the 10-min typing task had been completed and summary performance data had been presented to each of the subjects as described above, the experimenter announced that he would assign extra credit points at this time "before he forgot". The experimenter then went around to each of the subjects and assigned class extra credit based on the performance summary information shown on the subject's CRT. Assigning extra credit points at this time was done to heighten any learned helplessness effects which might have occurred for those subject who did not meet their goal.

Upon completion of assigning class credit points, subjects were asked to turn to a blank page in their handout which directly preceded two pages containing 20 anagrams. The subjects were then informed that they would be taking part in a three-min anagram solution test, and the following was read to the subjects:

> "Now I would like you to solve some anagrams. As you know, anagrams are words with the letters scrambled. The problem for you is to unscramble the letters so they form a word. When you figure out the word simply write

it under the scrambled letters and move on to the next anagram. Please do each of the anagrams in order.

Now, there could be a pattern or principle by which to solve the anagrams. But that's up to you to figure out. You will be given three minutes to solve anagrams. Do as many as you can. After you finish the first page, move onto the second page. Let me say that there are no formal names among the anagrams. When I give the signal, turn the page and begin. I can't answer any questions now."

After the questions were read and the timer set, subjects were directed to turn the page and begin. The five-letter anagrams used in the study are shown in Appendix D. The directions for this procedure were taken from Hiroto and Seligman (1974) and the anagrams were obtained from a list compiled by Tresselt and Mayzner (1966). The subjects worked for 3 min until time was called.

Feedback Questionnaire

After completing the anagram test, subjects were instructed to turn to the last page of their handout. On this page were five questions with 1 to 5 Likert-type scales regarding the subject's perceptions of the performance feedback and the typing task during the 35-min period. Subjects were told that the questionnaire pertained only to the 35-min typing test, and their answers should reflect their opinions regarding the performance feedback.

The first question asked subjects to rate how helpful they felt the feedback was in aiding them reach their performance goal. The second question asked

subjects to rate how disruptive the feedback was of their typing performance. The third question asked subjects to rate their agreement or disagreement with the statement: "I think the feedback for the 35-min typing task did more harm than good." The fourth question asked subjects to rate their level of enjoyment of the 35-min typing task. The final question asked subjects whether they felt the task was frustrating. A copy of this questionnaire is shown in Appendix E.

Debriefing

After completing the questionnaire, the Experimenter told the subjects that the study was aimed at investigating the effects of different amounts of performance feedback on data entry performance.

Subjects were also asked to not discuss the study with other people, particularly those people who may have been intending to serve as test subjects in subsequent sessions. Subjects were then thanked for their time and dismissed.

Subjects received a letter in the mail a couple of weeks after the end of the study which provided more detail about the purpose of the study in addition to the name of the person who won the $100 prize.

List of Variables

Data were collected on the following variables during the course of the testing session:

- *Number of zip codes attempted during the 35-min task*
- *Number of zip codes typed correctly during the 35-min task*
- *Goal Acceptance* - Subjects answered "yes" or "no" to whether they accepted the goal assigned to them.

- *Goal Commitment* - Subjects responded on a five-point rating scale how committed they felt to the assigned goal.

- *Number of Feedback Window Presentations* - This measure consisted of the number of times a subject received feedback during the 35-min typing task and varied across subjects depending upon the subject's feedback frequency condition (i.e., feedback delivered after every 15, 30, or 120 sec of performance).

- *Number of Program Pauses* - This measure consisted of the number of program pauses and feedback window presentations that the subject received. The number remained relatively constant across subjects regardless of feedback condition. Program pauses were inserted to make sure that each subject had approximately the same number of typing breaks at approximately the same time periods.

- *Age*

- *Data Entry Experience* - Data entry experience was operationalized as having *any* job where traditional data entry tasks occur. For example, if they worked as a bank teller they were instructed to respond "yes" to this question. Thus, it was a rather liberal measure of data entry experience.

- *Years of Schooling*

- *Gender*

- *Typing Experience* - Subjects were asked to respond either "yes" or "no" to the question: "Have you ever had formal typing lessons?"

- *Personal Computer Use* - Subjects were asked to respond either "yes" or "no" to the question: "Have you ever had any experience working with personal computers?"

- *Race*

- *Proportion of zip codes typed correctly during the 35-min task*

- *Amount of time typing during the 35-min typing task* - The length of the test is (minimum) 35 min. However, slower data entry people typed consistently slower throughout the task and since they spent more time typing their last line of data than faster data entry persons, their times at task were slightly longer than those subjects who typed faster. (For instance, if two people get to the last line of data at 34.78, the faster typist will have a smaller overall time

for the test, since he/she can type the last line of data faster and be kicked out of the program sooner.)

- *Average errors during the 35-min typing task* - This measure was computed by dividing the number of errors by the total task time.
- *Number of zip codes attempted during the 10-min posttest task*
- *Number of zip codes typed correctly during the 10-min posttest task*
- *Feedback Questions* - As described earlier, a copy of these questions can be found in Appendix E.
- *Distance from Goal* - The program also computed the number of zip codes the subject was above or below the goal at the end of the task.
- *Word Per Min Typing Ability* - Prior to the test, subjects were asked to estimate their WPM typing ability.
- *Amount of time typing during the 10-min posttest task.* - This was computed in the same manner as the amount of time typing during the 35-min typing task.
- *Anagram Score* - The number of anagrams correctly solved were summed to provide this score.
- *Zip Codes Per Min* - Every time the subject pressed the return key during both the 35-min and 10-min typing task, the program computed the average number of zip codes typed per min.
- *Instantaneous Distance from Goal* - Since the program modeled a typical subject's performance curve (based on data obtained during a pilot study), it was possible to compute the number of zip codes the subject was either above or below the goal at the time he/she pressed the return key.
- *Feedback Window Specifics* - The computer also time-stamped precisely when feedback was provided and what information was provided during the feedback presentation (e.g., what percentage of time had elapsed and what percentage of the goal had been reached).

Results

Demographic Variables

To interpret unambiguously the treatment effects it was first necessary to establish that the nine experimental groups did not differ on certain demographic variables potentially important to performance on the tasks. Despite random assignment to treatment groups, the possibility still existed that differences in important demographic variables such as experience with personal computers and typing experience might have influenced performance. Thus, parametric statistical analyses were conducted to test for differences in demographic background between groups.

Age - The average age of the subjects who participated in the study was 20 years, seven months. An analysis of variance failed to detect any significant age differences between the nine feedback/goal-setting groups.

Reported Typing Speed in Words Per Min - Subjects were asked to report their estimated typing speed in words per min prior to participation in the performance test. The average reported typing speed for the ninety subjects was 28.2 words per min (range = 20 to 68). An analysis of variance failed to detect any statistically significant differences between groups in reported typing speed.

Data Entry Experience - Despite advertising explicitly for participants with no data entry experience, 41 (45.6%) of those subjects who did participate in the study actually reported having some experience with data processing tasks. It should be noted that data entry experience was operationalized rather liber-

ally, in that *any* experience with data entry tasks, whether it be entering data for a computer graphics package or working as a cashier in a grocery store, was considered as data entry experience. The CATMOD procedure from the Statistical Analysis System (SAS Institute, Inc, 1985) was used to determine if there were differences between experimental groups in terms of data entry experience. The CATMOD procedure performs a weighted least squares analysis of a single categorical dependent variable and multiple independent categorical variables, and produces output similar to an analysis of variance but with effects tested using the Chi Square statistic (Grizzle, Starmer, & Koch, 1969). The CATMOD procedure failed to detect any significant between-group differences in data entry experience, $p > .05$.

Education Level - Of the ninety subjects participating in the study, 22 (24.4%) were enrolled as freshman, 20 (22.2%) were college sophomores, 32 (35.6%) were enrolled as college juniors, 14 (15.6%) were college seniors, one (1.1%) was a recent high school graduate and another (1.1%) was a recent college graduate. The CATMOD analysis revealed no significant between-groups differences in education level, $p > .05$.

Gender - Fifty-one (57.7%) participants were female and 39 (43.3%) were male. The CATMOD procedure revealed a statistically significant main effect for Goal Difficulty, $\chi^2(2, N = 90) = 8.06$, $p = .02$, with 63.3% ($n = 19$) of participants in the easy goal condition being male as compared to 26.7%

(n = 8) in the medium goal condition and 40.0% (n = 12) in the difficult goal condition being male subjects.

Typing Experience - Of 90 subjects participating in the study, 69 (76.7%) had taken formal typing lessons while enrolled in either high school or college whereas 21 (23.2%) had not participated in formal typing lessons. The CATMOD analysis revealed no significant differences between groups in terms of subjects' exposure to formal typing lessons, $p > .05$.

Personal Computer Use - The overwhelming majority of test participants had had some experience with personal computers, either through programming, word processing, or the use of spread sheets. A total of 78 (86.7%) had experience with personal computers. The CATMOD analysis revealed no significant differences between groups in terms of subjects' use of personal computers, $p > .05$.

Race - Of those participating in the study, 73 (81.1%) were Caucasian, eight (8.9%) were Black, and 9 (10.0%) were of Asian or Hispanic descent. The CATMOD analysis revealed no significant differences between groups in terms of subjects' race, $p > .05$.

Manipulation Checks

Goal Acceptance - To determine if subjects actually intended to reach the goal difficulty level assigned to them, they were asked to respond by typing either "yes" or "no" to the question: "Do you agree to accept the goal of (329/388/446)

zip codes to be typed in the next 35 min" prior to the beginning of the 35-min typing task. All test participants agreed to accept their assigned goal.

Goal Commitment - The computer also prompted subjects to report their level of commitment to the goal. Subjects responded to the following question: "On a scale of 1 to 5, how committed are you to this goal?" The mean level of response to this question was 4.49, indicating that, on average, subjects were quite committed to reaching their goal. An analysis of variance (ANOVA) revealed no significant differences in reported goal commitment between groups, $p > .05$.

In summary, reactions to these two questions indicate strong commitment and acceptance of the goal levels assigned. Thus, it can be said with some degree of certainty that differences in performance cannot be attributed to differential rejection of assigned goals between groups.

Reliability of Feedback Presentation - Because of differences in typing speed between subjects it was not always possible for the computer program to deliver feedback exactly 15 sec (or 30 or 120 sec) after the the last feedback information was presented. This occurred because feedback was not delivered until after the subject pressed the enter key and, in some cases, subjects may have taken longer than 15 sec to enter a line of data.

If the feedback were delivered exactly on time for each subject, a subject in the 15 sec (Frequent) feedback condition would receive feedback 140 times, a subject in the 30 sec (Moderate) feedback condition would receive feedback 70

times, and a subject in the 120 sec (Infrequent) feedback condition would receive feedback 17 times.

In actuality, subjects in the Frequent Feedback condition received feedback an average of 126.2 times (SD = 8.02), while subjects in the Moderate Feedback condition received feedback an average of 64.1 times (SD = 3.47), and subjects in the Infrequent Feedback condition received feedback an average of 15.5 times (SD = *0.51*). Not surprisingly, a 3 (Goal Difficulty: Easy, Medium, Difficult) x 3 (Assigned Feedback Frequency: Infrequent, Moderate, Frequent) ANOVA with the number of feedback presentations as the dependent variable, indicated a strong main effect for Assigned Feedback Frequency, $F(2,81) = 1922.74$, $p < .0001$. The zero-order correlation between assigned Feedback Frequency and the actual number of feedback presentations was $r = -.91$. A significant main effect for Goal Difficulty was not found nor was the interaction between Goal Difficulty and Feedback Frequency statistically significant. These analyses indicated that the program provided feedback in a fairly reliable fashion.

Number of Program Pauses - The average number of 8-sec program pauses (referring to the number of breaks plus the number of feedback presentations) delivered to each subject was 121.7 (SD = 6.75). A 3 (Goal Difficulty) x 3 (Feedback Frequency) ANOVA showed no main effects for Goal Difficulty or Feedback Frequency, nor an interaction between Goal Difficulty and Feedback

Frequency. This indicated that all subjects received approximately the same number of rest breaks during the 35-min typing task.

Performance Measures

Number of Zip Codes Correctly Typed. Not all subjects had the same prior level of experience with personal computers, typing, or data entry work, nor had any subject been exposed to the feedback screens prior to the test situation. Therefore, it was expected that some adaptation to the task (or learning) would occur during the beginning of the 35-min typing task and this adaptation would be reflected in subjects' performance. A 3 (Goal Difficulty: Easy, Medium, Difficult) x 3 (Feedback Frequency: Infrequent, Moderate, Frequent) x 8 (Trials: Number of Zip Codes typed during the 1st, 5th, 10th, 15th, 20th, 25th, 30th, and 35th min) repeated measures ANOVA was conducted on the dependent variable of average number of zip codes typed per min to determine: a) if learning did in fact occur, and b) if learning interacted in any way with the manipulated variables of Goal Difficulty or Feedback Frequency.

The ANOVA indicated a strong main effect for Trials, $F(7,567) = 78.6$, $p < .0001$, with subjects typing an average of 4.6 zip codes during the first min, 8.6 during the fifth min, 9.9 zip codes during the tenth min, 11.2 during the 15th min, 11.6 during the 25th min, 12.6 during the 30th min, and 11.8 zip codes during the 35th min. Trials did not, however, interact with either Feedback Frequency, $F(14,561) = 0.73$, $p = .76$, or Goal Difficulty, $F(14,567) = .90$, $p = .57$, nor was the higher order interaction between these three variables sta-

Table 1

Analysis of Variance on Zip Codes Typed Per Minute for 35-Min Typing Task

Source	df	Sum of Squares	F Value
Feedback (FB)	2	11.44	0.29
Goal Difficulty (G)	2	566.78	14.33**
FB x G	4	338.19	4.28**
Subjects (S)	81	1601.44	
Trials (T)	7	4002.97	78.64**
T x FB	14	73.99	0.73
T x G	14	91.20	0.90
T x FB x G	28	169.20	0.83
T x S/FBxG	567	4122.85	
Total	719	10978.06	

*p < .05
**p < .01

tistically significant, $F(28,567) = 0.82, p = .73$. These analyses are summarized in Table 1. Since Trials did not interact in any way with the other two factors, it was not necessary to include the Trials factor in any subsequent portion of the analysis.

Figure 2 shows subjects' overall performance during the 35-min performance task. The total number of correctly typed zip codes is depicted on the ordinate with feedback frequency shown on the abscissa. Performance for the Difficult Goal/Frequent Feedback group did not show the greatest decrement in performance as predicted; rather, performance for this group was actually the highest of any group. Since the predicted inverted-U shaped (hyperbolic) function did not occur for subjects assigned to the difficult goal condition, rather than using a regression model to analyze these data (which provides an elegant model for testing hyperbolic functions; Pedhazur, 1982), a 3 (Goal Difficulty) x 3 (Feedback Frequency) between-groups ANOVA was conducted with total number of correctly typed zip codes serving as the dependent variable.

The ANOVA indicated a significant main effect for Goal Difficulty $F(2,81) = 13.78, p < .0001, \eta^2 = .26$, with subjects in the Easy Goal condition typing an average of 344.1 zip codes correctly ($SD = 50.8$), and subjects in the Medium Goal condition typed an average of 369.7 zip codes correctly ($SD = 58.0$). Subjects assigned to the Difficult Goal condition typing an average of 417.6 zip codes correctly ($SD = 64.5$). This finding is supportive of *Hypoth-*

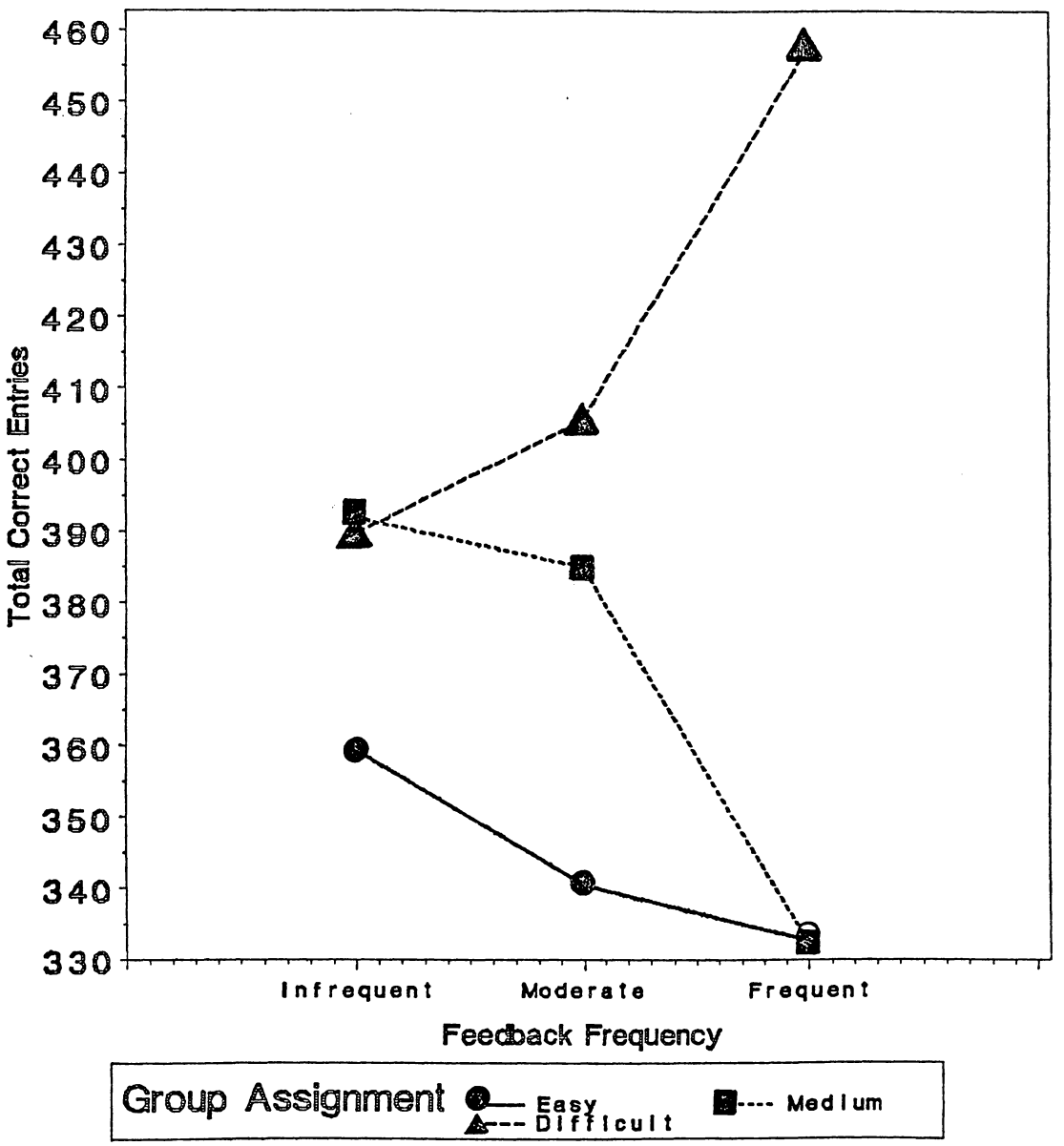

Figure 2. Summary results for 35-minute typing test.

esis 1a, that a main effect would be found for goal difficulty, and is consistent with previous findings (Locke et al., 1981; Tubbs 1986).

The hypothesis (*Hypothesis 1b*) that a main effect for feedback frequency would be found was not supported, $F(2,81) = .09$, $p = .91$. Given that a "no feedback" condition was not manipulated, it may not be altogether surprising that no main effect was found for feedback frequency. Specifically, prior tests of the effects of feedback on performance in a goal setting paradigm have manipulated the feedback factor such that feedback was either present or absent between experimental conditions (e.g., Becker, 1981; Matsui et al., 1983). In this study, all subjects received some amount of feedback.

The ANOVA did, however, reveal a significant interaction between Goal Difficulty and Feedback Frequency $F(4,81) = 4.11$, $p = .004$, $\eta^2 = .17$. The results of this interaction can be seen in Figure 2. This interaction was predicted and supports *Hypothesis 2*, that an interaction would be found between feedback frequency and goal difficulty. These analyses are summarized in Table 2.

An inspection of Figure 2 indicates that an inverted-U function was not found as a result of the Difficult Goal/Frequent Feedback condition showing a precipitous decline in performance as compared to the other difficult goal condition groups. (See Figure 1 on page 29 for the graphically displayed predicted results). As can be seen, the predictions that an inverted-U function would occur as a function of too frequent feedback (*Hypothesis 3*) and this inverted-U function would be moderated by goal difficulty (*Hypothesis 4*) were not supported.

Table 2

Analysis of Variance on Total Correct Zip Codes for 35-Min Typing Task

Source	df	Sum of Squares	F Value
Feedback (FB)	2	572.42	0.09[1]
Goal Difficulty (G)	2	83454.15	13.78**
FB x G	4	49771.11	4.11**
Subjects (S)	81	245363.20	
Total	89	379160.88	

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

[1]An Inverted F-test (Keppel, 1982) indicates that this value is significantly less than 1.0, $F(81,2) = 11.1$ at the $p = .10$ level.

Instead, performance in the Difficult Goal/Frequent Feedback condition was actually the highest of any group. Cell means and standard deviations are shown in Table 3.

To test for differences between individual cell means (k), a series of post-hoc pairwise comparisons using the Tukey test were conducted. The Tukey test is designed to maintain the familywise error rate at the .05 level for the entire set of pairwise comparisons (Keppel, 1983). Given that there are $k(k-1)/2 = 36$ comparisons, the alpha level for any single comparison was set to .0014.

Two popular alternatives to the Tukey test are the Duncan and the Newman-Keuls tests. Monte Carlo studies have indicated, however, that the Tukey test is preferable to the Newman-Keuls and Duncan tests because it has better control over the familywise error rate and is more likely to detect true differences between means (Einot & Gabriel, 1975; Petronovich & Hardyk, 1969).

To compute the Tukey test, a *minimum pariwise difference between means* (dT) value was computed, as the minimum mean difference that must exist for a pair of means to be significantly different. In this case the value of dT was 81.06. As can be seen from Table 3, only four pairwise comparisons were greater than 81.06. The Tukey test revealed statistically significant differences between subject's performance in the Difficult Goal/Frequent Feedback condition and all groups in the Easy Goal condition. In addition, performance for subjects in the Difficult Goal/Frequent Feedback condition was significantly greater than the

Table 3[1]

Mean Number of Correctly Typed Zip Codes
for 35 Minute Typing Task

	Feedback Frequency Level		
	Infrequent (120 Seconds)	Moderate (30 Seconds)	Frequent (15 Seconds)
Easy Goal (329)	359.3 (SD = 55.2)[2]	340.4 (SD = 64.7)	332.6 (SD = 25.6)
Medium Goal (388)	391.9 (SD = 61.1)	384.9 (SD = 20.0)	332.2 (SD = 68.7)
Difficult Goal (446)	389.7 (SD = 48.3)	405.4 (SD = 86.7)	457.6 (SD = 27.3)

[1] n = 10 for each group.

[2] Hartleys test for homogeneity of variance indicates that these cell variances were homogeneous, $F(9,9) = 18.79$, $p > .01$.

performance for those subjects assigned to the Medium Goal/Frequent Feedback condition.

As described earlier, there were gender differences between cells. That is, some cells contained a greater number of female subjects than others. To determine if gender affected the outcome of these findings, gender was used as a covariate in a 3 (Goal Difficulty) x 3 (Feedback Frequency) analysis of covariance. The analyses indicated that gender did not contribute significantly to the variance accounted for in the original model, and thus, did not serve as a useful covariate.

In summary, these analyses indicate that feedback frequency can play an important role in enhancing goal-setting techniques and specifically, highest levels of performance are likely to be found when one receives frequent feedback and is assigned a difficult goal.

A surprising finding in these analyses is the markedly low level of performance for those subjects in the Medium Goal/Frequent Feedback condition. These subjects performed at the lowest rate of typing than any other group. It is not clear why this occurred. The original hypotheses predicted that a learned helplessness effect may take place when there are appreciable decrements in performance in Difficult Goal/Frequent Feedback conditions. Perhaps the learned helplessness effect actually occurred in the Medium Goal/Frequent Feedback condition instead. The next set of analyses explores this post-hoc explanation.

Performance During the Ten-Min Posttest. After completing the 35-min performance test, subjects were given a short break and reminded that the assignment of extra credit points has already been made by the computer based on their performance during the 35-min typing task. The subjects then took part in a 10-min typing task (where feedback was not provided and no goal assignment was made). This task was administered to assess the possibility of learned helplessness.

Because it is possible that subjects typed at different rates during the 10-min posttest (i.e., they may have continued to improve in typing speed as a function of continued learning or they may have become fatigued, or the effects of the experimental manipulation may have attenuated), it was necessary to include in the analysis a within-subjects Trials factor along with the factors of Goal Difficulty and Feedback Frequency. Thus, a 3 (Goal Difficulty: Easy, Medium, Difficult) x 3 (Feedback Frequency: Infrequent, Moderate Frequent) x 5 (Trials: Number of Zip Codes typed during the 2nd, 4th, 6th, 8th, and 10th min) repeated measures ANOVA was conducted on the min-by-min average of zip code entry to determine if a change in rate of typing occurred and if this change in rate of typing interacted with the manipulated variables of Goal Difficulty and Feedback Frequency.

Figure 3 on the following page graphically depicts these results. The ANOVA revealed a main effect for Trials, $F(4,324) = 3.4$, $p = .01$, with overall typing speed averaging 12.5 zip codes per min during the second min, peaking at

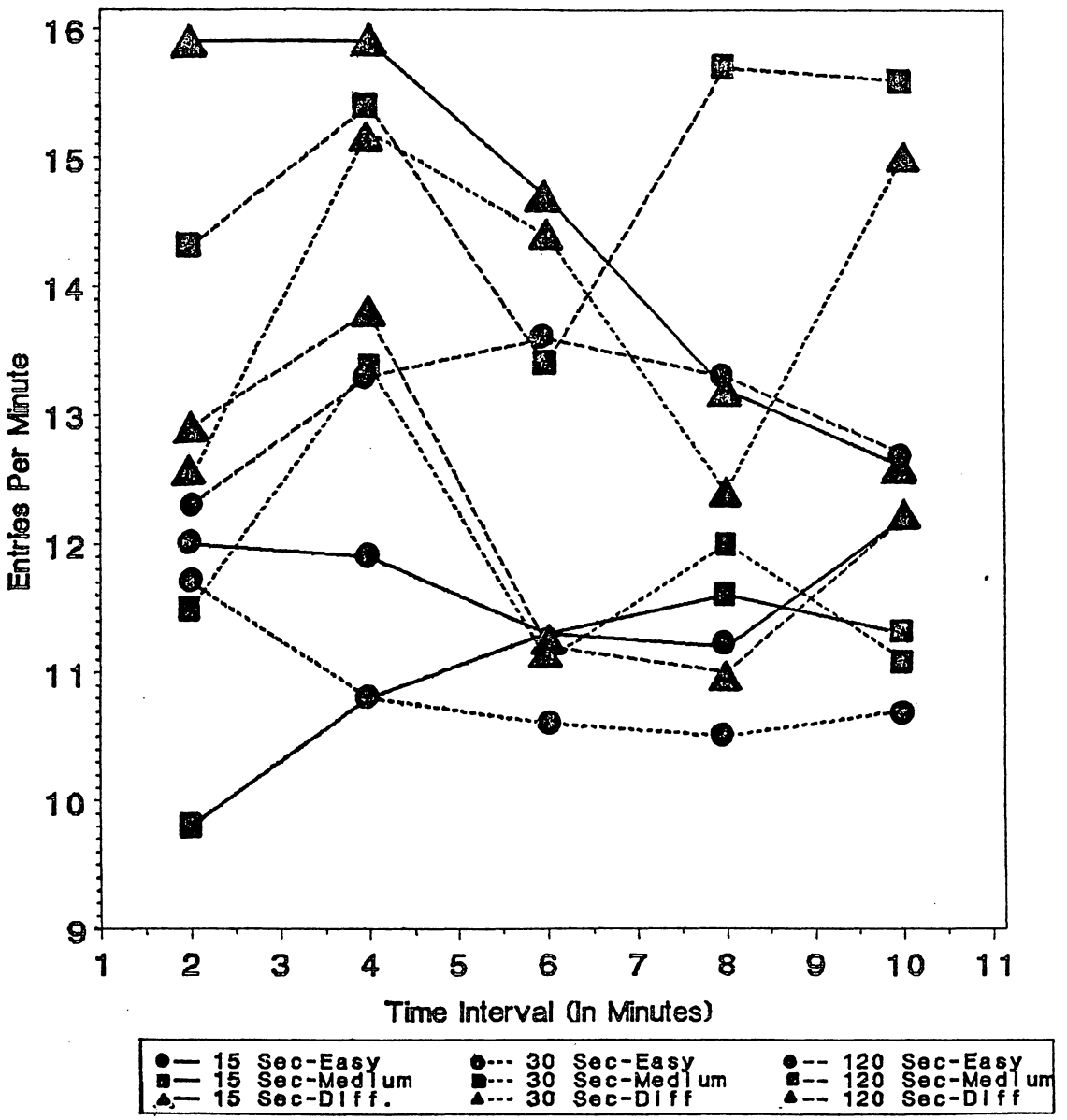

Figure 3 . Performance during posttest plotted over time.

13.4 zip codes per min during the fourth min, and decreasing to 12.5 zip codes per min during the last min of typing. The ANOVA also revealed a significant interaction between Trials and Goal Difficulty, $F(8,324) = 2.59$, $p = .001$, and a significant three-way interaction between Trials, Goal Difficulty, and Feedback, $F(16,324) = 1.99$, $p = .01$. No effect was found for the interaction of Trials with Feedback Frequency at the $p = .05$ level. These analyses are summarized in Table 4.

As can be seen from Figure 3, these interactions are difficult to interpret. In general, however, these analyses show that subjects in the Difficult Goal/Frequent Feedback condition began the ten-min typing task at a higher rate of responding ($M = 15.9$) than the other groups, while subjects in the Medium Goal/Frequent Feedback condition began the ten-min typing task at the lowest rate of responding ($M = 9.8$). Subjects in the Difficult Goal/Frequent Feedback condition had the highest rate of typing after 4 min than any other group ($M = 15.9$); however, their performance dropped off the most of any group to an average of 12.6 zip codes typed per min (a decrease in typing speed of 21%) during the final min of typing. Typing performance of subjects in the Medium Goal/Frequent Feedback condition, however, peaked during the sixth min at 11.3 zip codes typed per min and remained at that level during the last min of typing.

In general, this analysis indicates that high performing groups during the 35-min typing task entered the 10-min typing task typing zip codes at a faster rate than groups that performed poorly during the 35-min typing task. Subjects

Table 4

Analysis of Variance on Zip Codes Typed Per Minute for 10-Min Posttest

Source	df	Sum of Squares	F Value
Feedback (FB)	2	119.22	1.49
Goal Difficulty (G)	2	207.06	2.58
FB x G	4	546.52	3.41*
Subjects (S)	81	3249.81	
Trials (T)	4	65.13	3.36*
T x FB	8	21.88	0.56
T x G	8	100.42	2.59**
T x FB x G	16	154.45	1.99*
T x S/FBxG	324	1568.67	
Total	449	6033.16	

*p < .05
**p < .01

in the higher performing groups also peaked at higher levels than did subjects in groups that performed poorly in the 35-min typing task. However, subjects in groups that performed well during the 35-min typing task were typing at a slower rate (relative to their peak performance) by the end of the 10-min period than were subjects in groups who did not perform as well during the 35-min typing task. Whether the groups' performance would have reached the same level after a given amount of time is not revealed by this 10-min typing test.

One point worth noting is that despite a greater relative drop-off in performance by subjects in groups that performed well during the 35-min typing task, these subjects, in terms of the absolute number of zip codes typed, still performed at a higher level than subjects in groups that performed poorly during the 35-min typing task.

To determine statistically if differences existed between groups in terms of the absolute number of correctly typed zip codes, a second ANOVA was conducted. This 3 (Goal Difficulty: Easy, Medium, Difficult) x 3 (Feedback Frequency: Infrequent, Moderate, Frequent) between-groups ANOVA revealed a statistically significant interaction between Goal Difficulty and Feedback Frequency, $F(4,81) = 2.80$, $p = .03$, $\eta^2 = .11$. These analyses are summarized in Table 5. Figure 4 graphically displays the means for each group.

As shown in Figure 4, the same pattern of findings obtained during the 35-min typing task was also obtained in the 10-min posttest. Specifically, subjects in the Medium Goal/Frequent Feedback condition again performed at the

Table 5

Analysis of Variance on Total Correct Zip Codes for 10-Min Posttest

Source	df	Sum of Squares	F Value
Feedback (FB)	2	1156.07	0.78
Goal Difficulty (G)	2	4474.87	3.03
FB x G	4	8279.07	2.80*
Subjects (S)	81	59876.90	
Total	89	73786.90	

*p < .05
**p < .01

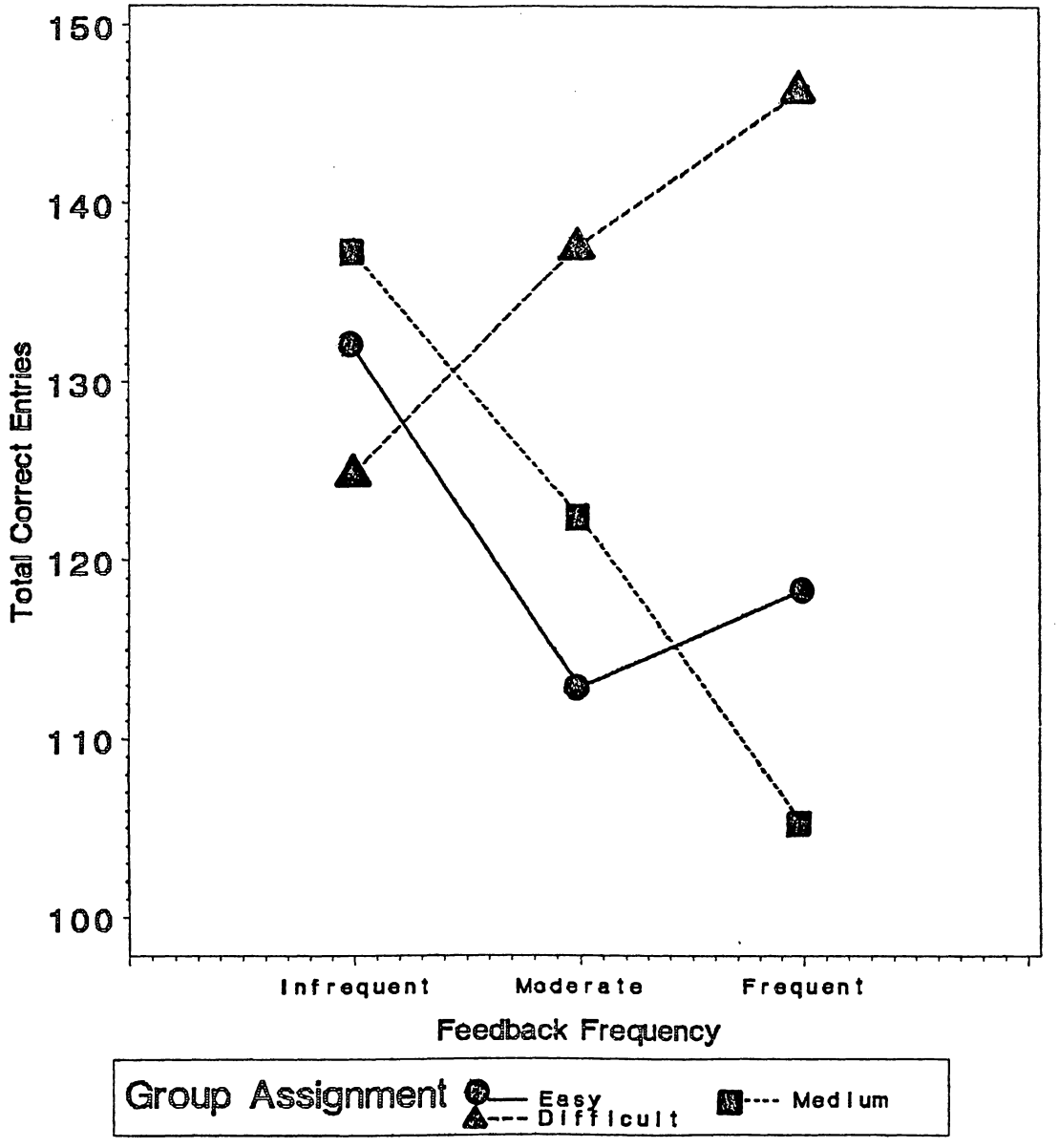

Figure 4. Summary results for ten-minute posttest.

poorest rate, typing an average of only 105.2 (SD = 30.2) zip codes during the 10-min posttest. Conversely, subjects in the Difficult Goal/Frequent Feedback condition again typed at the highest rate, correctly typing 146.4 (SD = 15.9) zip codes during this same time period. A post-hoc Tukey test indicates these means are significantly different at the p = .005 level. Means and standard deviations for all groups are shown in Table 6. No other main effects or interactions were statistically significant at the p = .05 level.

In summary, it can be concluded from the results obtained during the 10-min posttest that there was a carryover effect from the 35-min typing task, with groups performing at rates similar to performance during the 35-min typing task. In addition, it appears that these effects may be transient, with rates of responding between most groups converging toward the same level by the end of the ten min period.

What is not clear is why these carryover effects occurred. Specifically, the carryover effects can be attributed to one of (at least) two factors. First, the results obtained during the 10-min typing task may be due to simple transfer of training, where the skills practiced during the 35-min typing task were so overlearned that they transferred naturally to the 10-min posttest. The results of the 10-min posttest, however, could be explained in terms of learned helplessness as well. Specifically, it may be that subjects assigned to the Medium Goal/Frequent Feedback condition performed poorly in the 10-min posttest because they had basically learned to become "helpless". That is, they realized that they had done

Table 6[1]

Mean Number of Correctly Typed Zip Codes
for 10 Minute Posttest

	Feedback Frequency Level		
	Infrequent (120 Seconds)	Moderate (30 Seconds)	Frequent (15 Seconds)
Easy Goal (329)	132.0 (SD = 19.4)	112.9 (SD = 36.4)	118.4 (SD = 24.3)
Medium Goal (388)	137.3 (SD = 22.8)	122.5 (SD = 20.2)	105.2 (SD = 30.2)
Difficult Goal (446)	124.9 (SD = 25.1)	137.7 (SD = 40.4)	146.4 (SD = 15.9)

[1] n = 10 for each group.

poorly in the 35-min typing task, and they would not be earning their desired extra credit points. Thus, rather than typing at a normal rate during the 10-min posttest, they typed at a depressed rate because of the effects of learned helplessness. It is noteworthy, however, that because of the nature of the 10-min typing task, it is difficult to conclude which mechanism (transfer of training, learned helplessness, or some other unidentified factor) might have caused the poor performance of the Medium Goal/Frequent Feedback condition.

In other experiments testing the learned helplessness hypothesis, subjects are often exposed to a situation which induces the learned helplessness effect, and then tested in a second situation dissimilar to the original learned helplessness situation. If the learned helplessness effects generalize to the second dissimilar situation, one can be more confident that the effects obtained in the original situation are indeed attributable to a learned helplessness effect taking place (Albert & Geller, 1978; Hiroto & Seligman, 1975).

To test this possibility, subjects were administered an anagram test after the 10-min posttest. The anagram test was selected because it targets a task more cognitive in nature than the psychomotor abilities tapped by the ten-min typing posttest.

Anagram Scores

Upon completion of the typing portions of the test, subjects were assigned extra credit points, depending on whether they met their assigned goal. Subjects received extra credit points at this time to enhance the learned helplessness effect

if it indeed occurred. After assigning extra credit points, subjects were administered a test containing 20 anagrams, where they were instructed to solve as many five-letter anagrams as possible in a 3-min period. Anagram solution tests have been used to assess possible learned helplessness effects (cf. Hiroto, 1974; Seligman, 1975).

Figure 5 graphically displays the results of this test. The mean anagram score for each group is shown on the ordinate and feedback frequency is shown on the abscissa. A 3 (Goal Difficulty) x 3 (Feedback Frequency) between-groups ANOVA revealed neither a main effect for Goal Difficulty, $F(2,81) = .49$, $p = .62$, nor Feedback Frequency, $F(2,81) = .29$, $p = .75$. The analysis also failed to reveal a statistically significant interaction between Goal Difficulty and Feedback Frequency, $F(4,81) = .35$, $p = .84$. These analyses are summarized in Table 7. Means and standard deviation are summarized in Table 8.

It is worth noting, however, that subjects assigned to the Medium Goal/Frequent Feedback condition actually did score the lowest on the anagram test among Frequent Feedback subjects, with a mean of 8.3 ($SD = 6.7$) anagrams solved. To determine if lack of statistical power was responsible for this null result, a post-hoc power analysis was performed (Cohen, 1977). The following information was used to calculate power: (a) alpha = .05, one tailed test, (b) sample size = 10 per cell, and (c) effect size (**f**) = .125. Under these conditions, the power of the test for the interaction was .12. Given these findings, a total sample size of at least 1,254 would be needed to test the learned helplessness hy-

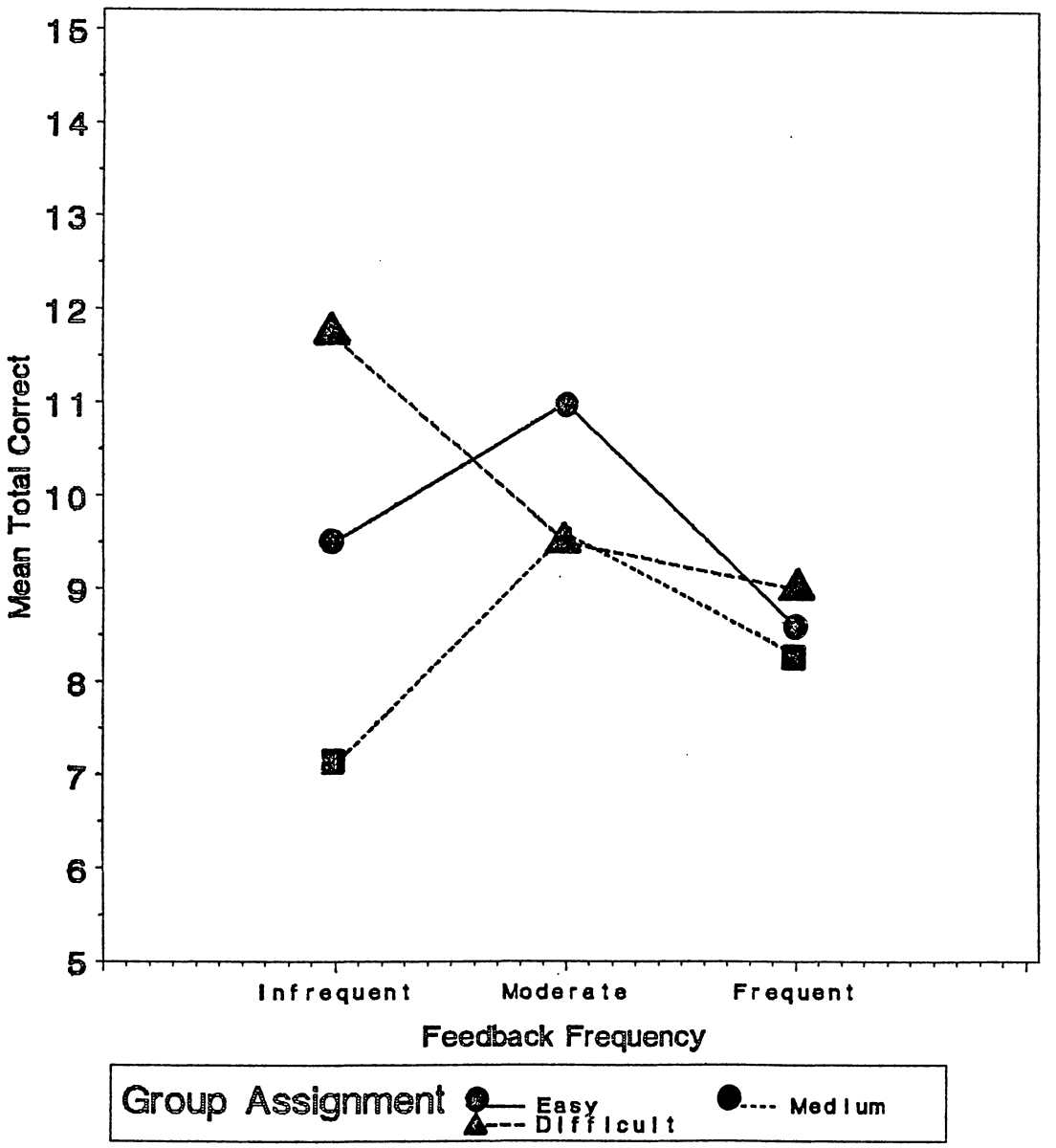

Figure 5. Summary results for anagram test.

Table 7

Analysis of Variance for Anagram Scores

Source	df	Sum of Squares	F Value
Feedback (FB)	2	29.60	0.29
Goal Difficulty (G)	2	50.07	0.49
FB x G	4	72.33	0.35
Subjects (S)	81	4174.90	
Total	89	4326.90	

*p < .05
**p < .01

Table 8[1]

Mean Anagram Scores

	Feedback Frequency Level		
	Infrequent (120 Seconds)	Moderate (30 Seconds)	Frequent (15 Seconds)
Easy Goal (329)	9.5 (SD = 7.72)	11.0 (SD = 7.87)	8.6 (SD = 5.91)
Medium Goal (388)	7.1 (SD = 6.89)	9.6 (SD = 7.42)	8.3 (SD = 6.67)
Difficult Goal (446)	11.7 (SD = 7.53)	9.5 (SD = 7.63)	9.0 (SD = 6.73)

[1] n = 10 for each group.

pothesis with a power of .80. In summary, these analyses provide rather convincing evidence that the drop off in performance for the Medium Goal/Frequent Feedback condition was probably not the result of learned helplessness occurring. The pattern of responding for the feedback questionnaire may provide more insight into the unusual performance of subjects in the Medium Goal/Frequent Feedback condition.

Feedback Questionnaire

After finishing the anagram test, subjects completed a five-item questionnaire which attempted to assess subjects' perception of the performance feedback they received during the 35-min typing task. The first question asked subjects to assess how helpful they believed the feedback was in helping them reach their goals. The second question asked subjects to rate how disruptive they felt the feedback was. The third question asked subjects to estimate how harmful they believed the feedback was in preventing them from reaching their goal, and the fourth question asked subjects to rate how enjoyable they believed the 35-min typing task to be. The fifth question asked subjects to rate how frustrating the task was.

To obtain a better understanding of the pattern of subjects' responding, items two, three and five of the feedback questionnaire were reversed scored and the five responses were analyzed using a principle component factor analysis with a Varimax rotation. The analysis extracted an orthogonal two-factor solution with eigenvalues greater than one. This solution accounted for approximately 78% of the total variance. Inter-item, zero-order correlations are shown in Table 9 while

Table 9[1]

Product Moment Correlations for Responses to Feedback Questionnaire

Item	$\bar{X}$	SD	Correlation 1	2	3	4	5
(1) Helpful	3.84	1.24		.5912**	.6834**	.2903*	.2770*
(2) Disruptive	3.71	1.38			.7171**	.2753*	.2207*
(3) Harmful	3.90	1.27				.4832**	.3309*
(4) Enjoyed	2.85	1.12					.5222**
(5) Frustrating	3.30	1.35					

** $p < .0001$
* $p < .001$

[1] $n = 10$ for each group.

Table 10

Varimax Rotated Component Analysis Factor Matrix
for Feedback Questionaire

Variables	Factors (I)	(II)	Communality
Helped	.84058	.15983	.7321
Disruptive	.87943	.09136	.7817
Harmful	.85869	.32084	.8403
Enjoyed Task	.23568	.83576	.7540
Task Frustration	.11555	.87041	.7710
Sum of Squares (eigenvalue)	2.28621	1.59294	3.8791
Percent of Trace[1]	45.72	31.86	77.58

[1]Trace = 5.00

factor loadings for each of the five items, as well as communality estimates, are shown in Table 10. As can be seen from Table 10, items 1, 2, and 3 loaded primarily on Factor I, while items 4 and 5 loaded primarily on Factor II. Factor coefficient scores were calculated for each subject in the study based upon the factor weights. Two new dependent measures were formed through this procedure: Factor 1 (Feedback Favorableness) and Factor 2 (Task Satisfaction).

It must be noted, at this point, that these questionnaire ratings might be confounded by the fact that subjects who rated the feedback less favorably may have done so not because they believed the feedback to be disruptive of their performance, but rather because they failed to meet their goal and were generally disillusioned with the entire test session, (particularly since they would not receive an extra credit point nor a chance to win the $100). Conversely, subjects who rated the feedback favorably may have been doing so, not because the feedback was important in aiding them reach their goal, but rather because of a general feeling of goodwill towards the task, since they would receive an extra credit point and a chance to win the $100 prize. Figure 6 shows the proportion of subjects in each group who reached their assigned goal. As shown, the proportion of subjects who met their assigned goal varied greatly, ranging from 80% in the Easy Goal/Frequent Feedback and Easy Goal/Infrequent conditions, to only 20% in the Difficult Goal/Infrequent Feedback condition.

Thus, Met Goal/Did Not Meet Goal was used as a covariate in two separate 3 (Goal Difficulty) x 3 (Feedback Frequency) analyses of covariance conducted

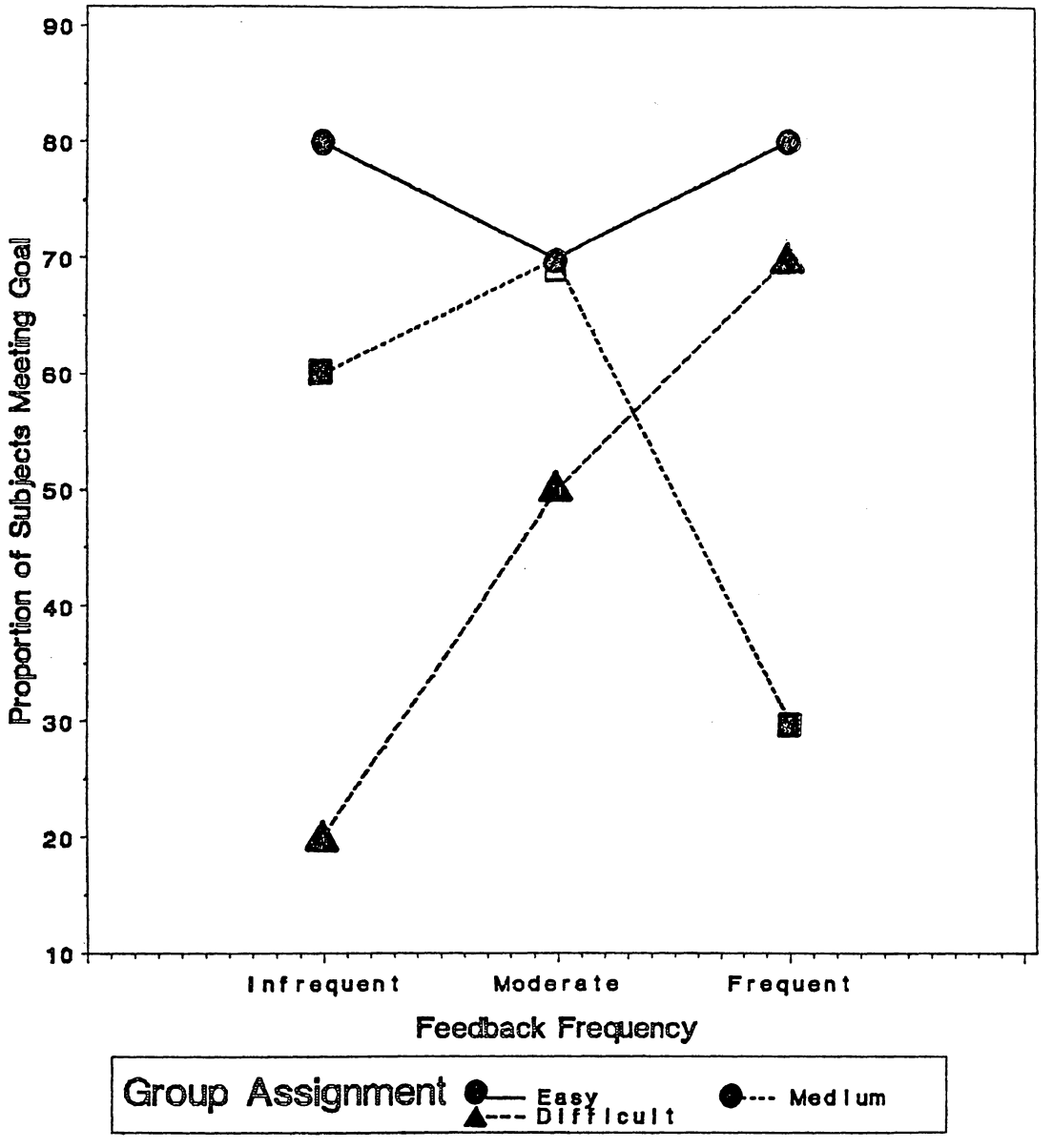

Figure 6. Proportion of subjects meeting assigned goal.

on the factor scores for Feedback Favorableness and Task Satisfaction. (extracted by the components analysis) to control for this possible effect. If a general halo did exist towards the task (whether positive or negative), then it is likely that after the effects of meeting the goal (or not meeting the goal) are covaried out, the interaction between Feedback Frequency and Goal Difficulty will not be statistically significant. On the other hand, if there is not a general halo, the interaction will remain statistically significant.

The 3 (Goal Difficulty) x 3 (Feedback Frequency) analysis of covariance on the feedback favorableness score using Met Goal (Subject either met or did not meet the assigned goal) as a covariate revealed a statistically significant main effect for Met Goal $F(1, 72) = 42.7, p < .0001$. The analysis also revealed a significant interaction between Goal Difficulty and Feedback Frequency, $F(4, 72) = 3.93, p = .006, \eta^2 = 11$. Since items 1 through 3 accounted for approximately 97% of the variance in Factor 1, these scores were summed and are graphically depicted in Figure 7 to show the effects of this interaction. As can be seen, this significant interaction can be explained by the fact that subjects in the Difficult Goal/Frequent Feedback condition rated the feedback in a highly favorable fashion ($M = 14.1, SD = 1.6$), whereas subjects in the Medium Goal/Frequent Feedback condition rated the feedback in a particularly disfavorable fashion ($M = 9.6, SD = 4.92$), $t(18) = 5.21, p < .01$. No other main effects or interactions were significant at the $p = .05$ level. These analyses are summarized in Table

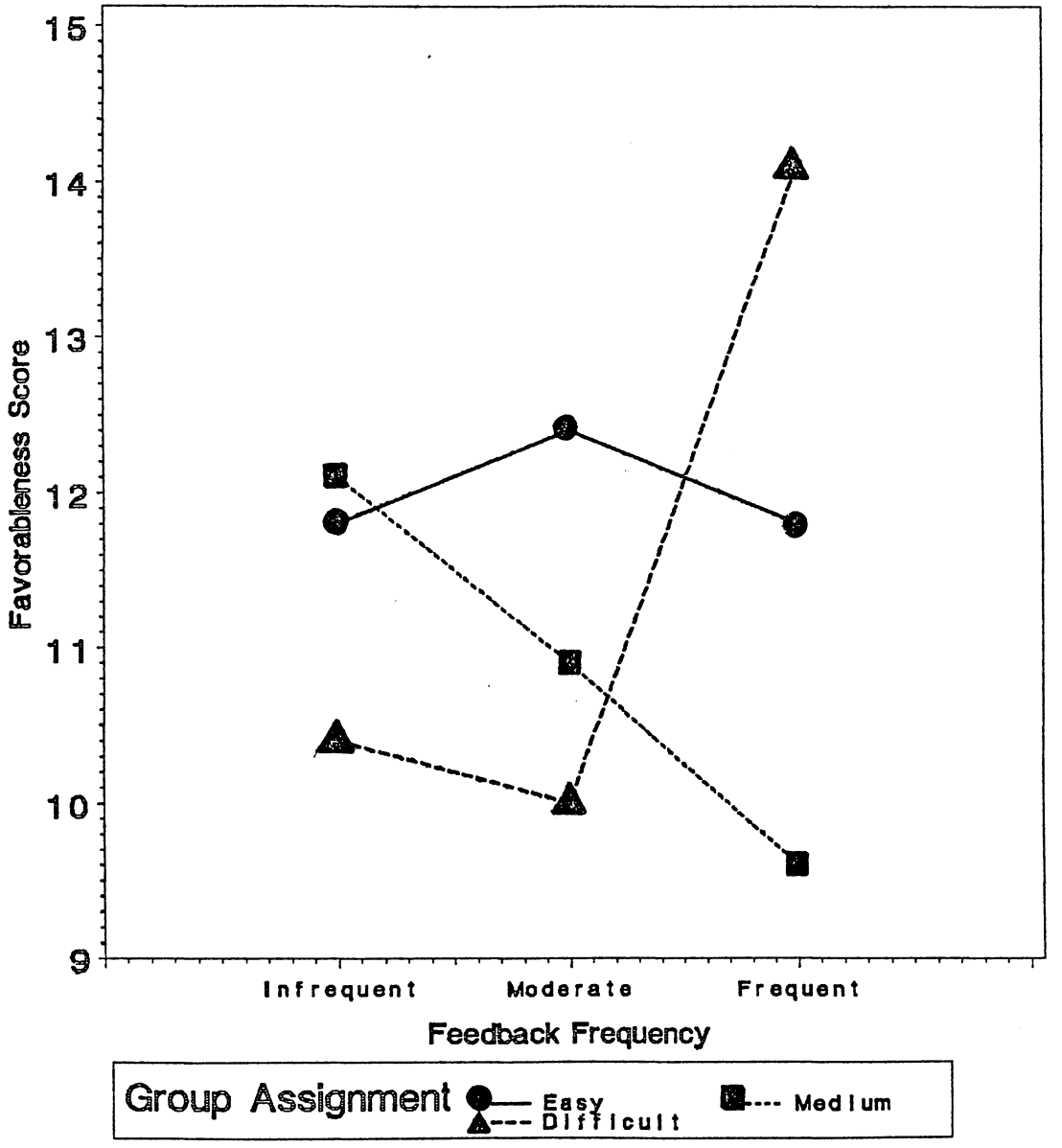

Figure 7. Feedback favorableness score.

Table 11

Analysis of Covariance for Feedback Favorableness Factor Score

Source	df	Sum of Squares	F Value
Feedback (FB)	2	1.21	1.01
Goal Difficulty (G)	2	0.74	0.62
FB x G	4	9.45	3.93**
Met Goal (M)	1	25.70	42.74**
M x FB	2	0.33	0.28
M x G	2	1.58	1.31
M x FB x G	4	6.69	2.78
Subjects (S)	72	43.30	
Total	89	89.00	

*p < .05
**p < .01

Table 12[1]

Feedback Favorableness Score

(Items 2 and 3 reversed scored and summed with Item 1)

	Feedback Frequency Level		
	Infrequent (120 Seconds)	Moderate (30 Seconds)	Frequent (15 Seconds)
Easy Goal (329)	11.8 (SD = 2.6)	12.4 (SD = 3.9)	11.8 (SD = 3.6)
Medium Goal (388)	12.1 (SD = 2.6)	10.9 (SD = 3.2)	9.6 (SD = 4.9)
Difficult Goal (446)	10.4 (SD = 3.7)	10.0 (SD = 3.0)	14.1 (SD = 1.6)

[1] n = 10 for each group.

11. Means and standard deviations for the Feedback Favorableness score are shown in Table 12.

Thus, the Feedback Favorableness score reflected subjects' perceptions of the helpfulness of the feedback they received, even after statistically controlling for the effects of meeting the assigned goal. These results clearly mirror the findings of the 35-min performance task and the ten-min posttest.

The analysis of covariance conducted on the Task Satisfaction measure revealed a significant main effect for Met Goal, $F(1, 72) = 5.75, p = .02$. However, as can be seen in Table 13, no other main effects or interactions were found to be statistically significant at the $p = .05$ level. Therefore, the Task Satisfaction measure probably reflects general task halo.

In summary, these analyses performed on the scores obtained from the feedback questionnaire indicate that subjects in the Medium Goal/Frequent Feedback condition did perceive the feedback as being less useful in helping them attain their goal during the 35-min task because the feedback disrupted their performance. Specifically, because these subjects were assigned a goal based on what the average person could accomplish in a 35-min period, it may be that the feedback these subjects received was much more inconsistent than the feedback a person assigned to an easy goal or difficult goal condition may have received. A person assigned to the easy goal condition would be likely to receive feedback messages which were mostly positive in nature ("You are ahead of schedule"), whereas a person in the difficult goal condition would be likely to receive a ma-

Table 13

Analysis of Covariance for Task Satisfaction Factor Scores

Source	df	Sum of Squares	F Value
Feedback (FB)	2	3.59	2.07
Goal Difficulty (G)	2	4.02	2.32
FB x G	4	5.57	1.61
Met Goal (M)	1	4.98	5.75*
M x FB	2	2.74	1.58
M x G	2	1.72	0.99
M x FB x G	4	4.03	1.16
Subjects (S)	72	62.35	
Total	89	89.00	

*p < .05
**p < .01

jority of negative feedback messages (i.e., "You are behind schedule"). Conversely, a person in the medium goal condition would be expected to receive a mixture of both positive and negative feedback messages. If a subject receives many switches from positive to negative feedback messages (as would be the case for subjects in the Medium Goal/Frequent Feedback condition), the subject may become frustrated or disillusioned with the task and perform poorly. The next section describes a series of analyses designed to test these hypotheses.

Performance Variability

Feedback Switching. Since the program recorded and time-stamped every response made by the subject, it was possible to trace the "feedback history" for each person. Specifically, it was possible to determine how often feedback messages switched sign from the feedback message that preceded it (i.e., how often a "behind schedule" message followed an "ahead of schedule" and vice versa).

If feedback switches were indeed related to the poor performance levels of subjects in the Medium Goal/Frequent Feedback condition, then these subjects would receive a significantly greater amount of feedback switches than subjects in other groups, particularly during the first few minutes of the task. Rather than conducting an omnibus multivariate test, separate analyses were conducted on two dependent variables: proportion of feedback switches and absolute number of feedback switches. Univariate analyses were conducted because: (1) it is believed that subjects perceive proportions of feedback messages differently than *absolute numbers* of feedback messages, thus, it is thought these two measures are

conceptually inconsistent. This is evidenced by the low zero-order correlation between these two measures, $r = .15, p > .05$. (2) even if the multivariate analysis of variance was statistically insignificant, the search for the causal mechanism of the poor performance of the Medium Goal/Frequent Feedback group would necessitate a univariate analysis.

Proportion of Feedback Switches. This was operationalized as the number of feedback switches a subject received (a feedback switch was defined as a positive message that followed a negative message or a negative message that followed a positive message) divided by the total number of possible switches that he/she could have received.

A 3 (Goal Difficulty) x 3 (Feedback Frequency) x 5 (Time: Intervals of 7, 14, 21, 28, and 35 min) repeated measures ANOVA was conducted to test whether groups incurred differential levels of feedback switches over time. If the proportion of feedback switches was an important determinant of the poor performance of the Frequent Feedback/Medium Goal condition subjects, particularly during the early stages of the task, then a statistically significant three-way interaction can be expected, with Medium Goal/Frequent Feedback subjects receiving a high proportion of feedback switching and Difficult Goal/Frequent Feedback subjects receiving a low proportion of feedback switches. (It is expected that switching for the Medium Goal/Frequent Feedback condition subjects also decreased over time as these subjects fall behind the goal).

The three factor repeated measures ANOVA revealed a main effect for Time, $F(4, 324) = 2.98, p = .02$, with subjects, in general, receiving a greater proportion of feedback switches during the first seven min of the task ($M = .19$, $SD = .22$) than during the last seven min of the task, ($M = .14$, $SD = .20$). The repeated measures ANOVA also revealed a main effect for Feedback Frequency, $F(2,81) = 3.46, p = .04$, with subjects in Frequent Feedback conditions ($M = .18$, $SD = .24$) and Moderate Feedback groups ($M = .16$, $SD = .20$) receiving a greater *proportion* of feedback switching than subjects in the Infrequent Feedback condition groups ($M = .09$, $SD = .20$), [$t(18) = 4.16, p < .001$ and $t(18) = 3.91, p < .001$ for Frequent and Moderate Feedback groups, respectively]. No other main effects or interactions were statistically significant at the $p = .05$ level. These analyses are summarized in Table 14.

Absolute Number of Feedback Switches. Although it does not appear that the proportion of feedback switches a subject receives was important in influencing the performance of the Frequent Feedback/Medium Goal condition group, it may be that the *absolute* number of feedback switches was an important factor in influencing performance. Thus, the total number of feedback switches served as the dependent variable in a 3 (Goal Difficulty) x 3 (Feedback Frequency) x 5 (Time) repeated measures ANOVA. This analysis is summarized in Table 15.

Table 14

Analysis of Variance for Proportion of Feedback Switches

Source	df	Sum of Squares	F Value
Feedback (FB)	2	0.73	3.46*
Goal Difficulty (G)	2	0.24	1.14
FB x G	4	0.72	1.71
Subjects (S)	81	8.53	
Time (T)	4	0.36	2.98*
T x FB	8	0.05	0.22[1]
T x G	8	0.09	0.38
T x FB x G	16	0.56	1.16
T x S/FBxG	324	9.75	
Total	449	21.03	

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

[1]An Inverted F-test indicates that this value is signficantly less than 1.0, $F(324,8) = 4.54$ at the $p = .05$ level.

Table 15

Analysis of Variance for Absolute
Number of Feedback Switches

Source	df	Sum of Squares	F Value
Feedback (FB)	2	563.39	17.93**
Goal Difficulty (G)	2	118.67	3.78*
FB x G	4	219.21	3.49*
Subjects (S)	81	1272.74	
Time (T)	4	10.84	0.72
T x FB	8	9.20	0.30[1]
T x G	8	19.26	0.64
T x FB x G	16	50.52	0.83
T x S/FBxG	324	1227.76	
Total	449	3491.59	

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

[1]An Inverted F-test indicates that this value is signficantly less than 1.0, $F(324,8) = 3.33$ at the $p = .05$ level.

The analysis revealed a statistically significant main effect for Feedback Frequency, $F(2, 81) = 17.93$, $p < .0001$, with subjects in the Frequent Feedback condition receiving an average of 2.9 ($SD = 3.9$) feedback switches as compared to an average of 1.5 ($SD = 1.9$) feedback switches for subjects in the Moderate Feedback condition, $t(58) = 3.47$, $p < .01$. Subjects in the Infrequent Feedback conditions received an average of .19 ($SD = .44$) feedback switches messages, which was significantly less than the average number of feedback messages received by the Moderate Feedback groups, $t(58) = 7.23$, $p < .01$.

The analysis also revealed a statistically significant main effect for Goal Difficulty, $F(2,81) = 3.78$, $p = .03$, with subjects in the Difficult Goal conditions receiving significantly more feedback switches ($M = 2.3$, $SD = 3.5$) than subjects in Medium Goal conditions ($M = 1.3$, $SD = 2.6$), $t(58) = 2.25$, $p < .05$, and subjects in the Easy Goal conditions ($M = 1.1$, $SD = 1.9$), $t(58) = 2.96$, $p < .05$. The interaction of Goal Difficulty and Feedback Frequency was also significant, $F(4, 81) = 3.49$, $p < .05$, and is illustrated in Figure 8.[1]

As can be seen, the Difficult Goal/Frequent Feedback condition subjects received the greatest number of feedback switches, averaging 5.02 ($SD = 4.5$),

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[1] Although an F-max test showed that the cell variances were not homogeneous for this analysis, $F(9,9) = 124.3$, $p < .01$, Keppel (1982) indicates that the assumptions concerning the nature of treatment populations are not critical in the evaluation of F-tests for completely randomized designs. Only severe violations of the assumptions of homogeneity of population variances call for some concern, and then only when unequal sample sizes, certain single-*df* comparisons, or repeated measures designs are involved (pp. 468-469).

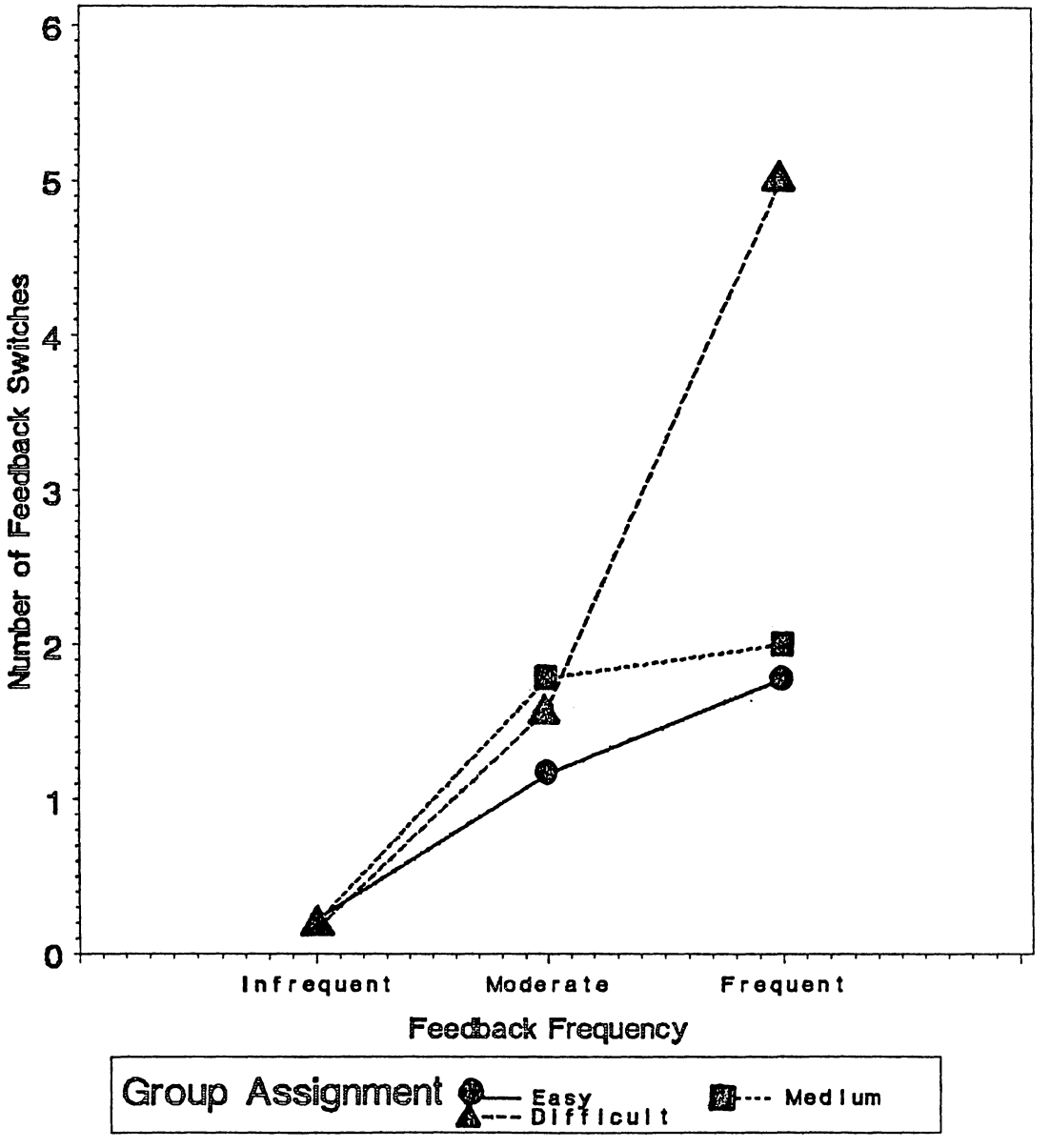

Figure 8. Absolute number of feedback switches.

more than twice the number of feedback switches received by subjects assigned to the Medium Goal/Frequent Feedback condition (M = 2.0, SD = 3.7.), p < .05. Group means and standard deviations are provided in Table 16. No other main effects or interactions were significant at the p = .05 level.

Given that subjects in the Difficult Goal/Frequent Feedback condition received, on average, a significantly greater number of feedback switches than subjects assigned to the Medium Goal/Frequent Feedback condition, it is unlikely that switching in feedback messages caused the decrement in performance of the Medium Goal/Frequent Feedback condition.

Proportion of Positive Messages. Another set of analyses were conducted to determine if the proportion of positive messages (i.e., messages which told the subjects he/she was ahead of schedule) received changed over the 35-min typing task and specifically, whether subjects in the Medium Goal/Frequent Feedback condition were more likely to receive a discrepant proportion of positive (or negative) messages over the time period than other groups. If this occurred, the feedback may have been confusing (in that negative messages would have a different effect on motivation than would positive messages) and not have been helpful in attaining the goal. Two analyses were conducted to investigate this possibility.

Proportion of Positive Messages to Total Messages. A 3 (Goal Difficulty) x 3 (Feedback Frequency) x 5 (Trials: Performance during the 7th, 14th, 21st, 28th, and 35th min time intervals) repeated measures ANOVA was conducted

Table 16[1]

Mean Absolute Number of Feedback Switches[2]

	Feedback Frequency Level		
	Infrequent (120 Seconds)	Moderate (30 Seconds)	Frequent (15 Seconds)
Easy Goal (329)	0.2 (SD = 0.51)[3]	1.2 (SD = 1.43)	1.9 SD = 2.73)
Medium Goal (388)	0.2 (SD = 0.40)	1.8 (SD = 2.02)	2.0 (SD = 3.71)
Difficult Goal (446)	0.2 (SD = 0.42)	1.6 (SD = 2.21)	5.0 (SD = 4.46)

[1] n = 10 for each group.

[2] Defined as the total number of times a positive feedback message is followed by a negative feedback message and vice versa.

[3] Hartleys test for homogeneity of variance indicates that these cell variances were not homogeneous, $F(9,9) = 124.3$, $p < .001$.

on the dependent variable of proportion of positive feedback messages. The analysis revealed a main effect for Goal Difficulty, $F(4,81) = 5.13$, $p = .008$, with Easy Goal subjects, not surprisingly, receiving a much greater proportion of positive messages ($M = .70$, $SD = .38$) than either Medium Goal condition subjects, $M = .46$, $SD = .43$, $t(58) = 4.50$, $p < .01$; or Difficult Goal condition subjects, $M = .42$, $SD = .41$), $t(58) = 5.39$, $p < .01$. As can be seen from Table 17, no other main effect or interaction was significant. In sum, this analysis provided no insight into the cause of the performance decrements observed in the Frequent Feedback/Medium Goal group.

Absolute Number of Positive Feedback Messages. A second 3 x 3 x 5 repeated measures ANOVA was performed on the absolute number of positive feedback messages received by each subject, revealing a main effect for Feedback Frequency, $F(2,81) = 31.3$, $p < .0001$. Subjects in the Frequent Feedback conditions received significantly more positive messages, $M = 10.4$, $SD = 7.31$, than subjects in the Moderate Feedback condition, $M = 5.5$, $SD = 4.41$, $t(58) = 6.18$, $p < .01$. Moderate Feedback subjects received significantly more positive messages than subjects in the Infrequent Feedback condition, $M = 0.4$, $SD = 1.47$), $t(58) = 11.82$, $p < .01$. No other interactions or main effects were significant at the $p = 05$ level. These analyses are summarized in Table 18.

Thus, it appears that neither feedback message switching nor the amount or proportion of positive feedback messages delivered can explain the performance

Table 17

Analysis of Variance for Proportion of Positive Feedback Messages

Source	df	Sum of Squares	F Value
Feedback (FB)	2	1.37	1.06
Goal Difficulty (G)	2	6.67	5.13**
FB x G	4	5.46	2.10
Subjects (S)	81	52.73	
Trials (T)	4	0.27	1.74
T x FB	8	0.40	1.29
T x G	8	0.24	0.79
T x FB x G	16	1.01	1.64
T x S/FBxG	324	12.44	
Total	449	80.59	

*p < .05
**p < .01

Table 18

Analysis of Variance for Absolute
Number of Positive Feedback Messages

Source	df	Sum of Squares	F Value
Feedback (FB)	2	6093.20	31.30**
Goal Difficulty (G)	2	296.12	1.52
FB x G	4	803.09	2.06
Subjects (S)	81	7884.18	
Trials (T)	4	15.99	0.68
T x FB	8	51.97	1.10
T x G	8	87.25	1.85
T x FB x G	16	147.06	1.56
T x S/FBxG	324	1911.72	
Total	449	17290.58	

*p < .05
**p < .01

decrements observed in subjects assigned to the Medium Goal/Frequent Feedback condition.

Intra-Subject Variability. The performance decrements observed in subjects assigned to the Medium Goal/Frequent Feedback condition may have been due to subjects in this condition being inefficient in the way they completed the task. Specifically, subjects may have typed erratically throughout the task, as a result of the goal requirements and feedback presentation, instead of establishing a steady rate of performance (which is important when performing a repetitive task). This inefficiency would serve to limit the performance capabilities of the subject. The previous analyses probably masked these effects because these analyses were aimed at identifying inter-subject differences rather than intra-subject differences. If erratic typing performance is an important determinant of performance, high levels of intra-subject variability would be present in the Medium Goal/Frequent Feedback condition cell.

It should be pointed out that this intra-subject variability issue is an important one for the other experimental conditions as well, since it provides information regarding whether or not feedback and goal assignments have any effect on subjects' typing efficiency (i.e., did group assignment in any way affect subjects' uniformity of their own typing rate). To test this hypothesis, a 3 (Goal Difficulty) x 3 (Feedback Frequency) x 5 (Time: Performance during the 7th, 14th, 21st, 28th, and 35th min time intervals) repeated measures ANOVA was conducted on the dependent variable of intra-subject variability.

The analysis revealed a significant main effect for Trials, $F(4, 324) = 4.27$, $p = .0002$, with intra-subject variances averaging 7.6 entries per minute (EPM) ($SD = 3.92$) during the first seven min, 5.1 EPMs ($SD = 3.38$) during the second seven min segment, 6.2 EPMs ($SD = 3.88$) during the third seven min segment, 6.6 EPMs ($SD = 6.02$) during the fourth seven min segment, and 7.1 EPMs ($SD = 5.57$) during the final seven min. No other main effects or interactions reached statistically significance at the $p = .05$ level. This analysis is summarized in Table 19.

Thus, it appears that intra-subject performance variability was not a factor in explaining the performance decrements found in the Medium Goal/Frequent Feedback condition.

Other Analyses

Error Rate. The decrement in performance for the Medium Goal/Frequent Feedback condition may have been influenced by the number of zip codes attempted in relation to the number of zip codes typed correctly. That is, one could hypothesize that the decrement in performance for the Medium Goal/Frequent Feedback condition may be a function of subjects becoming frustrated with the task as evidenced by the number of typing mistakes in the task. Two behavioral indicators of frustration in this study are number of typing errors and proportion of correctly typed zip codes. If subjects become frustrated, they would be likely to commit more typing errors.

Table 19

Analysis of Variance for
Intra-Subject Variability

Source	df	Sum of Squares	F Value
Feedback (FB)	2	53.92	0.78
Goal Difficulty (G)	2	87.21	1.25
FB x G	4	35.51	0.26
Subjects (S)	81	2817.41	
Trials (T)	4	323.09	4.27**
T x FB	8	257.96	1.70
T x G	8	98.41	0.65
T x FB x G	16	257.57	0.85
T x S/FBxG	324	6129.64	
Total	449	10060.72	

*p < .05
**p < .01

To test this hypothesis, a 3 (Goal Difficulty) x 3 (Feedback Frequency) between-groups ANOVA was conducted on the total number of zip codes typed incorrectly by each subject. The analysis revealed no statistically significant main effects, nor was the interaction between Goal Difficulty and Feedback Frequency significant. This analysis is summarized in Table 20.

A second 3 x 3 ANOVA was conducted with proportion of correctly typed zip codes as the dependent variable (i.e., correctly typed zip codes ÷ total number of zip codes attempted). This second analysis again failed to yield a significant main effect for either Goal Difficulty or Feedback Frequency, nor was the interaction significant. This analysis is summarized in Table 21.

Distance From Goal. Since subjects were assigned goals prior to the beginning of the 35-min typing task, one measure of typing efficiency is distance from the goal (in terms of number of zip codes either above or below the assigned goal) at the end of the 35-min period. Frequent feedback may not only be effective at improving performance, but it may also be effective at promoting *efficient* performance. When a worker is assigned a goal, ideally, he or she would prefer to come as close to this goal as possible. Failing to meet the goal may elicit reprimand from a work supervisor or exceeding the goal may prompt negative reaction from co-workers, especially in piece rate work systems, where performance standards are based on ongoing levels of performance.

Thus, to test the hypothesis that frequent feedback promotes efficient performance, a 3 (Goal Difficulty) x 3 (Feedback Frequency) between-groups

Table 20

Analysis of Variance on Total Number of Zip Codes Typed Incorrectly

Source	df	Sum of Squares	F Value
Feedback (FB)	2	614.82	0.25[1]
Goal Difficulty (G)	2	2013.36	0.81
FB x G	4	1666.31	0.34
Subjects (S)	81	100514.40	
Total	89	104808.89	

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

[1]None of these F values are significantly less than 1.0 at the $p < .05$ level.

Table 21

Analysis of Variance on Proportion of Zip Codes Typed Incorrectly

Source	df	Sum of Squares	F Value
Feedback (FB)	2	1.87	0.02[1]
Goal Difficulty (G)	2	85.80	0.96
FB x G	4	121.96	0.68
Subjects (S)	81	3610.94	
Total	89	3820.58	

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

[1]An Inverted F-test indicates that this value is significantly less than 1.0, $F(81,2) = 50.0$ at the $p = .05$ level.

Table 22

Analysis of Variance on Average Distance from Assigned Goal

Source	df	Sum of Squares	F Value
Feedback (FB)	2	572.42	0.09
Goal Difficulty (G)	2	30142.96	4.98**
FB x G	4	49771.11	4.11**
Subjects (S)	81	245363.20	
Total	89	325849.69	

*p < .05
**p < .01

ANOVA was conducted. The dependent variable was the difference between the number of zip codes assigned and the actual number of zip codes typed correctly.

The analysis, summarized in Table 22, revealed a statistically significant main effect for Goal Difficulty, $F(2,81) = 4.98, p = .01$ with subjects in the Easy Goal condition averaging 14.3 ($SD = 50.8$) zip codes above their goal of 329, while subjects in the Medium Goal condition averaged 18.3 ($SD = 58.8$) zip codes below their assigned goal of 388 zip codes. This difference was statistically significant, $t(58) = 4.52, p < .01$. Difficult Goal subjects averaged 28.6 ($SD = 64.4$) zip codes below their assigned goal of 446 zip codes.

The analysis also revealed a statistically significant interaction, $F(4,81) = 4.11, p = .004$. This interaction is displayed graphically in Figure 9. Group means and standard deviations are shown in Table 23. As can be seen in Figure 9, more frequent feedback promoted more efficient typing for subjects in the Easy Goal and Difficult Goal conditions. For subjects in the Easy Goal condition, the average distance from the goal decreased from 29.5 for the Infrequent Feedback condition, to 10.6 for subjects in the Moderate Feedback condition, to an average distance of only 2.8 for subjects in the Frequent Feedback conditions. Subjects in the Frequent Feedback condition were significantly closer to the goal than Infrequent Feedback subjects, $t(18) = 2.63, p < .01$. Comparable results were obtained for subjects in the difficult goal condition. Subjects assigned to the Infrequent Feedback condition averaged a distance of 56.5 zip codes from their goal, while subjects in the Moderate Feedback condition averaged 40.8 zip codes

from their assigned goal. Subjects in the Frequent Feedback condition averaged a goal distance of 11.4 zip codes. The distance from the goal for Frequent Feedback subjects was significantly less than Moderate Feedback subjects, $t(18) = 3.44$, $p < .01$; and Infrequent Feedback subjects, $t(18) = 7.35$, $p < .01$. Thus, for subjects in these conditions, more frequent feedback provided for more efficient typing performance as gauged by average distance from the assigned goal.

For subjects in the Medium Goal condition, feedback frequency appeared to have no effect on performance efficiency. Subjects in the Infrequent Feedback condition averaged only 3.9 zip codes above their goal whereas the Moderate Feedback condition subjects averaged only 3.1 zip codes away from their assigned goal. This should not be surprising for these two groups since they were assigned a goal based on a normative standard of performance. That is, the pilot studies indicated that the average person will type 388 zip codes in 35-min in a completely free-responding situation (with feedback absent).

The explanation for the poor performance of subjects in the Medium Goal/Frequent Feedback condition remains an enigma. As can be seen, this group averaged 55.8 zip codes below their assigned goal. Despite numerous post-hoc analyses, a suitable explanation for this drastic and unexpected decrement in performance has not been identified.

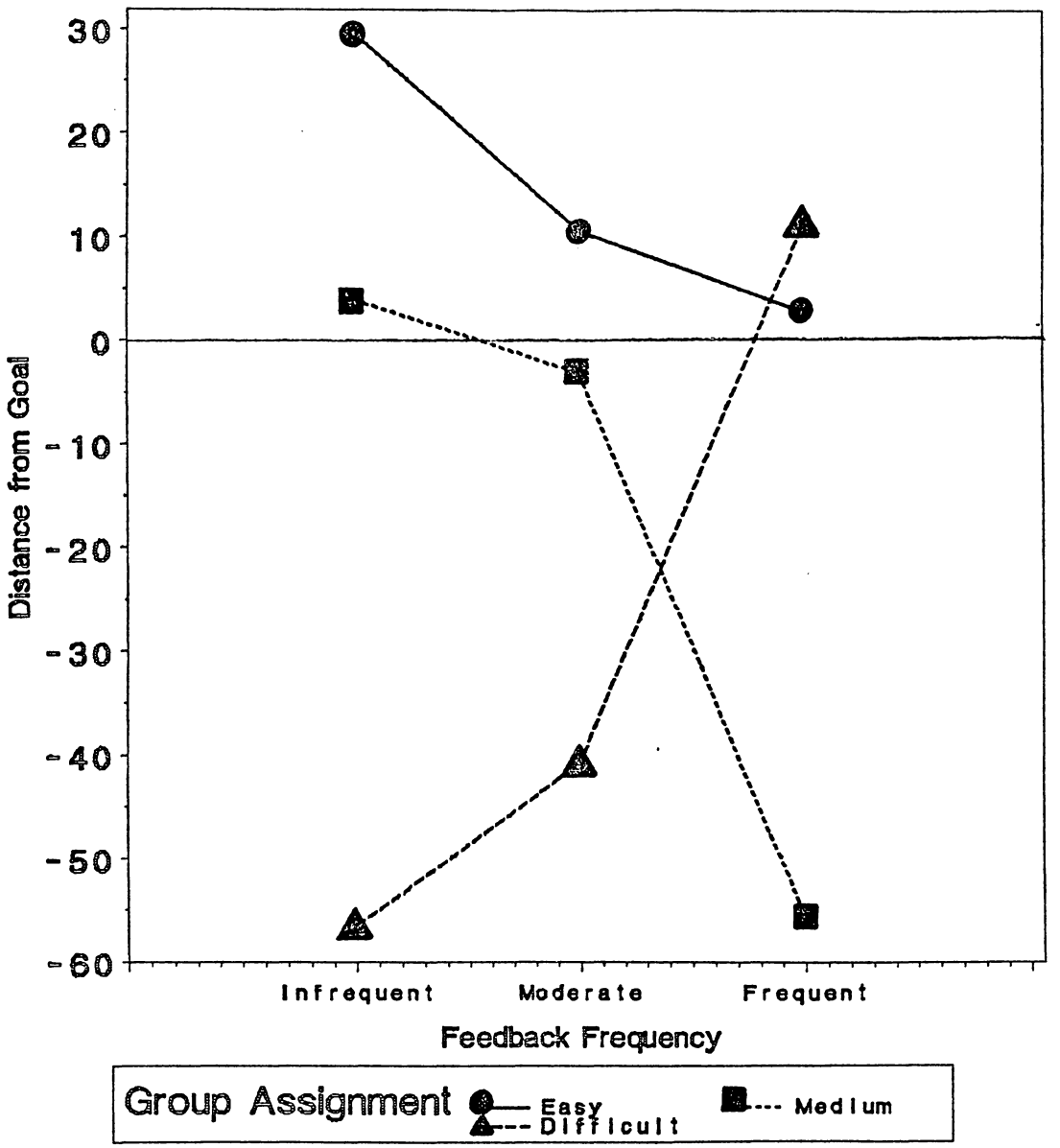

Figure 9. Average distance from assigned goals.

Table 23[1]

Mean Distance from Assigned Goal

	Feedback Frequency Level		
	Infrequent (120 Seconds)	Moderate (30 Seconds)	Frequent (15 Seconds)
Easy Goal (329)	29.5 (SD = 55.2)	10.6 (SD = 64.8)	2.8 (SD = 25.6)
Medium Goal (388)	3.9 (SD = 61.1)	−3.1 (SD = 20.0)	−55.8 (SD = 68.2)
Difficult Goal (446)	−56.5 (SD = 48.2)	−40.8 (SD = 86.7)	11.4 (SD = 27.3)

[1] n = 10 for each group.

Discussion

Electronic surveillance has become an increasingly popular tool for monitoring and evaluating employee performance. Not only can electronic performance monitoring accurately and fairly record individual productivity figures, it also establishes fair performance expectations and provides a matter-of-fact performance appraisal instrument (Henriques, 1986).

Despite the popularity of electronic performance monitoring among management, much resistance to the practice of electronic monitoring exists, particularly among unionized workers employed in data-intensive industries. In the last two years, bills have been introduced in seven state legislatures aimed at prohibiting the practice of computer monitoring (Henriques, 1986). This resistance is due, in part, to the unsatisfactory implementation of some performance monitoring software systems. In particular, not much is known regarding acceptable techniques for motivating persons working under such systems. Rather than being a system that intimidates employees, this author suggests that performance monitoring systems might serve to motivate subjects in a positive fashion. Greater efforts are needed to further the understanding of the psychological aspects of such systems. Indeed, principles derived from psychological research could be very useful in improving user acceptability and performance.

The purpose of the present study was to determine whether the application of feedback and goal-setting techniques would improve the performance and satisfaction of persons working in a simulated performance monitoring environment.

The main question of interest was whether frequent feedback in conjunction with a performance goal would result in improvements in worker performance. Besides the obvious practical implications of attempting to improve the acceptability of performance monitoring systems, the current research is also noteworthy since it is the only study to date that systematically investigated the relationship between goal difficulty and feedback frequency. Indeed, prior to the present research, it has been generally recognized that little is known about the effects of frequent feedback on work performance, particularly in terms of a goal-setting paradigm (Komaki et al., 1980, Locke et al., 1981).

Through the use of a computer-driven feedback mechanism, the experimental unreliability of treatment implementation, ceiling effects, and confounding of feedback specificity with feedback frequency could be addressed and controlled precisely. Previous research in this area has been fraught with critical flaws in experimental design and interpretation of findings. The following discourse summarizes tests of the hypotheses formulated previously in the introduction.

Hypothesis 1a: ***A linear relationship will be found between goal difficulty and performance.***

The results of this experiment are entirely consistent with those of numerous other studies which found that specific and difficult task goals motivate higher performance than easier goals (e.g., Locke et al., 1981; Tubbs, 1986). The typing performance of subjects assigned to the Difficult Goal conditions averaged 13% higher than the performance of subjects assigned to the Medium Goal conditions, and 21% higher than subjects assigned to the Easy Goal conditions. This finding

adds to the list of over 50 research articles documenting the beneficial effects of difficult versus easy goals Tubbs (1986).

Hypothesis 1b: ***A linear relationship will exist between feedback frequency and performance output.***

The prediction that greater amounts of performance feedback, would motivate higher levels of output was not supported. This result is contrary with findings from other studies (Anderson, Kulhavey, & Andre, 1971; Cook, 1968; Hundal, 1969; Ivancevich et al., 1970). As shown in Figure 2, performance for Difficult Goal subjects did improve as the frequency of feedback increased. In contrast, performance decreased in both Easy and Medium Goal conditions as subjects received greater amounts of feedback.

On a superficial level, one might conclude from the results of this study that frequent feedback does not facilitate performance in most cases (i.e., when the goal is of easy or medium difficulty). However, when one considers performance in terms of distance from the goal (e.g., Figure 9), it was found that subjects administered frequent feedback in Difficult and Easy Goal conditions actually came closer to their assigned Goals than Easy and Difficult Goal subjects assigned to the Infrequent and Moderate feedback conditions. Furthermore, simple effects analysis on the distance from the goal data substantiated the observation that frequent feedback facilitates efficient performance for subjects in both Difficult Goal and Easy Goal conditions, $ps < .05$.. Thus, the current notion that the effects of feedback frequency in work environments can be explained predominantly in terms of increasing worker output (Chhokar & Wallin, 1984; Ilgen et

al., 1979) is incomplete. Not only does the frequency dimension of feedback provide a motivational function (in terms of increasing output), but frequency also contributes an informational function by providing the worker with up-to-date knowledge regarding his/her efficiency in reaching the assigned goal. Consistent with cybernetics approaches, feedback is most efficient when it increases knowledge through a reduction of uncertainty (Moray, 1981; Shannon & Weaver, 1949). Apparently, the extra feedback provided in the Frequent Feedback condition with Difficult and Easy goals was instrumental in reducing subjects' uncertainty regarding goal requirements to a greater degree than subjects assigned to the Infrequent or Moderate Feedback levels. As a result of this reduced uncertainty, subjects in the Frequent Feedback condition became more efficient.

In sum, these data indicate that not only can performance feedback increase worker output, it also can improve the *efficiency* in which that output is produced by the worker, particularly when explicit performance goals are provided. It is therefore suggested that frequent feedback be provided not necessarily to motivate greater improvements in worker output, but rather to promote efficiency in performance. Greater frequencies of feedback can allow workers to pace themselves, and set their own rate of performance, while still meeting production goals. Indeed, greater task autonomy can lead to higher levels of job satisfaction (Spector, 1978).

Hypothesis 2: ***Feedback in combination with difficult, specific goals will lead to optimal levels of performance.***

As predicted, the interaction between goal difficulty and feedback frequency was significant. That is, in addition to specific, difficult, but attainable goals, greater frequencies of feedback are needed to perform at higher levels. Either low frequencies of feedback or goals alone are not sufficient to improve performance. As can be seen from Figure 2, the subjects in the Difficult Goal/Frequent Feedback condition performed at a level 12% higher than the next highest performing group (i.e., Difficult Goal/Moderate Feedback group) and an average of 25% higher than the average performance of the rest of the groups combined.

Before the present study, little was known about the effects of more frequent feedback on performance when goals were assigned. The only other previous study investigating this relationship was poorly controlled and showed no effects for greater frequencies of feedback. The findings of the present study provide rather convincing evidence, that optimal levels of performance output will be achieved not only when the performance standard is set at a difficult level, but also when performance feedback is provided frequently.

Not only did subjects in this group perform at higher levels when the feedback was applied, but they also performed at the highest level even when the feedback was withdrawn during a ten-min posttest. Obviously, the residual effects of frequent feedback were present even after it has been withdrawn. Whether are not these effects are transitory is not known (see Figure 3), and is an important empirical question for follow-up research.

The Feedback Favorableness score indicated that not only did Difficult Goal/Frequent Feedback subjects perform at the highest level, they also rated the feedback in the most favorable fashion. Even when the effects of meeting the goal were controlled for, these subjects still rated the feedback as more useful than the other subjects. In addition, it appears that these Difficult Goal/Frequent Feedback subjects were more likely to use the feedback on an ongoing basis during the test period as evidenced by the average number of feedback switches which occurred during the task (see Figure 8). Feedback switching is defined as the number of times a negatively signed feedback message ("You are behind schedule") is followed by a positively signed message ("You are ahead of schedule") and vice versa. Subjects in the Difficult Goal/Frequent Feedback condition averaged 250% more feedback switches than subjects in the other two frequent feedback groups. When feedback switching is at a high level, feedback presentations provide greater increments of information. Conversely, the absence of switching indicates that the feedback is not providing information beyond the previous presentation. For example, if a person is behind on Presentation #1 and each subsequent presentation tells the subject he/she is behind, the utility of the feedback decreases, since the degree of uncertainty is minimal. However, if many feedback switches occur, the subject is probably experiencing greater levels of uncertainty, since he/she will not be able to predict as confidently whether he/she is ahead or behind schedule. Thus, each presentation can serve to reduce uncertainty and therefore will be valued by the subject. In general,

greater frequencies of feedback switching are indicative of the feedback allowing subjects to perform in an efficient and timely manner. The greater degree of feedback switching among Difficult Goal/Frequent Feedback subjects substantiates subjects' self-report that the feedback was helpful to them in reaching their assigned goals.

Currently accepted notions regarding frequent feedback suggest that frequent feedback will result in performance decrements when it is too frequent, particularly when the work standard is challenging (Ilgen et al., 1979). Ilgen et al. suggest that as the frequency of feedback increases, the degree to which the person feels controlled by the source of the feedback also may increase. This in turn is expected to decrease the recipient's desire to respond because of a perceived loss of personal control. Personal control is seen as a necessary condition for intrinsic motivation (Deci, 1975). Personal control can be described as an individual's feeling that he or she has chosen freely to engage in a particular behavior. Thus, as the frequency of feedback increases, it is presumed that subject's perceptions of personal control should decrease, and as a result, intrinsic motivation should decline, thus reducing the individual's willingness to respond. This thinking is almost parallel to the findings in the Path-Goal theory of leadership, in which only subordinates who lacked structure were satisfied with structured feedback, whereas in structured situations, similar behavior by the feedback source was perceived as unnecessary control (cf. House, 1971).

In addition to issues of personal control and intrinsic motivation, research in learned helplessness would predict that subjects assigned to a nearly unattainable goal would perform poorly. Seligman and his associates (Peterson & Seligman, 1984, Seligman, 1975; Seligman & Maier, 1967) have stressed that a perceived lack of control over circumstances is the crucial factor in producing learned helplessness. In the context of the present study, subjects assigned to the Difficult Goal condition groups should have perceived more of a lack of control over the task than subjects in the Easy and Medium Goal conditions, simply because of the greater chance of failure. Thus, subjects assigned to the Difficult Goal/Frequent Feedback condition should have shown the least willingness to respond, not only because the frequent feedback should have decreased subject's perceptions of personal control but also because the likelihood of failure was greatest.

The results of the present research are not supportive of intrinsic motivation and learned helplessness. In the current study, subjects assigned to the Difficult Goal/Frequent Feedback condition should have experienced very low perceptions of personal control. Not only was the task highly structured (in that the task was very rudimentary, with little opportunity to engage in responding other than that of keyboard typing), but feedback was also provided at a very high rate. In fact, it is unlikely that feedback could have been provided at a more frequent rate. As a function of this loss of personal control, intrinsic motivation should have decreased, leading to a reduction in the subject's willingness to respond. How-

ever, rather than a reduction in responding, these subjects performed at a rate 25% higher than the average rate of the other groups. In addition, the findings of Path-Goal theory suggest that despite their rate of responding, these subjects should have low levels of satisfaction with the task. Again, these predictions were not supported. The findings of the questionnaire data indicate that subjects in the Difficult Goal/Frequent Feedback condition were actually more appreciative of the performance feedback.

In contrast to subjects assigned to the Difficult Goal/Frequent Feedback, subjects assigned to the Infrequent and Moderate Feedback/Difficult Goal condition should have experienced higher perceptions of personal control (since the feedback was provided on a less frequent basis) and, according to Path-Goal theory, should have been more satisfied with the task, since less structuring feedback was provided. Compared to subjects in the Difficult Goal/Frequent Feedback condition, however, a simple effects analysis indicated subjects assigned to the Infrequent and Moderate Feedback/Difficult goal conditions reported significantly lower levels of satisfaction with the feedback, $p < .05$. This negative evaluation of the task feedback occurred despite these two groups having the second and third highest performance rates of the nine groups. Thus, it appears that, although performance can be maintained at a high rate, these subjects neither enjoyed the task nor believed the feedback to be very helpful in reaching their goal. In summary, the current findings do not support the generally ac-

cepted notion that too frequent feedback can be deleterious to performance and job satisfaction.

It is the opinion of this author that frequent feedback per se is not the operative factor which directly influences subjects' perceptions of personal control and intrinsic motivation. Instead, it is believed that feedback will be valuable to the person as long as it aids in the reduction of task uncertainty. Thus, frequent feedback will probably not be perceived as controlling as long as the feedback provides beneficial increments in information over the last feedback presentation. In other words, irrespective of its frequency, feedback will be beneficial as long as it serves to reduce uncertainty (Shannon & Weaver, 1949). When feedback does not serve to reduce uncertainty, however, it is suggested that perceptions of personal control will decline, tasks will no longer be intrinsically motivating, and as a result, willingness to respond will decrease.

Hypotheses 3 and 4: ***Frequent feedback will improve performance except where the goal is set to a difficult level. Then frequent feedback will have a debilitating effect on performance.***

As described above, this effect obviously didn't occur. The Difficult Goal/Frequent Feedback condition subjects actually performed at the highest rate of all subjects. This may be the result of not making the difficult goal challenging enough. For example, would the outcome have been the same if the goal were set to 600 zip codes instead of 446? It should be noted, however, that many previous investigations of the effects of goal difficulty on performance have identified 115% of normative performance as a difficult but attainable goal (cf.

Locke et al., 1981). In this study, only 5 of the 14 subjects (36%) who met their goal in the Difficult Goal condition were *not* in the Frequent Feedback condition. Thus, for subjects not assigned to the Frequent Feedback condition, 446 zip codes was a formidable goal. In terms of the work environment, the assignment of impossible goals may not only be unrealistic but also may promote resistance not found in the laboratory. For example, actual workers generally have much more normative information available regarding performance, and are likely to reject assigned goals which are impossible to reach (Garland, 1983). Thus, it is probably more realistic to assign difficult, yet attainable goals, rather than impossible goals when attempting to quantify the effects of frequent feedback on performance in real-world work environments.

On the other hand, the assignment of impossible goals may be advantageous in a laboratory study, since it would provide for a more complete test of the difficult goal-feedback frequency relationship. Perhaps an inverted-U shaped function would occur if the goal were truly impossible and the feedback frequent. It is suggested that a partial replication of the current study be performed, where goal difficulty is greater.

The poor performance of the Medium Goal/Frequent Feedback condition subjects remains perplexing. Not only did subjects in this group perform the poorest of any group in the 35-min typing test, these subjects also typed fewer zip codes than any other group during the posttest session. In addition, these subjects rated the feedback as least helpful and scored lowest on the anagram test among

Frequent Feedback subjects. Obviously, these are powerfully consistent results. Even if the subjects assigned to this group, by chance, had low aptitudes for data entry tasks (although this is unlikely given the consistency of insignificant findings when important demographic variables such as WPM typing speed and data entry experience were compared), one would not expect to find negative results across-the-board for this group. Even when the effects of not meeting the goal were partialled out (70% in this group did not meet the goal), these subjects still rated the favorableness of the feedback lower than any other group.

In an attempt to explain these results, a number of post-hoc analyses were undertaken. First, it was hypothesized that a learned helplessness effect occurred for this group rather than the Difficult Goal/Frequent Feedback group because the feedback which the Medium Goal/Frequent Feedback group received was disruptive (did not reduce uncertainty). Specifically, since these subjects were assigned the normative goal level of 388 zip codes in a 35-min period, they should have been able to attain that level even without feedback. This is verified by the performance of the Medium Goal/Infrequent Feedback subjects. These subjects finished an average of only 3.9 zip codes away from the goal even though they received feedback an average of only once every two minutes. This 3.9 average is significantly less ($p < .05$) than the distance from goal average of the Easy Goal/Infrequent Feedback group (an average of 29.5 zip codes above the goal) and the Difficult Goal/Infrequent Feedback group (an average of 56.5 zip codes below the goal). As a result it was hypothesized that Medium Goal/Frequent

Feedback subjects felt unduly controlled, experienced learned helplessness, and thus, their willingness to respond was attenuated.

To test this hypothesis the results of the 10-min posttest were analyzed. The analysis showed that the Medium Goal/Frequent Feedback condition subjects scored lowest on this test. These data provided support for the notion that a learned helplessness effect occurred. However, if learned helplessness did occur, one would expect the residual of this effect to transfer to a task dissimilar to the initial motor-skills task. Thus, an anagram test was administered. The anagram test was thought to tap cognitive abilities not accessed during the typing test. An analysis of these data showed no significant effects, although the Medium Goal/Frequent Feedback subjects did score the lowest on this test. This effect, however, was not significant. In fact, a post-hoc power analysis indicated that to show an effect with the differences observed, a sample size of 1,260 would be needed to support the learned helplessness hypotheses. This is not to say that learned helplessness did not occur. It is possible that the administration of the anagram test may have failed to tap feelings of learned helplessness.

An analysis of the feedback questionnaire data indicated that subjects in the Medium Goal/Frequent Feedback condition rated the feedback in the most negative fashion. This finding provides support for the contention that the frequent feedback delivered to the Medium Goal group was unnecessarily often (since it did not serve to reduce uncertainty), and thus subjects perceived it as superfluous.

To test whether Medium Goal/Frequent Feedback condition subjects received a disproportionately high amount of disruptive feedback, the amount of feedback switching was calculated. The results showed that Difficult Goal/Frequent Feedback subjects were most likely to receive the greatest amount of feedback switching, as discussed above.

A subsequent set of analyses investigated the ratio of positive to negative messages for the Medium Goal/Frequent Feedback group. It was thought that, if this ratio changed drastically over the 35-min typing task, the decrement in performance may have been due to the feedback confusing the subject. The analysis failed to reveal any informative findings.

A final analysis investigated the role of intra-subject performance variability. Specifically, this analysis was aimed at identifying differences in performance rates within subjects if they existed. Perhaps subjects in the Medium Goal/Frequent Feedback condition performed in bursts, in order to instill greater levels of control over the task. The analysis revealed no significant differences in average intra-subject variability between groups.

In summary, none of the post-hoc analyses adequately explained the drop-off in performance of the Medium Goal/Frequent Feedback condition. Obviously, follow-up research is necessary to explore this effect.

Shortcomings in the Present Study and Implications for Further Research

An obvious shortcoming in this study was the duration of the performance session. Subjects were enlisted for two-hour sessions. Further work needs to be

conducted to determine if the effects obtained in the present study are generalizable to situations where the work period is much longer (i.e., up to eight hours). Actually, the results of this study suggest that more frequent feedback provides a mechanism for allowing more efficient performance, such that with more frequent performance feedback, workers wouldn't need to go all out for eight hours to make sure they have met their work goal for that day. Rather, greater amounts of performance feedback should allow workers to be more efficient at pacing individual work output.

It is important to note that the use of college students as subjects may not be an issue in this study. Nearly half of the subjects enlisted for the study had had some data entry experience and most subjects reached their performance asymptote early in the testing session. In fact, the robustness of the effects obtained in this study (42% of the variance accounted for by the main effect of goal difficulty and the interaction of goal difficulty and feedback frequency) may actually be larger in an actual work setting where operators have more at stake than the $100 jackpot of this study. Obviously, follow-up research could be aimed at investigating this possibility. In addition, follow-up research could investigate whether these effects are generalizable to other tasks such as word processing, or to situations where performance feedback is provided by a manager or supervisor instead of a machine.

As stated earlier, a puzzling outcome of this study was the poor performance of the Medium Goal/Frequent Feedback condition subjects. It is possible that

the performance of this group was due to sampling error. One way to address this problem is to administer a pretest to control for differences in typing ability among subjects. This source of error can then be controlled through direct means, such as blocking, or statistically, through regression analysis. Thus, it is recommended that a follow-up study employ a pretest measure. In addition, pretests can be used to set individual goals, rather than setting goals on the basis of a normative standard. If it is not a problem of sampling error, the most fruitful line of study may incorporate some of the ideas of information theory (i.e., the role that feedback is thought to have in the reduction of uncertainty).

In addition, it may be that the present study did not adequately test *Hypotheses 3 and 4*. Specifically, no effect may have been found because goal difficulty was not manipulated to a great enough degree. Perhaps if the performance goal was set to 150% of normative performance in the Difficult Goal condition (rather than 115%), the hypothesized inverted-U effect may have been found. A follow-up study is needed to test this possibility.

This research paradigm lends itself readily to the investigation of other feedback-related performance issues with practical implications. For example, follow-up research could investigate the impact of different schedules of performance feedback (e.g., fixed interval vs. fixed ratio vs. variable ratio vs. variable interval) on task performance. Another study could investigate the effects of feedback specificity (specific versus non-specific feedback) on performance. The pilot research conducted for this study suggests that non-specific feedback (in the

form of a general "ahead" or "behind" schedule) can have a significantly different effect on performance than specific feedback. A third study could test the relative impact of goals and feedback on performance in a 2 (Feedback: Present vs. Absent) x 2 (Goals: Present vs. Absent) experimental design. Finally, follow-up research could address the question of whether self-administered feedback (perhaps through the use of a dedicated PF key) could increase perceptions of personal control, and thus facilitate task performance.

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Appendix A

Informed Consent Form

Informed Consent

In this study you will learn how to input data without looking at the keyboard. If you have any experience with a number pad, please tell the experimenter.

Your identity and any records of your performance will remain confidential. **Your participation is voluntary and you may discontinue participation at any time without penalty other than the loss of experimental credit.**

For more information, or if you have any questions, please call:

Jim Rudd at . or
E. Scott Geller, Ph.D.
or see:
, Ph.D. or
, Ph.D. from the Human Subject's Committee.

Under the conditions set forth above, I _____ voluntarily agree to participate in this study.

Signed _____ Date _____

I.D. # _____ Phone _____

Address _____ (optional)

Teacher _____

Can you type? _____ WPM Average_____

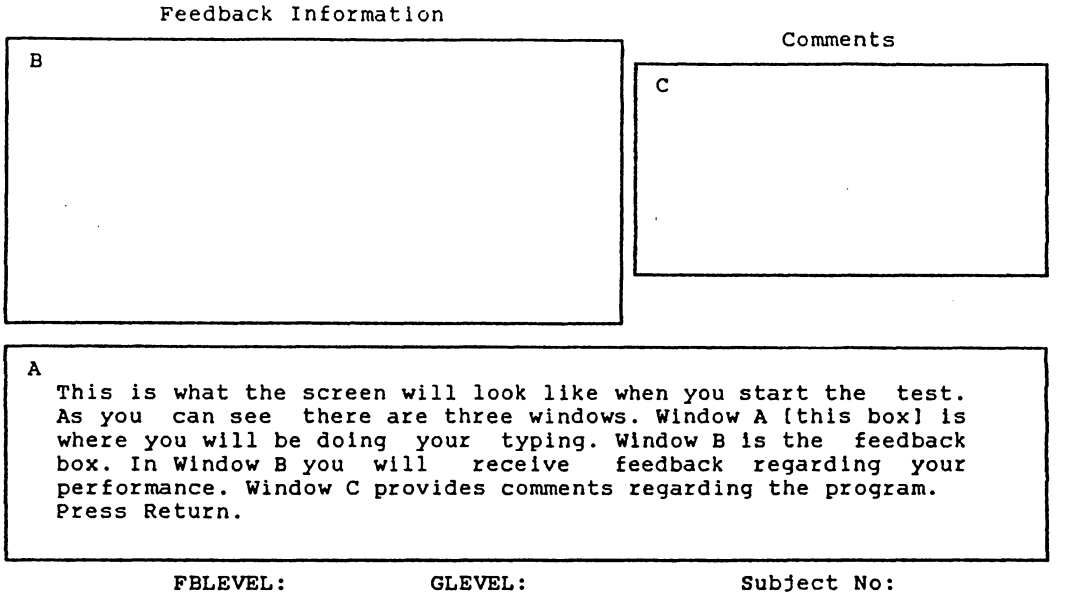
Right or Left Handed? _____

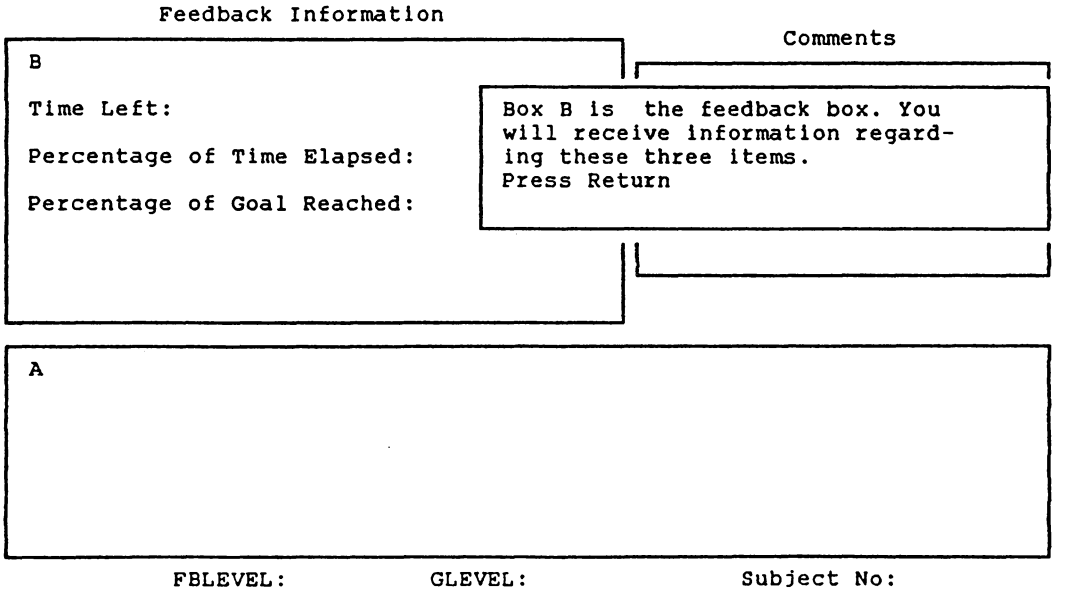
Have you ever had a job where you used a number pad? (e.g., data entry, check processor, book keeper, etc) _____.

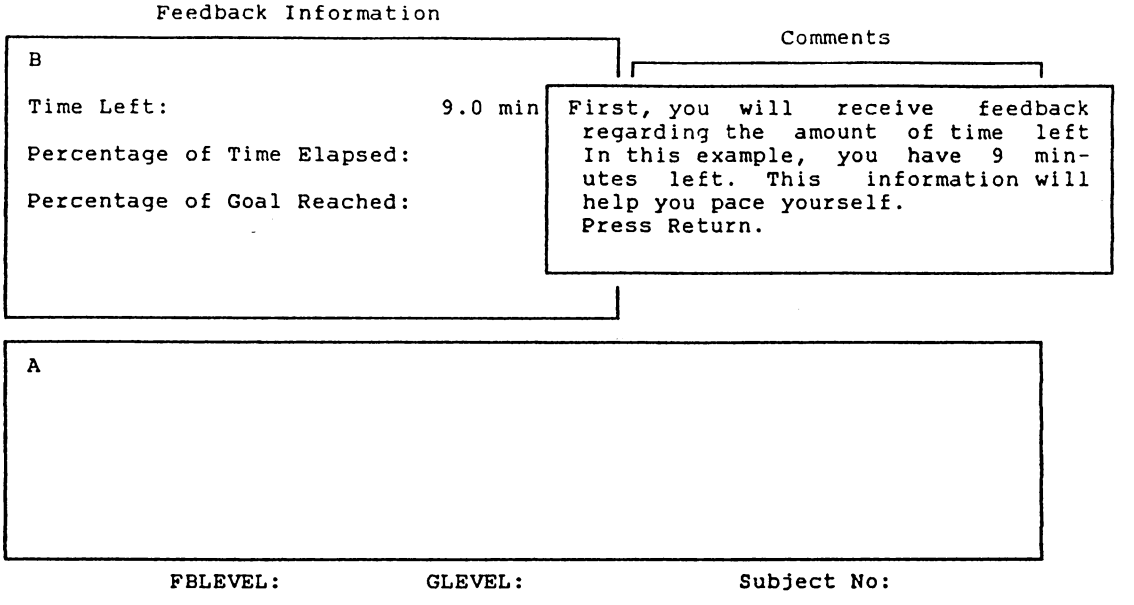
You will receive 2 credits for your participation.

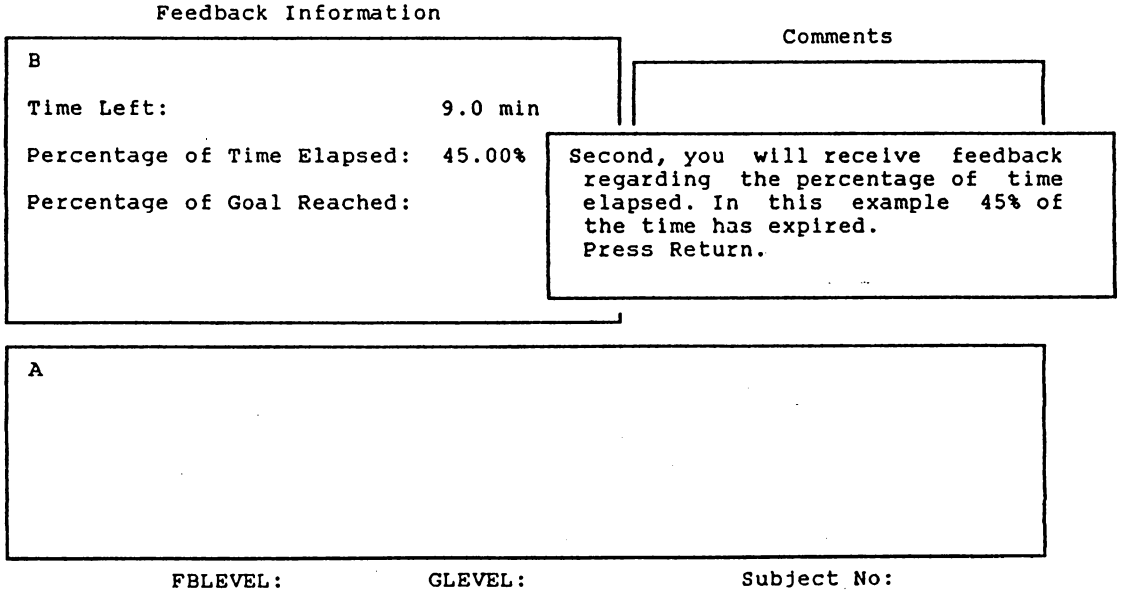
Appendix B

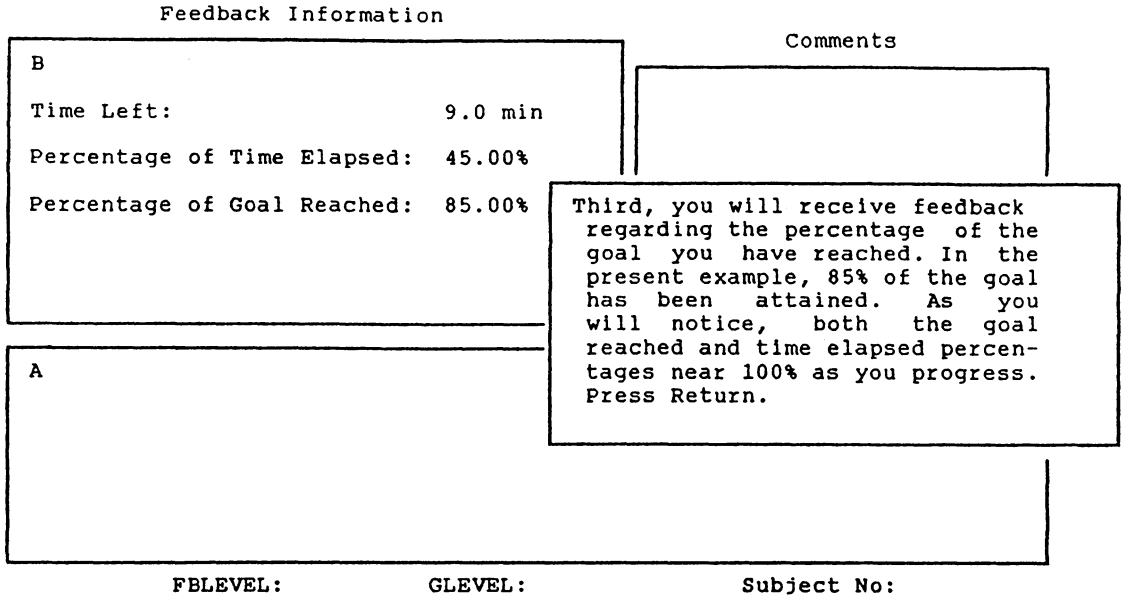
Feedback Tutorial Screens

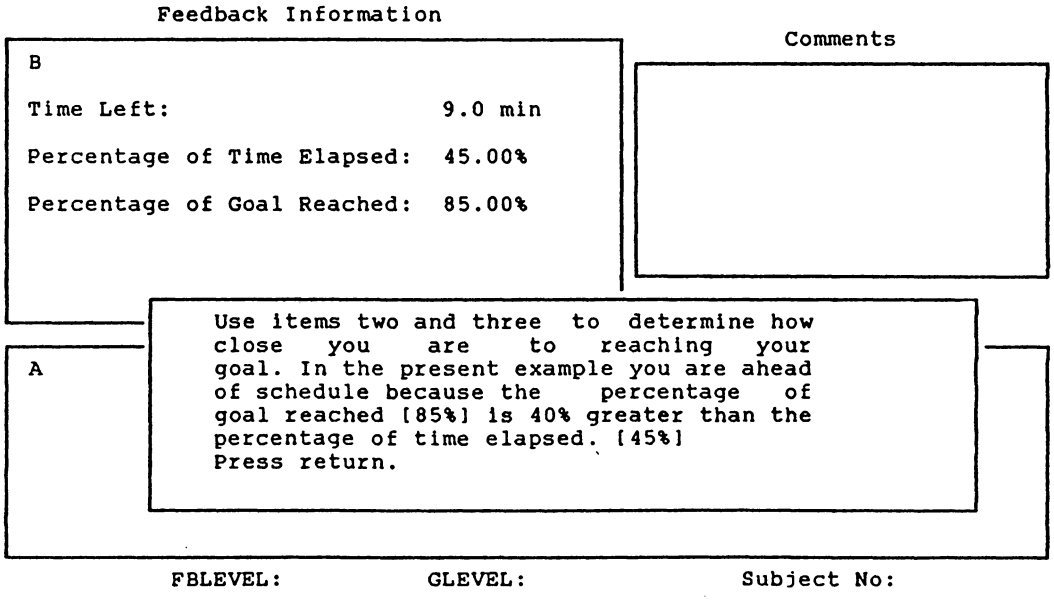

Feedback Information
B
Comments
C
A
This is what the screen will look like when you start the test. As you can see there are three windows. Window A [this box] is where you will be doing your typing. Window B is the feedback box. In Window B you will receive feedback regarding your performance. Window C provides comments regarding the program. Press Return.
FBLEVEL:
GLEVEL:
Subject No:

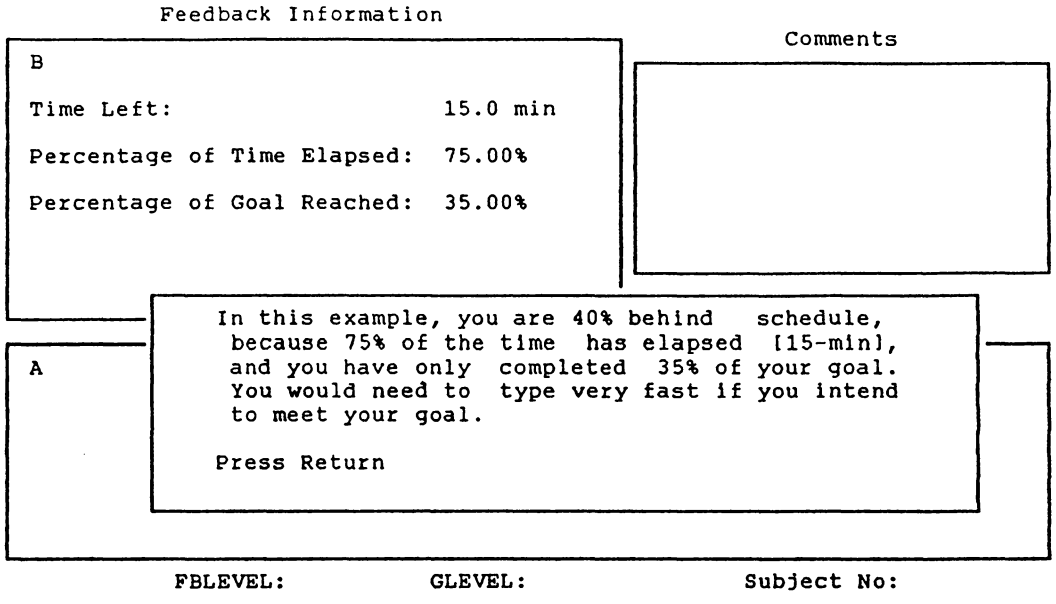

Feedback Information
B
Time Left:
Percentage of Time Elapsed:
Percentage of Goal Reached:
Comments
Box B is the feedback box. You will receive information regarding these three items.
Press Return
A
FBLEVEL:
GLEVEL:
Subject No:

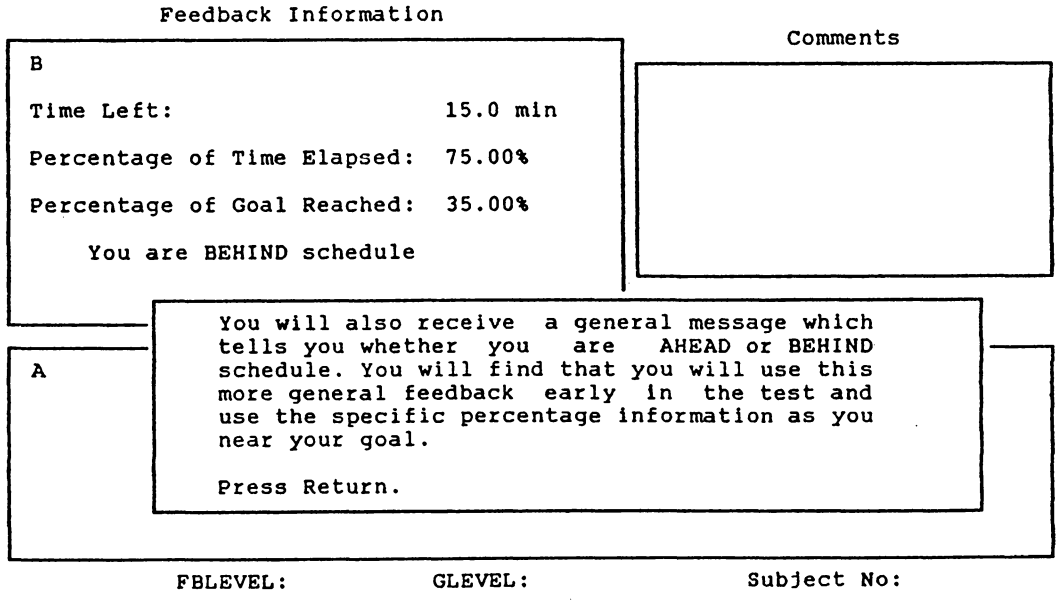

Feedback Information
Comments
B
Time Left: 9.0 min
Percentage of Time Elapsed:
Percentage of Goal Reached:
First, you will receive feedback regarding the amount of time left In this example, you have 9 minutes left. This information will help you pace yourself.
Press Return.
A
FBLEVEL:
GLEVEL:
Subject No:

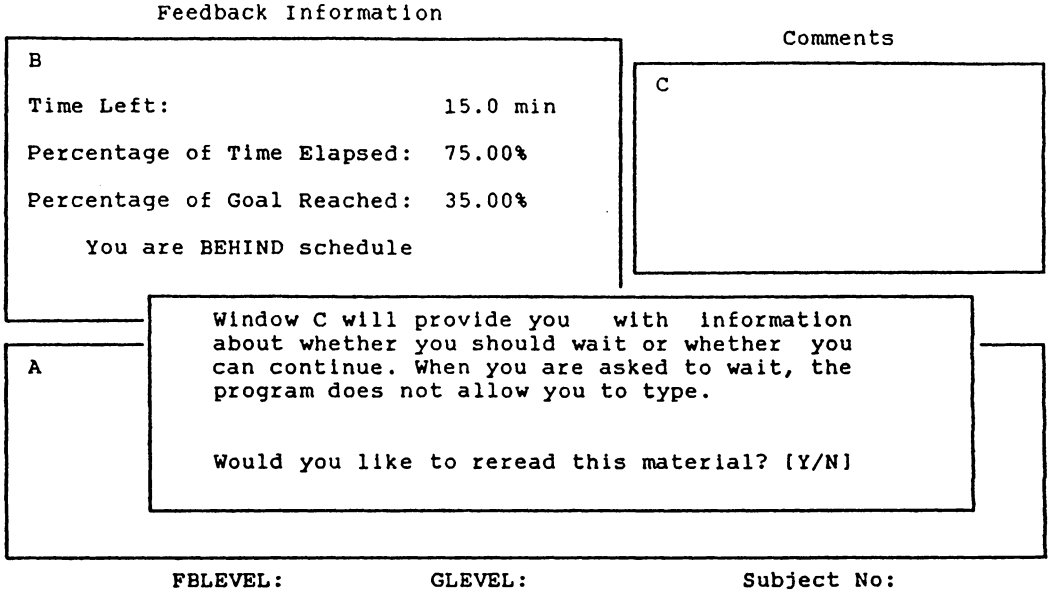

Feedback Information
Comments
B
Time Left: 9.0 min
Percentage of Time Elapsed: 45.00%
Percentage of Goal Reached:
Second, you will receive feedback regarding the percentage of time elapsed. In this example 45% of the time has expired.
Press Return.
A
FBLEVEL:
GLEVEL:
Subject No:


Feedback Information
Comments
B
Time Left: 9.0 min
Percentage of Time Elapsed: 45.00%
Percentage of Goal Reached: 85.00%
Third, you will receive feedback regarding the percentage of the goal you have reached. In the present example, 85% of the goal has been attained. As you will notice, both the goal reached and time elapsed percentages near 100% as you progress. Press Return.
A
FBLEVEL:
GLEVEL:
Subject No:


Feedback Information
Comments
B
Time Left: 9.0 min
Percentage of Time Elapsed: 45.00%
Percentage of Goal Reached: 85.00%
Use items two and three to determine how close you are to reaching your goal. In the present example you are ahead of schedule because the percentage of goal reached [85%] is 40% greater than the percentage of time elapsed. [45%]
Press return.
A
FBLEVEL:
GLEVEL:
Subject No:


Feedback Information
Comments
B
Time Left: 15.0 min
Percentage of Time Elapsed: 75.00%
Percentage of Goal Reached: 35.00%
In this example, you are 40% behind schedule, because 75% of the time has elapsed [15-min], and you have only completed 35% of your goal. You would need to type very fast if you intend to meet your goal.
Press Return
A
FBLEVEL:
GLEVEL:
Subject No:


Feedback Information
Comments
B
Time Left: 15.0 min
Percentage of Time Elapsed: 75.00%
Percentage of Goal Reached: 35.00%
You are BEHIND schedule
You will also receive a general message which tells you whether you are AHEAD or BEHIND schedule. You will find that you will use this more general feedback early in the test and use the specific percentage information as you near your goal.
Press Return.
A
FBLEVEL:
GLEVEL:
Subject No:


Feedback Information
Comments
B
Time Left: 15.0 min
Percentage of Time Elapsed: 75.00%
Percentage of Goal Reached: 35.00%
You are BEHIND schedule
C
Window C will provide you with information about whether you should wait or whether you can continue. When you are asked to wait, the program does not allow you to type.
Would you like to reread this material? [Y/N]
A
FBLEVEL:
GLEVEL:
Subject No:

Appendix C

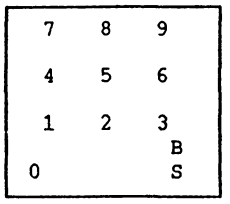
10-min Posttest Typing Screen

Data Processing Test

Please enter the following:

97656 63175 89303 16275

97656



Remember ... You only get credit for correctly typed data!
Do not look at the keyboard. Use the number pad on the screen.

Appendix D

Anagram List

USOTJ	TCAHM	BEODR
UIRTF	SUSEI	OWRNC
INLGF	ACOHR	OUBTA
CUNRI	IUPMO	MPYHN

RUCBS	ROPNA	COANB
KEORP	TAILV	NIACP
AWRLB	UGOHC	

Appendix E

Feedback Questionnaire

Questionnaire

1) It seemed to me that the feedback provided me regarding my performance helped me reach my goal.

1	2	3	4	5
Totally Disagree		Uncertain		Totally Agree

2) I found the feedback for the 35 minute typing task to be disruptive of my performance.

1	2	3	4	5
Totally Disagree		Uncertain		Totally Agree

3) I think the feedback for the 35 min task did more harm than good.

1	2	3	4	5
Totally Disagree		Uncertain		Totally Agree

4) I really enjoyed the 35 minute typing task.

1	2	3	4	5
Totally Disagree		Uncertain		Totally Agree

5) I thought the 35 minute typing task was frustrating.

1	2	3	4	5
Totally Disagree		Uncertain		Totally Agree

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